

NORTHWEST CENTER FOR SMALL FRUITS' RESEARCH

2009 Annual Conference

Welcome to the 18th annual conference of the Northwest Center for Small Fruits Research in Kennewick, WA. 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.

Research Priorities: During the conference, time is set aside to revisit all research priorities by commodity. 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.

Guest Speaker: The guest dinner speaker for the Annual Conference will be Chad Finn, USDA-ARS. His talk is entitled "Traipsing Through Berry Fields on Three Continents".

Congressman Doc Hastings has prepared a video message for this conference which we will be playing during dinner. He has been a strong supporter of the Center and we greatly appreciate his efforts!

TABLE OF CONTENTS

BERRY / GRAPE PROCESSING	3
Effect of Deficit Irrigation and Particle Film on Flavor and Flavor Precursors in Merlot Grape and Aroma Quality of Finished Wine	3
Dehydration of Berry Purees to Produce Value-Added Powders of High Quality for Use in Nutritional Supplements	3
GENETICS	4
Edible-Fruited Honeysuckle (<i>Lonicera caerulea</i> L.): Cultivar Development and Advanced Trial Plots with Growers	4
Evaluation of Wild Black Raspberry (<i>Rubus occidentalis</i>) Populations for Disease Resistance, Fruit Quality and Vigor	4
Breeding Blueberry Cultivars for the Pacific Northwest	5
Response of Black Currants to White Pine Blister Rust Inoculation	5
Evaluation of New Cranberry Germplasm for Fresh Fruit Production in the Pacific Northwest	6
PEST MANAGEMENT	6
Integrated Management Strategies & Biology of Bud Mites in Oregon and Washington Vineyards	6
Characterization and Control of Aphid-Borne Viruses in Red and Black Raspberry Associated With Decline and Crumbly Fruit	7
Characterization and Detection of Viruses Associated With Blueberry Fruit Drop, Blueberry Mosaic and Flower Drop Diseases in Blueberry	7
Evaluation of Nematode Resistant Grape Rootstock for Managing <i>Mesocriconema xenoplax</i>	8
Influence of Sun Exposure on Progress of Grapevine Powdery Mildew Epidemics and UV-A and UV-B on Airborne Spore Population of <i>Erysiphe necator</i>	8
Attraction and Retention of Beneficial Insects Through Enhanced Plant Biodiversity in Irrigated Vineyards (<i>Vitis vinifera</i> L.)	9
Impact of Rootstock-Scion-Virus Interactions on Grape Yield and Quality Attributes	10
Profiling Viruses Associated With Grapevine Leafroll Disease in the Vineyards of the Pacific Northwest	10
Effects of Plant Parasitic Nematode Densities on Grapevine Establishment – Development of Damage Thresholds	11
PRODUCTION / PHYSIOLOGY	11
Practical Implications of the Relationship Between Vigor and Xylem Vessel Anatomy in Grapevine	11
Reducing Leaf Chlorosis of ‘Concord’ Vines: Effects of FeEDDHA and Rootstocks	12
Nutrient Accumulation and Partitioning in Mature Blueberry Plants	12
Weed and Fertility Management of a Newly Established Organic Blueberry Field	13
Storing Cranberry Fruit on the Vine – Impacts on Fruit Physiology, Yield, and Quality	13
Correcting Iron Deficiency in Blueberries	14
Huckleberry and Bilberry Physiology, Development, and Environmental Factors Related to Production Systems	14
Best Irrigation Management Practices for Red Raspberry	15

Particle Film and Deficit Irrigation: Partners to Enhance Wine Grape Quality and Sustainability	15
Trellis Tension Monitor: Tool for Vineyard Sampling and Yield Estimation	16
Understanding and Applying Physiological and Anatomical Adjustments of Grapevine to Identify Drought Resistant Cultivars for Sustaining Grape Production in Drought Conditions	16
Practical Implications of the Relationship Between Vigor and Xylem Vessel Anatomy in Grapevine	17
Changes in Grape Berry Size Due to Late-Season Irrigation	17
Relationship Between Shoot Number and Vigor in Grapevines: Physiological Causes and Practical Implications	18
WINE PROCESSING	18
Development of Value-Added Products from Wine Pomace	18
Understanding Micro-Oxygenation Technique and the Oxidation of Grape/Wine Polyphenolics: Year 3	19
Impact of Specific Amino Acids and Pantothenic Acid on Yeast Metabolism and H ₂ S Formation	19
Rootstock and Scion Influences on Grape and Wine Composition and Quality	20
Impact of Ethanol on the Aroma and Flavor Perception of Red Wine	20
SMALL FRUIT INITIATIVE	21
Evaluation of Small Fruit Germplasm at the North Willamette Research & Extension Center, Oregon State University (Breeding Initiative)	21
Quality Evaluation of Berry Selections and Varieties	22
Small Fruit Breeding for the Pacific Northwest at Washington State University, Puyallup	22
RESEARCH PRIORITIES	
Grape (Table, Wine & Juice) Viticulture Research Priorities	25
Wine Processing Research Priorities	26
Blueberry Research Priorities	27
Cranberry Research Priorities	28
Strawberry Research Priorities	29
Blackberry Research Priorities	30
Red/Black Raspberry Research Priorities	31
New Specialty Crops Research Priorities	32

BERRY / GRAPE PROCESSING

Effect of Deficit Irrigation and Particle Film on Flavor and Flavor Precursors in Merlot Grape and Aroma Quality of Finished Wine

Michael Qian, OSU

Krista Shellie, USDA-ARS

Carolyn Ross, WSU

Chuck Devlin, Winemaker Ste. Chapelle

Dale Jeffers, Skyline Vineyard Manager, Winemakers LLC

The impact of deficit irrigation and particle coating during berry development on Merlot wine volatile composition was investigated in this study. Own-rooted Merlot vines grown in a commercial vineyard in Idaho were supplied with 100 to 35% of their estimated crop evapotranspiration needs throughout the berry development. Wines were produced from those grapes from 2006, 2007 and 2008 growing seasons. Volatile compounds in the wines were analyzed using stir bar sorptive extraction-gas chromatography-mass spectrometry (SBSE-GC-MS) technique. The results demonstrated that despite vintage differences in volatile composition, in each of three years of this study, deficit irrigation during berry development had a consistent effect on wine volatile composition. Wine produced from deficit-irrigated vines had an increased amount of b-damascenone and terpene alcohols relative to wine produced from well-watered vines. Deficit irrigation had no effect on the concentrations of other measured volatiles such as esters. Particle coating had no significant impact on wine volatile composition.

Dehydration of Berry Purees to Produce Value-Added Powders of High Quality for Use in Nutritional Supplements

Kerry Ringer, WSU

James Harbertson, WSU

An important aspect of the nutrition industry is the dried powders made from fruits, vegetables, and plant extracts found in many nutraceutical products. In the nutrition industry, powders are typically made by manufacturers and sold in bulk quantities to companies that then use them in consumer products. A key component that has been severely lacking in this market is economical powders that are also high quality. The majority of puree powders on the market are low quality because they contain high amounts of additives (up to 80%) such as maltodextrin or cornstarch, are heat damaged, or oxidized. In order to address this need for high quality nutritional supplement powders, whole blueberries and strawberries were pureed and low quantities of additives (cornstarch and maltodextrin) were added to the blueberry at 40% weight / weight of solids and no additives were added to the strawberry. The blueberry was dried on a pilot Radiant Zone Dryer (Columbia PhytoTechnology, LLC, Dallesport, WA) and the strawberry was dried on a commercial sized Radiant Zone Dryer, and a pilot freeze dryer (WSU, Pullman, WA). The starting liquid puree and dried powder was analyzed for total phenolics, total anthocyanins, total antioxidant activity, and anthocyanin profile and the data was compared to determine losses on drying. The Radiant Zone dried blueberry and strawberry powders were milled using a commercial sized Quadro-Comil and evaluated for physical characteristics including moisture content, water activity, flowability, and potential for clumping. The freeze dried powder is currently being prepared for similar analysis. Thus far, both modes of drying liquids appear to produce relatively high quality powders that retain nutrients and are suitable for encapsulation or tableting by the nutritional supplement industry. Production of high quality, value-added berry powders using freeze drying and/or Radiant Zone drying may also be a first step in establishing the Northwest as a producer of premium nutritional supplement powders as both of these drying technologies are located at companies in the Pacific Northwest. This type of research provides a use for damaged, bruised, or over-produced fruit that may not be suitable for sale in the fresh and frozen market as well as for berry waste streams from the juicing industry.

GENETICS

Edible-Fruited Honeysuckle (*Lonicera caerulea* L.): Cultivar Development and Advanced Trial Plots with Growers

Maxine Thompson, OSU

Danny Barney, University of Idaho, Sandpoint REC

1. Corvallis site.

Abstract This year major activities were directed towards salvaging potentially interesting seedlings from the research plot on USDA land which will be cleared this coming winter. For a new preliminary trial plot, 155 seedlings were propagated in winter 2009 and additional 25 seedlings were selected this harvest year for propagation in 2010. To accommodate the new selections, an existing plot at my home was expanded. Four hundred hybrid seedlings from 2008 pollinations were planted in the greenhouse and will be field-planted in October, 2009. As a result of placing a bird net over the selection plot accurate yields records were obtained for the first time. In October, 2008, 600 plants were distributed to 23 grower-cooperators

2. Sandpoint site

Abstract. During 2002 through 2007 we selected 27 fruit-bearing and 8 ornamental genotypes of *Lonicera caerulea* (haskap). During 2007 and 2008 we gave some of these selections to private growers for testing. In 2008, we established breeder trial plots at the SREC to evaluate advanced and early selections in randomized, replicated trials. Selections include those made at SREC and some by Dr. Thompson in Oregon. The plots were established partially in 2008, with completion originally scheduled for 2009. Because of the announced possible closure or relocation of the SREC, plans were changed to both continue the already established plots and also to prepare planting material for new plots, should we have to move. The first detailed fruit evaluations are planned for 2011 as plants enter their 4th year in the field. Additional plots will be established during fall, 2009 through spring 2011.

Evaluation of Wild Black Raspberry (*Rubus occidentalis*) Populations for Disease Resistance, Fruit Quality and Vigor

Chad Finn, USDA-ARS

Wild black raspberry (*Rubus occidentalis* L.) populations from across the native range in eastern North America have been evaluated in the greenhouse for resistance to the large raspberry aphid *Amphorophora agathonica*, the principal vector of *Black raspberry necrosis virus* in North America. Four sources of resistance to the aphid have been identified and are being studied. Two of these appear to be controlled as a dominant trait, while the inheritance of the other two is still unknown. In addition, replicated plots from 110 populations and unreplicated plots of an additional 23 populations have been established in the field with 'Jewel', 'Munger', and 'Mac Black' for comparison. These plants are being evaluated for vigor, fruit size, season, and disease resistance in the field over a two year period. The first year of this has been completed and observations will continue next season as well. Initial data show a degree of variation in these traits not observed in current cultivars indicating potentially valuable germplasm for use in breeding.

Breeding Blueberry Cultivars for the Pacific Northwest

Chad Finn, USDA-ARS, NWREC

Bernadine Strik, OSU

Forty-five crosses were planned for Spring 2009 and 41 were successfully made in 2008. The primary goals were to produce seedling populations that had one or more of the following traits: 'Draper'/'Duke' quality fruit throughout the season; late ripening highbush blueberry; Pacific Northwest adapted, late-ripening rabbiteye blueberry; early ripening highbush blueberry, in addition to the common goals of all crosses which are high yielding genotypes with high quality fruit that can ideally be machine harvested. While only a few crosses, we have several selections that fruit very strongly on current season's growth and we intercrossed a few of these to investigate the potential of developing this trait. Roughly 3500 seedlings will be planted this fall as has been done the past two years. Eighteen selections were made in 2008 and, as of mid-July, eight selections and been made in 2009. The selections made last year have been virus tested and propagated for planting into trial in 2010. Selections from 2007 will be planted this fall into observation plots for evaluation. At OSU-NWREC, selections for evaluation from our program and other programs established in Fall 2006 were evaluated for fruit quality this year. An initial evaluation of the selections established in Fall 2007 was made although the plants were too small to harvest. Newer selections will be planted this fall. Three selections from our blueberry breeding efforts are being propagated for commercial trial.

Response of Black Currants to White Pine Blister Rust Inoculation

Kim Hummer, USDA-ARS NCGR

Joseph Postman, USDA-ARS NCGR

Daniel Dalton, OSU

White pine blister rust (WPBR) is an exotic fungal disease that since its introduction has decreased acreage of black currant production in the United States. A wild Asian black currant species was found to be immune to the disease, and three immune progeny ('Consort,' 'Coronet,' and 'Crusader') were released in Canada by 1952, but the fruit of these cultivars are inferior to industry standard black currants for juice production. In an effort to improve fruit quality of WPBR-resistant black currants, 'Consort' was backcrossed with 'Ben Lomond' at the USDA ARS National Clonal Germplasm Repository (NCGR). From this cross, 95 seedlings were field planted in 2005. With financial support from the NCSFR, the seedlings were evaluated for resistance to WPBR in 2007 and 2008. Plants were clonally propagated in the greenhouse to generate material for inoculation treatments. Inoculations were performed using two spore types. Spores were collected from WPBR sources in western Oregon and applied to unrooted single-leaf softwood plantlet cuttings. Inoculated plantlets were individually placed into small polypropylene chambers and incubated inside a large climate-controlled growth chamber. Plantlets were scored weekly to identify susceptible seedlings. In addition to the growth chamber inoculations, rooted plants representing most of the seedlings were also placed in the field under natural conditions of elevated spore concentrations. To determine the inheritance of resistance in the backcross population, three statistical tests were used. Analysis of variance identified a significant effect of treatment date, but no significant effect of spore type. Chi-square procedures indicated that half of the seedlings were susceptible to at least one spore type. The Cochran Q test confirmed that both spore types and also natural field exposure produced disease on a similar number of seedlings. This study provides support that inheritance of immunity to WPBR in black currants is achieved through simple Mendelian segregation of the *Cr* gene. Fifteen seedlings were immune to WPBR and also resistant to powdery mildew, thus providing a broader base of disease resistant black currants for North American production.

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

Kim Patten, WSU

A replicated field planting of advanced selection of cranberries from the breeding program at Rutgers University and elsewhere was established and maintained. Comparisons were made to standard cultivars. Yield, fruit size, color, rot and keeping quality, disease resistance, and suitability for dry harvest parameters were collected for four years. Based on production and other variables, none of the new selections out-yielded Pilgrim. CNJ 44-83, CNJ95-37 and CNJ93-9-42 appear to be the most promising new selections in the trial. BE4 and CNJ95-37 distinguish themselves for fresh fruit potential based on yield and low fruit rot. Of the two new releases, Crimson Queen and Mullica Queen, only Crimson Queen has distinguished itself as a superior cultivar for the fresh fruit production in the PNW. Based on these results, both BE4 and Crimson Queen would be highly desirable new cultivars for both processed and fresh fruit cranberry production in the PNW. BE4 is being renamed Willapa Red and will be available for the industry in 2010. Crimson Queen is currently beginning to be extensively planted by growers. CNJ 44-83, CNJ95-37, and CNJ93-9-42 have been established in new germplasm trials for additional comparisons.

PEST MANAGEMENT

Integrated Management Strategies & Biology of Bud Mites in Oregon and Washington Vineyards

Vaughn Walton, OSU

Glenn Fisher, OSU

Amy Dreves and Angela Gadino, OSU

Short Shoot Syndrome (SSS) is recognized to cause economic losses in vineyards in the Pacific Northwest of the United States. New grower reports of similar symptoms were found in Roseburg (Oregon), Monterey and Sonoma (California) vineyards during 2008 and 2009. The aim of this research was to investigate the causes of SSS found in vineyards in this region. It was hypothesized that SSS are caused by eriophyid mite feeding on young developing tissues and is supported by research during the past three seasons. In order to minimize symptoms caused by eriophyid mites, winter shoot samples were analyzed on an industry-wide basis during 2007 through 2009. Control recommendations were made to growers based on mite incidence. Data from several mite-treated vineyards during 2007 through 2009 show a decrease in mite numbers and damage. Survey work show widespread mite incidence of eriophyid mites in all major West Coast grapegrowing areas. It is however believed that SSS is especially pronounced in the cooler West Coast grapegrowing areas, due to susceptible tissues that are exposed to pest mite populations for extended periods. Rust mite outbreaks are believed to be related to fungicide spray regimes. For this reason future research will focus to develop integrated control practices for eriophyid mites, powdery mildew, and conservation biological control. In order to investigate the impact of often-used pesticides, trials were started in two mite-infested vineyards during 2007 through 2009. Data from 2007 and 2008 shows increased abundance of key biological control agents in blocks which received reduced sulfur applications. Field and laboratory trials are currently in process in order to determine the impacts of often used pesticides on key natural enemies of eriophyid mites.

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

Robert Martin, USDA-ARS, HCRL

Two new viruses have been detected in raspberries and blackberries in the PNW, in addition to Black raspberry necrosis virus (BRNV), which we described earlier in year one of this proposal. We have complete sequence for BRNV and Raspberry leaf mottle virus (RLMV) and partial sequence for the third virus which has not yet been named. The sequence information for BRNV and RLMV suggest they should be aphid transmitted, which has been borne out in greenhouse studies. The sequence for the third virus (Reo-like virus) suggests it should be leaf hopper transmitted, but we have not been able to demonstrate that in greenhouse studies to date. Surprisingly, the Reo-like virus has been transmitted by aphids in the greenhouse. We are continuing to carry out additional transmission studies with various leaf hoppers collected from *Rubus* to see if they will transmit the virus. We have collaborated with colleagues in the UK and their isolates of BRNV lack an *alkB* domain that we have identified in isolates from North America. In initial testing of raspberries from northern WA and the Willamette Valley it appears that RLMV and the Reo-like viruses are spread rapidly in the north and more slowly in the Willamette Valley. This observation fits with aphid as a vector since the aphid populations are much lower in the Willamette Valley than in northern Washington. The sequence obtained for the three viruses has been used to design primers for detection and these viruses are now tested for in the clean plant program run at the USDA-ARS in Corvallis, Oregon. We have started using 'Deep Sequencing' to increase the odds of identifying minor viruses that may be present in the dsRNA extracted from diseased plants. The best news is that with the data obtained from this work and additional work on blackberry viruses in the southeastern US, we have been able to get an SCRI project funded to study the epidemiology of these viruses and vector management. This will be done in collaboration with nematology, entomology and virology groups in our unit and colleagues in AR, CA, MS, NC.

Characterization and Detection of Viruses Associated With Blueberry Fruit Drop, Blueberry Mosaic and Flower Drop Diseases in Blueberry

Robert Martin, USDA-ARS, HCRL

Ioannis Tzanetakis, University of Arkansas

In the past, investigating new diseases in blueberry that were suspected to be caused by viruses was severely hampered by the extreme difficulty in extracting virus-specific double-stranded RNA from *Vaccinium* species. We developed an efficient reliable method for extracting dsRNA from blueberry and other *Vaccinium* species and used this for dsRNA extractions from blueberries exhibiting: Blueberry Fruit Drop (BFD), Blueberry mosaic and a new ringspot diseases of blueberry. We have identified high molecular weight dsRNAs from plants with each of these diseases and are in the process of cloning, sequencing and developing diagnostics for each. For BFD we have completed the sequence of a virus associated with the disease, but have also found this virus in symptomless plants. Thus, the virus we have sequenced may be part of a virus complex that causes BFD or unrelated to the disease. We have also extracted a larger dsRNA from BFD bushes that are being cloned. For the Blueberry Necrotic Ring Blotch (BNRB) we have obtained dsRNA and some sequence. Detection primers have been developed and are being evaluated currently. With Blueberry mosaic we have obtained very low amount of dsRNA and are bulking up the extraction to obtain enough dsRNA for cloning etc.

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

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Vine performance of Pinot noir grapevines grafted onto 5 rootstocks or self-rooted with known differences in susceptibility to ring nematodes was studied under field conditions in microplots to better understand the physiological effects of ring nematode parasitism and to further test durability of resistance of rootstocks. Results indicated that ring nematode populations built up the fastest on self-rooted vines followed by 3309C and 1103P vines, similar to results from prior greenhouse trials. Little to no nematode population growth occurred in 110R, 101-14 and 420A rootstocks during the first two years. However, in year 3 (2008) ring nematodes increased dramatically in 110R and 101-14 rootstocks. Only 420A remained highly resistant to ring nematodes in this trial. The first effect of nematodes on plant or soil variables occurred below ground in year 2. Nematodes decreased root growth and AMF colonization of roots in self-rooted vines and these effects were detected the next year in the other susceptible rootstocks (3309C and 1103P). Nematodes also increased soil respiration in self-rooted vines in year 2. Effects of nematodes on above-ground vine performance were not apparent until year 3 (2008), when shoot length of vines was reduced by ring nematodes in self-rooted vines at bloom and in 3309C vines at veraison. Nematodes did not affect vine nutrient status in a consistent manner, although rootstock treatment did. Nematodes did not alter gas exchange of vines or leaf water potential during the first three years of vine establishment, nor did they affect yield in year 3.

Influence of Sun Exposure on Progress of Grapevine Powdery Mildew Epidemics and UV-A and UV-B on Airborne Spore Population of *Erysiphe necator*

Gary Grove, WSU-IAREC

Markus Keller, WSU

Wayne Wilcox, Cornell

Craig Austin

A fully equipped weather station (Campbell CR-1000 logger) was established in the vineyard having a history of severe powdery mildew infestations. In addition to standard meteorological sensors the station was also equipped with UV-A, UV-B, and UV A + B sensors. The configuration was used to support studies where a volumetric spore trap was continuously operated in order to provide information regarding the population of *Erysiphe necator* conidia in the vineyard air. Meteorological variables were measured every 15 seconds and these values were averaged over 15-minute periods and forwarded to a central collection facility. Conidia were trapped beginning in early June and continued until after veraison. Although more detail statistical analysis are forthcoming with the acquisition of additional data, preliminary correlation analyses indicate a significant relationship between airborne conidia counts and radiation, particularly UV-B. Further data analyses and data acquisition should more clearly define the relationship between solar radiation and spore dispersal. The filtering of UV light reduced disease severity from 43% (regular sunlight) to 28% (filtered sunlight). The effects of leaf-removal experiments were overshadowed by the extreme disease pressure of 2008. The application of Cluster Exposure Flux Availability algorithm indicated interaction between sulfur applications, cluster exposure, and cluster disease severity.

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

David James, WSU

Mercy Olmstead, WSU

Tessa Grasswitz, WSU

Bill Dickard, Ste. Michelle Wine Estates

Ron Dragoo and Rick Hamman, Hogue Ranches

Cover crops offer numerous potential benefits to grape growers, including reduced soil erosion, improved soil fertility, improved soil structure and health, increased traction for machinery, and the attraction and retention of beneficial insects. As such, they can play an important role in the development and implementation of sustainable viticulture practices by placing greater emphasis on biological inputs rather than the chemical inputs that characterize conventional systems. Such approaches are becoming increasingly important in the light of rising production costs and the increasing consumer demand for wines produced using sustainable or organic production practices.

The success of both integrated pest management and organic production is critically dependent on naturally-occurring insect biological control agents. Numerous studies (including some in vineyard systems) have indicated that populations of beneficial insects can be increased by increasing plant diversity (e.g. through cover cropping). A variety of factors can contribute to such increases, including the enhanced availability of nectar and pollen (critical components of the diet of both parasitic insects and some predatory species), increased availability of alternative prey in the cover crop (especially early in the season), and increased shelter for overwintering predators and parasitoids. However, to date, the results obtained with cover crops have varied widely with cropping system, climatic factors and the specific pest complex under consideration. Research targeted specifically at the situation in Northwest irrigated vineyards is therefore urgently needed.

This study examined four different cover crop treatments on key pest and beneficial insects in irrigated vineyards and assessed the agronomic performance of the cover crops to determine the most appropriate species for use in such situations. Emphasis was placed on determining the effect of the cover crops on the populations of key pest species and the beneficials associated with them. The pest species of particular interest included spider mites, cutworms, leaf hoppers, and mealybugs.

The establishment of cover crops varied in each season and in the third year did not establish well enough to provide useful data. In all years, cover crop treatments did not significantly decrease vine or berry growth parameters. Soil nitrogen and phosphorous fluxes were not significantly altered by any of the cover crop treatments, nor were other macro- or micronutrient parameters in the soil after three years of this study. A few key flowering species did establish well enough to recommend to growers, but with increased seeding rates based on this study.

The flowering cover crop treatment resulted in increased beneficial insect populations during the first and second years; however these were not sustained throughout the growing season and as such, did not have a significant impact on the pest population. Some of these key beneficial insects included big-eyed bugs (*Geocoris* spp.), Damsel bugs (*Nabis* spp.) and minute pirate bugs (*Orius* spp.). Pest populations varied between the conventional and organic vineyard sites, with higher levels of leafhoppers in the organic vineyard, but low mite and cutworm populations.

Certain mixes of cover crops can be effective at attracting beneficial insect populations, however their effectiveness depends largely upon establishment of an acceptable stand. This often requires the input of supplemental irrigation within vineyard alleyways.

Impact of Rootstock-Scion-Virus Interactions on Grape Yield and Quality Attributes

Naidu Rayapati, WSU, IAREC

Robert Martin, USDA-ARS, HCRL

Ken Eastwell, WSU, IAREC

The objective of this project is to conduct research to address which rootstocks are most sensitive to graft incompatibility issues when the scions are infected with *Grapevine leafroll-associated viruses* (GLRaVs) and *Grapevine rupestris stem pitting-associated virus* (GRSPaV), and to examine the effects of virus infections x scion x rootstocks on grapevine establishment and longevity and on grape yield components and fruit quality. A research vineyard has been established at the Botany and Plant Pathology research farm at Oregon State University, Corvallis, OR. The Pommard clone of Pinot Noir was grafted on to four rootstocks, namely Couderc 3309, MGT 101-14, 420A and Riparia Gloire as well as self-rooted vines. Budwood from grapevine cuttings infected singly with GLRaV-1, GLRaV-2, GLRaV-3, and GRSPaV have been graft inoculated in May of 2009. The impact of GLRaV-3 on cv. Merlot was studied using grapes collected from paired plants in a grower vineyard in Washington. Three Pinot noir vineyard blocks in Oregon, one with GLRaV-2 plus GRSPaV on rootstock, one self-rooted Pinot noir with GLRaV-3 and one grafted Pinot noir with GLRaV-3 were used to assess the impact of GLRaVs on Pinot noir. The results have shown significant negative impacts on vine performance, grape yield and quality.

Profiling Viruses Associated With Grapevine Leafroll Disease in the Vineyards of the Pacific Northwest

Naidu Rayapati, WSU, IAREC

Robert Martin, USDA-ARS, HCRL

Ken Eastwell and David James, WSU

The Pacific Northwest (PNW) of the U.S., consisting of Washington, Oregon and Idaho, is emerging as one of the country's leading producers of premium wine. Like other viticultural regions around the world, the PNW is also vulnerable to many debilitating grapevine virus diseases. Leaf samples were collected randomly from individual grapevines showing grapevine leafroll disease (GLD) symptoms in Washington, Oregon and Idaho vineyards. These samples were tested individually for different grapevine viruses using a combination of RT-PCR and molecular biology techniques. The results have shown the presence of six different *Grapevine leafroll-associated viruses* (GLRaV-1, -2, -3, -4, -5, and -9), three viruses associated with Rugose wood disease complex (*Grapevine rupestris stem pitting-associated virus* [GRSPaV], *Grapevine Virus A* [GVA] and *Grapevine Virus B* [GVB]) and one virus associated with grapevine degeneration (*Grapevine fanleaf virus* [GFLV]) were documented in several wine grape cultivars. Mixed infections of these viruses in different combinations were detected in a single grapevine. Among the GLRaVs documented, GLRaV-3 was found to be the most prevalent. Our results also revealed the presence of other grapevine viruses as mixed infections with GLRaVs in grapevines showing GLD symptoms. The outputs of this project have been deployed in the virus-indexing program at the Northwest Grape Foundation Service at WSU-IAREC, Prosser, for the supply of 'clean' planting materials to promote sustainability of the wine grape industry in the region. The project has disseminated information for increased awareness of different viruses prevalent in wine grapes among industry stakeholders and regulatory agencies.

Effects of Plant Parasitic Nematode Densities on Grapevine Establishment – Development of Damage Thresholds

Ekaterini Riga and Markus Keller, WSU

J. Pinkerton, USDA-ARS

The purpose of this project was to evaluate the effect of one root knot and two dagger plant parasitic nematode densities (*Meloidogyne hapla*, *Xiphinema pachtaicum* and *X. americanum*) on vine establishment on Chardonnay and Cabernet Sauvignon; and to develop nematode damage thresholds for the above varieties during the vine establishment period in Washington and provide growers with knowledge that will lead to appropriate management practices. A field site in WSU-IAREC, Prosser site was fumigated with Telone II in the fall 2006. Thirty gallon pots were buried and filled with Telone fumigated soil and each pot was additionally fumigated with Metam Sodium. In spring 2007, half of the pots were used for the root knot nematode trial, *Meloidogyne hapla*; in spring 2008, 2/3 of the remaining pots were infected with the dagger nematodes, *Xiphinema americanum* and *X. pachtaicum*; and in spring 2009 the remaining 1/3 of the pots were infected with the high densities of *Xiphinema americanum* and *X. pachtaicum*. Pots were infested with low, medium and high densities of *M. hapla* nematode densities or left as non-infested controls; and pots were infested with low, medium and high densities of dagger nematodes. Rooted cuttings of Chardonnay or Cabernet Sauvignon were planted immediately after infesting the soil with nematodes. All treatments have 7 replicates per nematode species, nematode density and grape variety. Soil samples from all pots inoculated with *M. hapla* contained nematodes in all three years. The data shows significant difference amongst the two grape varieties infected with *M. hapla*. So far, there is indication that Chardonnay grapes are more susceptible to *M. hapla* than Cabernet Sauvignon. The final set of nematode data including berry weight from the *M. hapla* trial will be collected in October 2009. The final set of data from the dagger nematode trials including berry weight will be collected in 3 years.

PRODUCTION / PHYSIOLOGY

Practical Implications of the Relationship Between Vigor and Xylem Vessel Anatomy in Grapevine

Bhaskar Bondada and Markus Keller, WSU

It is well known that vigor differs tremendously among different cultivars of wine grapes resulting large differences in fruit yield and quality. We hypothesize that differences in vigor are related to differences in xylem vessel anatomy. Morphometric analysis was performed at three different positions (basal, top, and distal portions) along the length of the shoot. The cross-sectional area (41.84, 11.71, and 3.24 mm²), thickness of bark (410, 284, 210 μm), and length of xylem parenchyma cells (1.78, 0.70, and 0.28 mm) were highest at the basal portions followed by middle and distal portions. The cross-sectional area of pith was lowest at distal portions (0.71 mm²) followed by basal (3.13 mm²), and distal portions (3.86 mm²). The number of vessels per xylem wedge did not vary among the three portions of the shoot. However, the total number of vessels per total cross-sectional area was greatest in the distal portions followed by bottom and middle portions. Xylem size (lumen diameter) progressively declined as the shoot tapered towards the apex. The diameter of the lumen of the largest vessel element was greater in the basal portions than either in the middle or distal portions. Since xylem hydraulic conductivity is proportional to vessel lumen diameter, the hydraulic conductance is expected to be greatest at the bottom and lowest at the top of the shoot. As per this analogy, vigorous vines are likely to grow with increased xylem density and vessel lumen size compared to a non-vigorous vine. In future studies, we will examine such a relationship in grapevines grown with different vigor levels and explain the mechanisms of vigor control.

Reducing Leaf Chlorosis of 'Concord' Vines: Effects of FeEDDHA and Rootstocks

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Many 'Concord' vineyards in central Washington are plagued by a leaf chlorosis problem that occurs around bloom. It significantly reduces vine size, vine uniformity and productivity, and even causes vine death. Our previous work has shown that 1) chlorotic leaves from WA vineyards have significantly lower active Fe compared with green leaves whereas total leaf Fe is the same or even higher; 2) high soil pH induces leaf chlorosis in Concord vines; 3) leaf active Fe content is a better indicator of Concord vine Fe status than total Fe. This project is a continuation of the work. The objectives were to determine the effects of FeEDDHA (a chelated form of Fe) and different rootstocks on reducing leaf chlorosis. A field trial in central WA over 3 years clearly showed that FeEDDHA application significantly decreased the degree of canopy leaf chlorosis; and 2) Concord vines grafted onto 3309, 5C and 110R had better growth, higher photosynthesis and less chlorosis than the own-rooted vines at high soil pH (7.6). Although the performance of different rootstocks needs to be confirmed under field conditions, our findings on the effect of FeEDDHA application and rootstocks on reducing leaf chlorosis will help Concord growers mitigate the chlorosis problem in central WA vineyards, and rootstocks that are tolerant of high soil pH may provide a long-term solution to the leaf chlorosis problem.

Nutrient Accumulation and Partitioning in Mature Blueberry Plants

Bernadine Strik, OSU

Dave Bryla, USDA-ARS, HCRL

The objectives of this study were to: 1) determine the concentration of nutrients (N, P, K, Mg, Ca, S, B, Mn, Zn, Cu, Fe) in blueberry plant parts (roots, crown, 1-, 2-, and 3-year old wood and leaves) throughout the growing season and winter over two years; 2) assess seasonal and yearly changes in plant part dry weight and nutrient concentrations to determine total nutrient uptake and partitioning; 3) calculate daily nutrient uptake of blueberry to determine peak demand amount and time; and 4) determine the impact of nitrogen fertilization on the uptake and partitioning of other plant nutrients.

A mature planting of 'Bluecrop' planted at 1.2 m in the row with 3 m between rows at the NWREC was used. Treatments studied were: 0, 100, or 200 kg N/ha over each of two years. One plant per plot was destructively harvested on each of 11 dates from winter 2002 to winter 2004. Plants were randomly selected per plot and were dug from the field to a depth of 50 cm and partitioned into their parts: flowers, fruits, shoots, leaves, 1-year-old, 2- year-old, and = 3-year-old wood, crown, small roots, and large roots, depending on the stage of development. Each part was dried to a constant weight. A sub-sample of each tissue was ground and analyzed for tissue nutrient content.

Weed and Fertility Management of a Newly Established Organic Blueberry Field

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A new research planting was established at the NWREC, Aurora, OR in Oct. 2006 on a silt loam with a soil pH of 4.9 and 3.7% organic matter. Treatments included: cultivar (Duke or Liberty); planting on flat ground or raised beds; fertilization with either fish emulsion or feather meal (at 29 or 57 kg/ha N); and weed management systems (sawdust mulch and hand weeding; compost plus sawdust mulch and use of flaming or acetic acid; and weed mat). The planting was certified organic in May 2008. Data were collected through the first two years of establishment (2007 and 2008) and are continuing for the third growing season (2009). In general, soil water content was lower through the season on raised beds than on flat ground, especially under weed mat (which increased soil temperature as much as 5 °C); this system thus required more irrigation water to maintain adequate soil moisture. Weed presence was not high in 2007, never exceeding 20% coverage. Weed mat plots had the fewest weeds whereas compost plus sawdust mulched plots had the most in both years. Acetic acid, applied every 3 weeks during the warmer months, worked well in 2007; flaming was added in 2008, but hand weeding was still required in both years in all treatments. GreenMatch was added as a weed management tool in 2009. In Oct. 2007, total plant dry weight (DW) was higher in Liberty than Duke, raised beds than flat ground, and with fish emulsion than with feather meal but was not affected by weed management system. Root DW was greatest in Duke and lowest in plants receiving 57 kg/ha N as fish emulsion when grown under weed mat. In Oct. 2008, treatment effects on total plant DW were similar to what was observed in 2007. Root DW in Duke was not affected by planting on raised beds, but was greater in plants grown with the organic mulches and fertilized with 29 kg/ha N of fish emulsion. In Liberty, the greatest root DW was in plants with compost plus sawdust mulch and fertilized with 29 kg/ha N of fish emulsion, while leaf area was greatest in plants grown on raised beds with sawdust mulch and 57 kg/ha N of fish emulsion. In 2008, yield was greater in Liberty than in Duke and on raised beds compared to flat ground, and fish fertilizer produced more yield than feather meal. Fruit firmness was affected by cultivar, mulch type, and raised bed production, whereas fruit weight was only affected by cultivar. In conclusion, our results to date indicate that after the first two growing seasons, production on raised beds and fertilization with fish emulsion, at either rate, led to greater plant growth, regardless of mulch treatment. Weed mat was very effective at preventing weeds from growing compared to the organic mulch treatments, even though higher amounts of irrigation water were required.

Storing Cranberry Fruit on the Vine – Impacts on Fruit Physiology, Yield, and Quality

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Ron and Mary Puhl

Oregon and Washington harvest over 60 million pounds of cranberries per year. Currently, the majority of the Oregon fruit is sent to the processed market; however, the interest by growers in the fresh fruit market is increasing as the price for fresh fruit is significantly higher than for processed fruit. Due to the nature of the Oregon climate, cranberries can be harvested very late in the season – potentially into December. This “late harvest” may be advan-

tageous to growers of fruit for the fresh market by increasing certain fruit quality parameters and post-harvest storage life; however, growers need recommendations on when to harvest to optimize fruit quality.

The objectives of this study are to 1) determine the effect of storing fruit on the vine (delaying harvest) on the post-harvest storage life of fresh cranberry fruit; 2) ascertain the effect of storing fruit on the vine on fruit yield and quality (color, acidity, sugar content), and the incidence of fruit disease or decay; 3) model the development of cranberry fruit size, dry weight, percent soluble solids, total acidity, total anthocyanins, and total phenols through the season, including past the "traditional" harvest period, on growing degree days over two years; and 4) measure the impact of nitrogen fertilization rate on the N concentration of fruit and fresh fruit storage life and quality.

Cranberry fruit were harvested from a 'Stevens' bed from July through December in 2007, and from the same bed, applying three nitrogen rates, 30, 50 and 70 lbs./A from July through December in 2008. In both years, fresh fruit weight peaked in early October, however, °brix, and total anthocyanin content peaked in mid-November. Fruit quality parameters, such as berry firmness, size, and weight, were significantly higher at the low nitrogen rate. Storing fruit at room temperature for 3 weeks significantly, and negatively, impacted the percentage of fruit rot, berry weight and firmness. Based on the current results of this study, Oregon cranberry growers may safely harvest cranberries late in the season with few negative impacts to fruit quality.

Correcting Iron Deficiency in Blueberries

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Nonnie Bautista and Eduardo Chavez, OSU

Two commercial blueberry fields (one in Silverton, Location 1 and one in Salem, Location 2) were selected to use FeEDDHA application to correct Fe deficiency symptoms in 2007. Four FeEDDHA treatment concentrations, 0 (being the control), 0.5, 2.5, and 5.0 ppm FeEDDHA were applied on the soil surface at 20 ml per square feet around plant crown area. Such treatments were arranged in a randomized complete block design with 5 replications for the two experimental locations. Soil pH concentrations were also obtained for each of the treatment. Leaf samples were taken before and after a month of application of the FeEDDHA for foliar Fe analysis. Thus far, we have determined the growth parameters of treated plants in both locations and no significant effect of FeEDDHA on plant growth were observed. In our pot study started in late spring 2008, we have found soil applied FeEDDHA have potential to increase yield and overcome iron chlorosis in 'Duke' blueberries.

Huckleberry and Bilberry Physiology, Development, and Environmental Factors Related to Production Systems

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U.S. Forest Service

This project was to be carried out primarily during Dr. Barney's sabbatical leave, scheduled for April through September 2009. Due to possible closure or relocation of the Research & Extension Center at which Dr. Barney is superintendent, he requested a one-year, no-cost extension of the project. The Required U.S. Forest Service permit is approved, as is a one-year delay in the sabbatical leave. In the interim, the huckleberry and bilberry cultivar development program has continued, as has work on model production systems.

Best Irrigation Management Practices for Red Raspberry

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Two studies were initiated in 2005 to identify irrigation practices that maximize yield and reduce problems with fruit and root rot. In one study, 'Meeker' and 'Coho' raspberry were irrigated by sprinkler or subsurface drip with optimum, excessive, or inadequate amounts of water; excessive and inadequate irrigations were included to determine the consequences of over- or under-irrigating the crop. In the other study, six varieties, four summer fruiterers and two fall fruiterers, were irrigated with one of three different drip lateral configurations, including one surface lateral per row suspended from a trellis wire, one buried lateral per row located near the center of the planting bed, and two buried laterals per row located on each side of the planting bed. Last year (2007) was the first year of full production. Overall, yields were good, averaging 5.4-7.0 ton/acre in the various treatments. Subsurface drip produced higher yields and larger fruit than sprinklers, which was attributed to less water stress with subsurface drip during harvest (study 1). Yield and fruit size were also higher when plants were irrigated with one line of surface or subsurface drip than with two lines of subsurface drip (study 2). Yields were much lower in 2008, averaging only 2.0-4.0 ton/acre in study 1 and 1.5-3.1 ton/acre in study 2. The lower yields this past year were attributed to usually cool spring and summer temperatures and to increased incidence of root rot. Interestingly, root rot was largely unaffected by irrigation method and the amount water applied and instead appeared largely affected by field position, where plants located in the lowest part of the field were most affected. Drip placement also appeared to have little effect on root rot. Information gathered during the study will be used to advise raspberry growers and consultants on the advantages and disadvantage of using various irrigation systems, especially with regard to increasing production and reducing problems with root and fruit rot disease.

Particle Film and Deficit Irrigation: Partners to Enhance Wine Grape Quality and Sustainability

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Irrigation is a production tool used to cultivate wine grapes in arid climates to beneficially control canopy size and enhance berry components associated with wine quality. Grape vines provided with less water than needed for optimum growth have smaller, less dense canopies and more clusters that are exposed to potentially damaging solar radiation. The objective of this research was to evaluate whether foliar application of a commercially available, clay particle film could reduce the incidence of solar injury to the berry and enhance water use efficiency when vines were grown under a water deficit. Field trials at two sites in southwestern Idaho were used during the 2008 growing season to maintain differential levels of water deficit and spray half of the vines within each plot with a clay particle film. Results from the prior two years of this project suggested that particle film enhanced vine water use efficiency only under well-watered conditions (Fig. 1) and did not prevent surface browning on exposed fruit located on the west side of the canopy. A greater correlation between berry soluble solids and titratable acidity (Fig. 2) and between berry fresh weight and yield (Fig. 3) were observed on vines with particle film, suggesting that the film may increase uniformity of fruit maturity within a harvest and the crop load carrying capacity of the vine. Vine water status throughout the growing season was not influenced by particle film (Table 1) but the particle film increased daily net leaf gas exchange by an amount that varied according to vine water status. The same irrigation and particle film treatments were applied in the 2008 growing season as previous years, but in addition to these treatments, the crop level of half of the control and half of the sprayed vines under each level of water deficit was reduced by half to test whether the net increase in daily leaf gas exchange increased vine carrying capacity. In 2008, irrigation amount was found to significantly affect berry weight at harvest, fruit maturity, yield, cluster number and harvest cluster weight. Crop load had a significant effect on harvest

cluster weight and vine yield. Application of particle film affected cluster weight and must soluble solids at harvest differently depending on vine crop load and the level of water deficit. The average cluster weight at harvest was increased by the particle film if the vines were well-watered, but was decreased by the particle film if the vines were under water deficit. The particle film increased must soluble solids content at harvest for vines with the high crop load but either had no effect or lowered the solids content of vines that had 50% lower crop load.

Trellis Tension Monitor: Tool for Vineyard Sampling and Yield Estimation

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In the 6 years prior to the funding of this project, we developed a method for monitoring crop development in vineyards and for predicting yield automatically, which we dubbed the "Trellis Tension Monitor" (TTM). The TTM involves direct measurement of tension in the trellis wire by load cells. The TTM offers continuous information about crop growth in a way that previously did not exist, and an alternate or supplemental way to estimate yield from traditional (hand-sampling) methods. This grant contributed to our completion of data collection in two research vineyards and 12 test sites in commercial vineyards. In combination with USDA-ARS CRIS funds and industry grant funds, we post-processed, statistically analyzed, interpreted, and published results from a portion the 71-TTM, multi-year dataset that produced about 2.5 million data points per year. During years 1 and 2 we accomplished two goals that are critical precursors to commercialization of the TTM: 1) demonstrate the dynamics of canopy growth and assess the potential for "correcting out" canopy weight from TTM data; and 2) demonstrate the accuracy of the TTM for vineyard yield estimation in a direct comparison with the methods followed by major Northwest juice processors. The outcome of accomplishment #1 is a new approach to setting the season's initial, or reference tension value, which will make interpretation of the tension curves more straightforward for growers, processors, and wineries. The outcome of accomplishment #2 was demonstration that in an objective assessment, the TTM generally outperformed industry yield estimation procedures.

Understanding and Applying Physiological and Anatomical Adjustments of Grapevine to Identify Drought Resistant Cultivars for Sustaining Grape Production in Drought Conditions

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Having no qualified graduate student and delayed funding precluded us from initiating this project. Notwithstanding such obstacles, we used potted vines of Cabernet Sauvignon, Grenache, and Zinfandel prepared earlier to collect preliminary data on physiological and anatomical drought adaptive features for identifying drought resistant cultivars. ABA levels decreased with increasing water levels. As expected, stomatal conductance increased with increasing soil moisture levels. In a similar pattern, leaf water potential was highest at the highest soil moisture levels. The leaves followed reticulate venation pattern in which veinlets circumscribed small areas of mesophyll known as areola confining free vein endings of different density. Between the two cultivars, Zinfandel and Grenache subjected to two water regimes (42% and 29% soil volumetric water content) Zinfandel appeared to be more tolerant to low moisture levels as indicated by their high stomatal conductance. After hiring a qualified graduate student, these features will be reexamined with more rigorous experiments using all three cultivars. Along with all the physiological measurements, anatomical measurements including surface morphology, leaf anatomical parameters, amount of wax, and vein density will be measured in all three varieties and identify drought resistant cultivars.

Practical Implications of the Relationship Between Vigor and Xylem Vessel Anatomy in Grapevine

Bhaskar Bondada, WSU

Markus Keller, Chateau Ste. Michelle, WSU-Prosser

The proposed research was supposed to start in April, 2007. However, we could not initiate it on time due to delay in funding and most importantly unavailability of a full time graduate student. We recently hired a graduate student who will be starting her MS degree this Fall. Notwithstanding obstacles, we used field grown grapevines to collect some data on xylem anatomy. We measured the xylem anatomy of current season shoot at different positions, i.e. top, middle, and bottom. Xylem vessel (tube) density and size (diameter) of the vessel lumen were greatest at the bottom of the shoot. Xylem density and size progressively declined as the shoot tapered towards the apex. On the contrary, the size of the pith followed an opposite trend, it was greatest at the top of the shoot. In the basal part of the stem (total cross-sectional area, $17.91 \pm 2.3 \text{ mm}^2$), the area occupied by the pith was $2.10 \pm 0.11 \text{ mm}^2$, the number of vessels between any two rays averaged about 12.45 ± 3.60 , and the average diameter of the vessel averaged about $58.23 \pm 23.65 \mu\text{m}$. In future studies, xylem anatomy of trunks, cordons and current season shoot (stem) at different intervals varying in vigor will be examined.

Changes in Grape Berry Size Due to Late-Season Irrigation

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Bhaskar Bondada, WSU

In premium wine production, fruit quality is considered to be far more important than crop yield, and small berry size is deemed desirable. There is a widespread belief in the wine industry that rain or irrigation close to harvest may increase berry size and cause a 'dilution' of solutes (sugars, acids, anthocyanins, tannins, etc.) or even cracking (splitting) of berries. In Europe this belief is often written into the law, and irrigation is prohibited or strictly regulated. Even in the New World wineries may encourage growers to withhold irrigation water at this critical time to avoid any perceived adverse effects. In juice grapes, on the other hand, excessive water is often applied in an attempt to maximize berry size. However, both withholding irrigation water and overirrigating in the arid inland Pacific Northwest is risky, because excessive water deficit or supply may not only have the opposite effect, namely reduced fruit quality, but may also compromise canopy efficiency and thus cold acclimation, bud fruitfulness (next-year productivity), and vine longevity. Moreover, it is unclear whether the suspected change in berry volume is due to water uptake by the roots and transport to the berries via the vascular system or due to direct absorption of water through the berry skin. This research focuses on berry water uptake in relation to berry anatomy and final berry size. We use pot-grown grapevines of very different genetic makeup (Merlot and Concord) to study the effects of soil moisture independently from those of air humidity. Berry diameter is monitored continuously during dry-down and rewatering cycles. In addition, root pressure is applied to force water up the vine in order to test whether this simulation of excessive soil moisture will increase berry size. When the berries approach maturity, intact clusters are immersed in water to determine changes in berry volume due to water absorption through the skin. At harvest, fruit is assessed for basic quality attributes in relation to berry size. In addition, we use dye tracers and microscopy to study if water can flow back from the berries to the vine at various stages of berry growth and ripening.

Relationship Between Shoot Number and Vigor in Grapevines: Physiological Causes and Practical Implications

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Bhaskar Bondada, WSU

Viticulturists learn as one of the basic principles of their trade that grapevine shoot vigor is inversely related to the number of shoots per vine. This fact is then applied to various pruning strategies, whereby increasing the number of buds retained during winter pruning is expected to decrease vigor. Although competition with berry growth and ripening is often said to be the culprit for the decline in vigor (after all, more shoots usually translate into more potential crop), this is far from clear, since most of the shoot growth occurs before fruit set, especially where vines experience seasonal water deficit. Moreover, vines with greater shoot numbers are believed to be more vulnerable to water stress. In this project we are testing the hypothesis ('hydraulic limitation' hypothesis) that one major reason for the shoot number/vigor relationship may be the physical limitation (resistance) to water transport through the vine that is imposed by its 'plumbing layout' (i.e. arrangement, size and length of xylem conduits). Field-grown Merlot grapevines were pruned to a range of bud numbers varying from 10 to 120 to generate a wide range of shoot numbers per vine. The physiological performance and growth patterns of these vines are currently being assessed. So far we have found no significant differences due to shoot numbers, but it is too soon to draw any firm conclusions before the end of the growing season.

WINE PROCESSING

Development of Value-Added Products from Wine Pomace

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John Simonson

Research effort during 08-09 was to determine compositions of some major Northwest wine grape pomace for understanding the nature of the raw materials and to investigate the internal bonding performance of pomaces with binding materials, crosslinking agents, and other functional additives for producing pomace based biocomposite boards using thermo-compression method. Five wine grape pomaces including 2 white wine grape pomace (Morio Muscat and Muller Thurgau) and 3 red wine grape pomaces (Cabernet Sauvignon, Pinot Noir, and Merlot) were evaluated for their basic composition and nutritional content. Morio Muscat and Pinot Noir pomace were thermally formed into biocomposite boards with different binding materials (soy flour (SF), soy protein isolate (SPI), and polyvinyl alcohol (PVA)) at different pomace:binder ratios, crosslinking agent Epichlorohydrin (EPI), and hydrophobic material of stearic acid. The mechanical and water absorption properties of thermally formed pomace boards were measured for identifying the optimal pomace board formulation. Results indicated that white wine grape pomace had significantly high sugar content than red wine grape pomace (>70% TSSC in white pomace vs. <30% TSSC in red white grape pomace), their antioxidant capacity based on DPPH assay were significantly lower (11-17 ACE mg/g dm) than red one (~20 ACE mg/g dm), while there was no significant difference in total phenolics content except a higher number in Cabernet pomace.

Based on the criteria of good mechanical properties and low water sensitivity for desired pomace biocomposite boards, formulation suggested for Pinot Noir based pomace boards is 1:1=SPI:PVA or SF as binder with 9:1=P:B ratio, 1% stearic acid and 1% EPI. For Morio Muscat based board, the optimal formulation was suggested as 1:1=SPI:PVA or SF as binder with 4:1=P:B ratio and 1% stearic acid. These formulations can be applied for other red and wine grape pomace based materials. Further studies to evaluate the carbohydrate profile of pomace, thermal property and biodegradability, as well as the potential application of the pomace are under the way.

Understanding Micro-Oxygenation Technique and the Oxidation of Grape/Wine Polyphenolics: Year 3

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Julie Tarara, USDA-ARS-HCRU

Kerry Ringer, WSU

This study was initiated to better understand the evolution of polyphenolics (focus being proanthocyanidins, also known as tannins). Wine phenolics (tannins, anthocyanins, etc) are crucial factors of red wine that can be altered by grape growing conditions and winemaking practices. Proanthocyanidins play important roles in red wine by stabilizing color and enhancing mouth-feel, which are critiqued qualities of premium wines. By studying the changes that purified compounds undergo in a controlled system (i.e. model wine system, gas doses, etc), it is easier to identify and monitor their progression during winemaking. Controlled oxidation (by continuous oxygenation and UV light) of catechin, purified grape skin proanthocyanidin, and purified grape seed proanthocyanidin that had been dissolved in model wine solutions were compared and monitored. Absorbance was measured at three wavelengths and by phloroglucinolysis, followed by HPLC analysis. The presence of catechol increased the half-life of catechin (monomer), but the opposite was observed in both skin and seed proanthocyanidins (polymers). All monomer and polymer oxidations were dependant on initial solution concentration. As expected, monomer and polymer solutions showed a decrease in measureable phenolics.

Impact of Specific Amino Acids and Pantothenic Acid on Yeast Metabolism and H₂S Formation

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J.C. Bohlscheid, University of Idaho

C.F. Ross and J.Q. Sturgeon, WSU

Synthetic media whose compositions simulate grape musts were prepared to contain either 60 or 250 mg/L "yeast assimilable nitrogen" (YAN) using balanced amounts of amino acids + ammonia. Appropriate amounts of ammonia or specific amino acids (aspartic acid or glutamine) were added to media originally containing 60 mg/L to increase YAN to 250 mg/L prior to fermentation. Fermentations with 60 mg/L YAN or 250 mg/L YAN (ammonia) treatments were somewhat slower compared to fermentations with 250 mg/L (balanced amino acids + ammonia, aspartic acid, or glutamine). While fermentations with 250 mg/L YAN (amino acids/ammonia) produced the least amount of H₂S (62.1 µg/L), the 60 mg/L YAN treatments produced the most (1,630 µg/L). The ferments with 250 mg/L YAN (ammonia) produced roughly half as much H₂S (197 µg/L) as those fermentations with either glutamine (474 µg/L) or aspartic acid (541 µg/L). All treatments produced nearly all of the H₂S within the first nine days of fermentation with the exception of those with 60 mg/L YAN which continuously produced the sulfur-containing molecule. When dryness (<2 g/L residual sugar) was reached, fermenters were placed in a refrigeration room (5°C) to assist in cold settling of the lees prior to being filtered through a 0.8 µm filter. The "model wines" were then bottled using screw-capped bottles and are being stored at refrigeration temperatures (5°C) until amino acid and sensory aroma analyses can be completed.

Rootstock and Scion Influences on Grape and Wine Composition and Quality

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Markus Keller, WSU

Although phylloxera is not an immediate threat to vineyards in Eastern Washington it still remains the most significant threat to vines in the world. No chemical or biological means of controlling the pest exist. Resistant rootstocks have been grafted to achieve not only resistance to phylloxera, but also nematodes. Unfortunately it is not clear if grafted vines under Eastern Washington soil and climatic conditions will have similar fruit composition as own rooted vines. Information on grafted vine performance will be important should the situation arise that grafting is necessary. The objective of this project was to determine the effects of rootstock and scion combinations on fruit ripening and composition at harvest. A field experiment was conducted with three wine grape varieties (Merlot, Syrah, Chardonnay) that were either grown on their own roots or grafted to five different rootstocks (1103-P, 5C, 3309, 101-14, or 140R). There were no consistent effects for anthocyanins, Brix, tannins, acids, or potassium in the fruit at harvest within a variety. All of the wines were fermented to dryness (>2.5 g/L residual sugar). Syrah, which had slightly less sugar correspondingly made wines with less alcohol, while Merlot and Chardonnay were not different from each other. Only the own-rooted Syrah had significantly more alcohol than the other rootstock scion combinations. For Merlot no significant differences were observed with the own-rooted trending slightly higher while with Chardonnay only the own-rooted and 1103 P were significantly (but slightly) lower than the other rootstock scion combinations. The pH of the wines was typically lower than in the previous vintage ranging from pH 3 to 3.3. Within a cultivar wines made from own-rooted vines tended to be greater in pH than their counterparts but not significantly. There were no significant differences in the wine TA's within a cultivar, between cultivars or with the different scion rootstock combinations. Suggesting the observed differences in pH were not indicative of the overall sourness of the wine, which based on our results should be fairly similar. At pressing the results show that Merlot has significantly more tannins than Syrah but also significantly less anthocyanins. Own-rooted Syrah and own-rooted Merlot greatest tannin concentrations were significantly different from some of the other combinations. For anthocyanins there were differences between cultivars and some differences observed between scion-rootstock combinations. Most of the differences were inconsistent with the exception of the own-rooted Syrah and Merlot having the greatest amount of anthocyanins present in the wine although only Syrah was the only wine significantly so. Thus the findings show primarily small difference in wine and grape composition between own-rooted and grafted vines. The inherent differences between cultivars were also observed. After two years of work the differences observed between own-rooted and grafted vines appear to be subtle. It is inconclusive at this stage but speculatively it seems that rootstocks should pose no immediate problem in terms of the most abundant classes of compounds including sugar, organic acids, tannins, anthocyanins or potassium in both grapes and wine.

Impact of Ethanol on the Aroma and Flavor Perception of Red Wine

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Charles Edwards, WSU

The objective of the current research is to examine the impact of alcohol (ethanol) and its interaction with other wine matrices and flavor and aroma compounds on the chemical and sensory properties of red wine. The specific objective in 2008/09 was to examine the impact of watering back/saignee technique, used to alter alcohol concentration, on the resulting properties of the wine. To achieve this objective, Merlot wines were made in November 2008. The harvest date was intentionally late to allow the grapes to reach a higher °Brix but not too late as to avoid freezing of the grapes. The grapes were ultimately harvested at 26°Brix. Following harvest, three treatments were applied. Treatment 1 was the wine prepared using standard winemaking practices (control; 26°Brix) while Treatment 2 involved the wine watered back to 22°Brix. Treatment 3 watered the wine back to 22°Brix, with sucrose added until the original Brix level (26°Brix) was reached. Chemical analysis of the wines prepared using the three

treatments showed no significant differences in alcohol concentration, residual sugar, TA or pH. Using a same-different test, sensory results indicated that untrained panelists were not able to distinguish between the three treatments. When wines were evaluated by a panel of 86 consumers for acceptance of appearance, aroma, flavor, mouthfeel and overall acceptance, no significant differences were observed. Finally, gas chromatography/mass spectrometry (GC/MS) analysis revealed similar volatile profiles between the three treatments. Taken together, these results indicated that watering back did not significantly alter the chemical or sensory profile of the wine suggesting that this method is an effective method to treat winegrapes with a high °Brix. However, these studies were conducted on young red wines. Future studies will evaluate these wines following 1 year of ageing as well as the preparation of Cabernet Sauvignon and a second vintage of Merlot using the three treatments in 2009.

SMALL FRUIT INITIATIVE

Evaluation of Small Fruit Germplasm at the North Willamette Research & Extension Center, Oregon State University (Breeding Initiative)

Bernadine Strik, OSU, NWREC

Chad Finn, USDA-ARS

All aspects of a breeding program are being conducted including parental selection, crossing, selection and testing for strawberry, blackberry, raspberry and blueberry. Recently under this project, seven new strawberry cultivars (Independence, Firecracker, Tillamook, Pinnacle, Valley Red, Puget Summer, and Stolo), three genetically thornless blackberries (Black Diamond, Black Pearl, and Nightfall), four trailing blackberries especially suited to the fresh market (Siskiyou, Black Butte, Obsidian, and Metolius), two thorny erect primocane fruiting blackberries (Prime-Jan and Prime-Jim), a primocane-fruiting raspberry (Chinook), five summer-bearing red raspberries (Coho, Lewis, Esquimalt, Saanich, and Cascade Bounty), and two blueberries (Chandler and Pink Lemonade) have been developed or co-developed and released. The trailing blackberry, Black Diamond, was the highest selling blackberry cultivar in three of the last five years. 'Tillamook' accounted for 30% of the production and value of strawberry harvested in the Pacific Northwest in 2007. While the strawberry cultivars will be grown primarily in the PNW, the raspberry, blackberry, and blueberry cultivars are grown in many other production regions in North America and the world. Appropriate cultural practices for optimum yield and quality of advanced selections and new cultivars have been researched and established. In 2007, the total estimated impact of cultivars released since 2001 in this program is about \$20 million for the PNW including fruit sales and plant nursery sales. This impact increases to \$24 million when including cultivars we co-developed with other breeding programs and to \$42 million when including all cultivars released from this cooperative program (including those prior to Finn and Strik). From 2005-07, 'Obsidian' and 'Siskiyou' were compared in 30" and 5' every year (EY) and alternate year (AY) production systems. Yield of 'Obsidian' was higher than that of 'Siskiyou' in 2005-2008. In 'Obsidian' and 'Siskiyou', yield at the higher planting density, 30" in the row, has been about 10 to 20% higher – an economic analysis is needed to see if this would be economical. 'Siskiyou' has been less cold hardy than 'Obsidian', yielding significantly less in 2 of the 4 years, particularly in EY systems. Thus AY production has led to a more consistent yield in 'Siskiyou'. In both cultivars, berry size was reduced in AY plots compared to EY plots. The following cultivars are being evaluated in machine-harvest production systems of 30" AY and EY and 5' AY and EY: ORUS 1431-1, planted May 2003; 'Nightfall', June 2005; 'Black Diamond', May 2003; and 'Black Pearl', May 2006.

Quality Evaluation of Berry Selections and Varieties

Brian Yorgey and Yanyun Zhao, OSU

Chad Finn, USDA-ARS

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 2006. Basic chemical data were collected on strawberries, raspberries, blackberries, and blueberries for several harvest dates throughout this period. Samples were frozen and will be 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.

Small Fruit Breeding for the Pacific Northwest at Washington State University, Puyallup

Patrick Moore, WSU

Wendy Hoashi-Erhardt, WSU

This project will develop new processing red raspberry cultivars adapted to the PNW that are machine harvestable. Additional traits to incorporate into new cultivars are RBDV resistance and root rot tolerance. The project will also develop new strawberry cultivars adapted to the PNW that have higher picking efficiency than current industry standards. Additional traits to incorporate are: fruit firmness and disease resistance.

Once raspberry seedlings are selected, they are then planted in small plots with a cooperating grower and evaluated for machine harvestability. Selections that appear to machine harvest well are tested for yield, fruit size, and fruit firmness in replicated trials at WSU Puyallup, and also evaluated for susceptibility to root rot and raspberry bushy dwarf virus. Selections with several promising traits are propagated into quantities suitable for grower trials. In 2009, a new machine harvesting planting was established with 102 WSU selections and two cultivars, which will be machine harvested and evaluated in 2011 and 2012. Additionally, the 2006 machine harvesting planting was evaluated for the second season, and the 2005 planted was evaluated for the first time in 2009. Promising selections in each planting were identified as a result. Among the 16,700 raspberry seedlings evaluated at WSU Puyallup in 2009, 113 preliminary selections were made. Several of the selections made in 2008 were planted in both the 2009 machine harvesting trial and replicated plots at Puyallup. This will result in a more rapid evaluation of these selections. Additional observations of root rot and RBDV susceptibility have led to the identification of some selections that are machine harvestable, root rot tolerant and RBDV resistant.

Ongoing strawberry breeding work is focusing on parents with large fruit size, firm fruit and high productivity. Twenty-nine selections were made in 2009 among the 4,300 seedlings planted in 2008. These selections will be propagated for planting in yield plots in 2010. Plants of a very large, productive, good-flavored selection were propagated via tissue culture and were planted with six cooperating growers in Oregon and Washington. Plants were also distributed to a commercial propagator for multiplication for grower trials with dormant plants to be planted in 2010.

NCSFR RESEARCH PRIORITIES FOR 2009-2010

Revised December 2008

Any **[Bold and Bracketed]** text indicates
proposed revisions by the referenced organization
for 2010-2011

NORTHWEST CENTER FOR SMALL FRUITS RESEARCH

Grape (Table, Wine & Juice) Viticulture Research Priorities for 2009-2010 funding Revised December 2008

- 1) Physiological disorders which may include berry shrivel; bunch, stem and inflorescence necrosis; short shoot syndrome; fruit set problems.

Evaluation of scions, rootstocks for cold hardiness, vigor, water requirements, effect of edaphic factors, nutritional status, yield parameters, and grape quality attributes. Soil, biological and chemical below ground environment.

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

Development of integrated/sustainable production systems

Organic production

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

Biology and management of powdery mildew, viruses and vectors, mites, nematodes, cutworms, mealy bug, leaf hoppers, Asian lady beetle, Botrytis and sour rot.

- 2) Yield Estimation/Modeling/Yield Prediction

Biology and control thrips, crown gall, weeds, Glassy-winged Sharpshooter, and Eutypa fungal disease

Evaluation of new and lesser known winegrape varieties and clones

- 3) Phylloxera and cane borer

Biodynamic production

NORTHWEST CENTER FOR SMALL FRUITS RESEARCH

Wine Processing Research Priorities for 2009-2010 funding Revised December 2008

- 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.

Managing fermentations to optimize wine quality
 - I. Yeast/bacterial interactions
 - II. Reductive character
 - III. Yeast and bacterial spoilage organisms
 - IV. Stuck/sluggish fermentations
 - V. Tannin management in the winery and vineyard
 - VI. Color and aroma
 - VII. Micro nutrition status

- 2) Sustainable winery practices
 - VIII. Winery waste management
 - IX. Utilization for value added products
 - X. Organic processing

- 3) Ethyl carbamate

Processing Technology (high pressure, filtration)

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

NORTHWEST CENTER FOR SMALL FRUITS RESEARCH

Blueberry Research Priorities for 2009-2010 funding Revised December 2008

- 1) Spotted Wing Drosophila (Emergency Addition October 2009)
 - Birds and other vertebrate control
 - Plant breeding/variety evaluation, including but not limited to
 - extend/shift harvest windows
 - suitability for mechanized harvesting
 - cold hardiness
 - fruit quality
 - disease resistance
 - Pollination issues
 - Organic production systems (including both horticultural and pest management issues)
 - Improve or extend fresh market through controlled atmosphere storage and packaging, mechanized harvesting, physical covers or chemicals, post harvest handling and cultural inputs
- 2) Fertility management in organic and conventional systems
 - Improved irrigation management/irrigation guidelines
 - Management of viruses
 - Frost protection
 - Biology and management of diseases especially root rot, mummy berry and pseudomonas
- 3) Plant architecture and training systems
 - Biology and management of Insects, especially root weevil, gall midge and winter moth
 - Genotyping
 - Food Safety
 - Methods to reduce cost of labor

NORTHWEST CENTER FOR SMALL FRUITS RESEARCH

Cranberry Research Priorities for 2009-2010 funding Revised December 2008

- 1) Cultivar Identification
 - Weeds
 - Soil borne pests (cranberry girdler and root weevil)
 - Organophosphate alternatives
 - Renovation and new planting systems (H2O use efficiency)
- 2) Irrigation for frost and heat protection and pesticide delivery
 - Sanding alternatives including sand use in new plantings
 - Pollination/fruit set
 - Tipworm
 - Fresh fruit keeping quality
- 3) Nutrient and fertilizer management
 - Dieback
 - "Monkey face" – physiologic disorder?
 - Market expansion through nutraceuticals/health
 - Effect of harvest date on fruit physiology and quality

NORTHWEST CENTER FOR SMALL FRUITS RESEARCH

Strawberry Research Priorities

for 2009-2010 funding

Revised December 2008

- 1A) Spotted Wing Drosophila (Emergency Addition September 2009) [**OSC: Move to 1E.**]
- B) Explore alternative production models for economic efficiency (e.g. tunnels, day neutral varieties, plasticulture, harvest efficiency, irrigation management, increased yield and cultivar management)
- C) Accelerate the introduction and commercialization of promising selections [**OSC: Move to 1D**]
- D) Develop cultivars with processed and fresh market potential, including earlier and later ripening cultivars [**OSC: Add "and accelerate the introduction and commercialization of promising selections"**]
- E) Biology and management of insects and arthropods, (e.g. root weevil, aphids, mites, lygus, symphylans)
[**OSC: Change to Biology and management of "Spotted Wing Drosophila and other" insects and arthropods, (e.g. root weevil, aphids, mites, lygus, symphylans)**]
- F) Biology and management of diseases, (e.g. powdery mildew, fruit rots, root rots, viruses, etc.)
- 2A) Nutritional/Nutraceutical benefits [**OSC: Move up to list of #1's**]
- B) Development of research programs to define and enhance strawberry quality related to marketability
- C) Weeds
- D) Food safety/sanitation/security
- E) Value added products
- 3A) Robotics
- B) Irrigation management
- C) Vertebrate pest management

NORTHWEST CENTER FOR SMALL FRUITS RESEARCH

Blackberry Research Priorities

for 2009-2010 funding

Revised December 2008

- 1A) Spotted Wing Drosophila (Emergency Addition September 2009)
[ORBC: New chemistries and management techniques to address newly emerging pests (e.g. Spotted Wing Drosophila), harvest contaminants and problems stemming from the loss of long-standing insecticides and nematocides (e.g. raspberry crown borer, strawberry crown moth, leafrollers, redberry mites).]
- B) Breeding cultivars that are summer bearing, thornless, high-yielding, winter hardy, machine harvestable, disease resistant, and that have superior fruit quality
- C) Biology and control of diseases (e.g. botrytis, purple blotch, dry cell syndrome)
- D) New chemistries to address harvest contaminant and other problems stemming from the loss of long-standing insecticides and nematocides (e.g. raspberry cane borer, strawberry crown moth, leafroller, redberry mites). **[ORBC: Move to 1A.]**
- E) Weed control of hard to control perennials (e.g. thistle, bindweed, quackgrass and equisetum)
- F) Water and nutrient management
- 2A) Develop and improve cultural, chemical and biological practices to improve cold hardiness
- B) Improving the viability of fresh market production through the use of tunnels, season extension techniques and/or methods for improving fruit shelf life.
- C) Understanding soil ecology and soil borne pathogens and their effects on plant health and crop yields
- D) Improved methods of primocane management in every year cropping systems for increasing yields and/or lowering labor costs.
- E) Development of genetic marker technology for varietal identification
- 3A) Thorn management and reduction systems
- B) Raspberry Bushy Dwarf Virus in blackberries
- C) Fruit composition and nutraceutical properties

NORTHWEST CENTER FOR SMALL FRUITS RESEARCH

Red/Black Raspberry Research Priorities

for 2009-2010 funding

Revised December 2008

- 1) Spotted Wing Drosophila (Emergency Addition September 2009)
WRRC & ORBC: Evaluation of the life cycle, economic impact, and management tactics of the Spotted Wing Drosophila]

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

Understanding soil ecology and soil borne pathogens and their effects on plant health and crop yields

Optimal soil fumigation techniques and alternative

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

Fruit rot including pre-harvest, post-harvest and/or shelf-life
- 2) Product and production certification systems – food safety and security, standards, traceability

Mite control [**WRRC: Mite management]**

Weed control [**WRRC: Weed management]**

Nutrient/irrigation management

Management of viruses and crumbly fruit
- 3) Season extension: improve viability for fresh marketing, protection of fruit shelf life

Management of foliar and cane diseases

Vertebrate pest management

Value added and health promoting raspberry product
[WRRC: Nutraceutical/Nutritional benefits for product development]

Labor saving cultural practices, mechanical pruning and tying techniques