Northwest Center for Small Fruits Research

2004 Annual Conference

Welcome to the 13th annual conference of the Northwest Center for Small Fruits Research in Boise, Idaho. 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 Rod Cook, President and CEO of Producer Marketing Corporation. His talk is entitled "Move It or Lose It, The Challenges of World Competition."

General Session Speaker: Our speaker for the General Session will be Ulrich Orth, OSU. He will be speaking on Small Fruits Marketing Research.

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BERRY / GRAPE PROCESSING

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

Subtitle for 2003-2004 research:

Antifungal coatings on fresh strawberries (Fragaria ananassa) to control mold growth during cold storage

S-I Park, S.D. Stan, M. Daeschel, and Y. Zhao* (PI) - Dept. of Food Science and Technology, OSU

Chitosan (2%) or hydroxypropyl methylcellulose (HPMC) (1%) based coatings were applied on fresh strawberries to evaluate their antifungal efficacies against *Cladosporium* sp. and *Rhizopus* sp. Potassium sorbate (PS) was also incorporated into the coating formula to measure any synergistic inhibitory effects on mold incidence. Strawberries were inoculated with *Cladosporium* sp. or *Rhizopus* sp. in a level of ~10^3 Log CFU/g, coated with 2% chitosan, 2% chitosan containing 0.3% PS, or 1% HPMC containing 0.3% PS, and stored at ~5°C and ~50% RH up to 23 days for determining the growth of mold, yeast, aerobic plate count, and coliforms. To assess antifungal activity of the coating materials *in vitro*, coating solutions were embedded into agar plates and the diameter of radial mold growth were measured after inoculation. In addition, the weight loss of coated strawberries and water vapor permeability of the coatings were measured. Results showed that there was no significant synergistic inhibitory effect between chitosan and potassium sorbate on fungal growth on fresh strawberries. However, significant synergistic inhibition activity was observed *in vitro* test when potassium sorbate was added into the chitosan formulation. Antifungal activity of chitosan against *Cladosporium* sp. and *Rhizopus* sp. was not affected by the autoclaving process of coating solutions. Coating treatment also reduced total plate count, coliforms, and weight loss of strawberries during storage.

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

James Kennedy (principal investigator) and Jessica Cortell (Co-principal Investigator) - Department of Food Science and Technology, OSU

Cooperators:

OSU - John Baham, Crop and Soil Science; Anne Connelly, Department of Horticulture; Mike Halbleib, Engineering Department; Tim Righetti, Department of Horticulture; Barney Watson, Department of Food Science and Technology

Red Hill Soils - Andy Gallagher- Precision Soil Mapping

United States Department of Agriculture - Paul Schreiner, Agricultural Research Service, Horticultural Crops Research Laboratory

Red wine quality is highly dependent upon the composition of specific phenolic compounds that provide astringency and color. These phenolics have been linked to positive health benefits of red wine along with other foods. The goals of this project are twofold: 1) to investigate the relationship between differences in the soil/landscape within a single commercial vineyard and how this influences wine composition; and 2) to determine the practical utility of precision agriculture tools including GIS (geographic information systems), GPS (global-positioning systems) and remote sensing techniques in managing vineyard variability and wine composition. Data was collected on soil characteristics, vine growth, fruit composition and corresponding wine chemistry. A

vine vigor index based on trunk circumference, leaf chlorophyll and shoot length was used to delineate zones for production of small-lot research wines. Very large differences were observed in the amount of red color and astringent compounds in wine when the vigor of the vine was reduced; essentially doubling the concentration of wine components across the vigor zones. More importantly, this research indicated that plant growth was related to manageable soil characteristics suggesting that wine composition can be manipulated in the vineyard.

Potential New Crops—Composition and Quality

Ronald E. 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 have been 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 have been completed for blue honeysuckle fruits, PNW Huckleberries, chokeberries, and lingonberries. This information is critical if these crops are to be adopted for use in functional foods and nutraceuticals.

Can *Escherichia coli* and *Salmonellae* Contaminate Harvested Berries and do they Survive in Fresh and Frozen Berry Juices/Purees?

Mark A. Daeschel, Yanyun Zhao and Carol Miles - OSU and WSU

Low pH, high acid foods such as fruit have been traditionally viewed as not being as source for food poisoning outbreaks. However, the appearance of acid resistant strains of pathogens in the 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. This suggests that berries are not a natural reservoir for food borne pathogens. However, this does not eliminate the possibility that post harvest contamination by either human or animal contact could introduce pathogens into berry fruit products.

GENETICS

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

Maxine M. Thompson-OSU

Danny L. Barney-ISU

Evaluation of germplasm introduced from Japan as open-pollinated seeds from Japanese selections has revealed several elite individuals that have been used as parents in breeding in 2003 and 2004. Currrent plantings of progeny resulting from controlled hybridizations are expected to exhibit superior performance as compared to previous plantings of open-pollinated seedlings. Some of these will produce first crops for evaluation next May. This year, several individuals have been identified in both Corvallis and Sandpoint for their outstanding traits such as vigorous shrubs with hIgh yields, large berry size (1.5 to 1.8 gm), attractive, firm fruit, and good flavor. These are being propagated and placed in a selection/cultivar plot for further observations as potential cultivars and for potential use in breeding.

Among 147 berry samples, Brix (soluble solids) values ranged from 5.75 to 13.13 and titratable acids ranged from 1.17 to 5.93. As fruit maturity influenced these values, future analyses must consider this factor. Ten berry samples were chosen for analyses of anthocyanins, total phenolics and anti-oxidant capacity. This work was done in YanYun Zhao's lab and will be reported by her. Each year comparable plantings of seedlings are made in Corvallis, OR and Sandpoint , ID in order to compare performance in two different environments. The Japanese subspecies (emphyllocalyx) appears well adapted to both locations. Evaluations are made on plant vigor, growth habit, dates of bloom and harvest, flower density, estimated yield, crop weights, and berry traits such as size, shape, appearance and taste.

With only the first 2 year's field observations of Japanese plants and fruits, there appears to be excellent possibilites for developing selections with cultivar potential. Within a few years we should have plants worthy of grower trials.

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

PI: Michael Qian

Cooperator: Chad Finn

'Marion' and 'Thornless Evergreen' blackberry aromas were analyzed with dynamic headspace-GC/Osme and aroma extract dilution analysis. 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.

Seasonal variations were also studied. The fruit from three seasons, year 2002, 2001 and 1999 were analyzed. A total of 106 volatiles was qualified in the two blackberry cultivars. In general, some variations were observed in the three seasons, nevertheless, the volatile profile of the two cultivars showed genetically determined patterns. Based on total percentage of FID area, the 'Thornless Evergreen' contains significantly more alcohols, hydrocarbons, and phenols than 'Marion', while 'Marion' contains more acids and esters. When compar-

ing the absolute concentration of volatiles, 'Thornless Evergreen' contains more volatiles than 'Marion' in every chemical class except acids. The most abundant volatiles in 'Marion' were ethanol, acetic acid, hexanoic acid, linalool, 2-heptanol, ethyl acetate and 2- methylbutanoic acid. In 'Thornless Evergreen', the most abundance volatiles are 2-heptanol, ethanol, 2, 3 butanediol, hexanol, a-pinene, octanol, nopol, *p*-cymen-8-ol and ethyl acetate. The total volatile of 'Thornless Evergreen' is about three folds of that of 'Marion'.

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.

Development Of Winter-Hardy Blackberry Through Genetic Engineering

Rengong Meng[1, 2], Tony H.H. Chen[2], and Chad E. Finn[1, 2]

[1]USDA/ARS HCRL; [2]Dept.of Horticulture,OSU

Further experiments were conducted to optimize conditions for *Agrobacterium*-mediated transformation of 'Marion' blackberry. Factors examined included: 1) cocultivation medium (regeneration medium with glucose/ acetosyringone, pH 5.2 vs. regeneration medium, pH 5.7), 2) L-cysteine in resuspension medium and cocultivation medium; 3) shaking time after sonication (30'', 1', 2', 4', 8', 16'), 4) Claforan's concentration (0, 250, 500, 750, 1000 mg/L) on recovery of transformants, 5) gelling agents on T-DNA delivery (phytagel and agar), 5) leaf explant condition for inoculation (TDZ vs. BMM pretreated plantlet for explant material), and 6) inoculation method (2-week old plantlets vs. 3-week old leaf explants). There was no difference in using regeneration medium (pH 5.7) and regeneration medium supplemented with glucose/acetosyringone (pH 5.2) as cocultivation medium. Since there were no differences, the glucose/acentosyringone will be the better option as it also converts the transformed cells into transgenic shoots. L-cysteine in cocultivation medium, but not in resuspension medium, increased the number of transformed cells on leaf explants. Shaking time after sonication had no significant effect on T-DNA delivery. Optimum Claforan concentration was found to be 250-500 mg/L. Gelling agent has no effect on T-DNA delivery. With the hope that using the explant from BMM pretreated plantlet (three-week old) would reduce the occurrence of chimera, putative transgenic shoots have been obtained for further analysis. We also inoculated 2-week old plantlets with *Agrobacterium* cells and then the leaves were placed on regeneration medium to encourage the transformed cells to grow into shoots. Putative transgenic shoots have been obtained for further analysis.

Identifying Blueberry Diversity Using DNA Fingerprints

Peter Boches, Nahla Bassil and Kim Hummer

The objective of this project was to develop additional microsatellite or simple sequence repeat (SSR) markers for blueberry. Previously, we had identified only five reliable and highly polymorphic microsatellite loci and used them for genotyping *Vaccinium*. Additional markers were obtained from two sources in 'Bluecrop': an SSR-enriched genomic library and the remaining EST sequences developed by Jeannine Rowland. Thirty eight of one hundred and twenty six blueberry genomic sequences contained microsatellite repeats indicating 30% enrichment. Thirteen of thirty nine primer pairs designed from SSR-containing sequences amplified a DNA fragment of the expected size while only nine primer pairs generated polymorphic DNA fragments among accessions of *V. corymbosum*. Thirteen additional SSR loci were obtained after screening 44 primer pairs designed from the remaining SSR-containing ESTs. We are using the full set of available markers to genotype a core set of 50 *V. corymbosum* accessions.

Reaction of Red Raspberry Genotypes to Phytophthora Root Rot

Peter R. Bristow, Associate Plant Pathologist and Patrick P. Moore, Horticulturist - WSU, Puyallup Research and Extension Center

The objectives were: 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 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*. Cane growth was evaluated at the end of the first growing season. At Puyallup, Malahat, WSU 1161, WSU 1226 and Cowichan all had over 10% diseased canes and Summit and Newburgh did not have any diseased canes. Data has been collected at Vancouver, but not analyzed yet. Small tissue culture propagated plants of each cultivar and selection were grown in small pots and inoculated by injecting a suspension of the fungus into the soil around the roots. Inoculated and control plants were maintained in a greenhouse. Data was collected for disease symptoms and plant weights, but has not been analyzed yet. This process will be repeated in the greenhouse in 2005.

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

Principal Investigator: Gary A. Moulton, Senior Scientific Assistant - Mount Vernon Research & Extension , 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. Several promising varieties and clones have already been identified and some new ones are being added to the varietal pretest.

The effects of certain grape rootstocks in advancing ripeness, reducing vigor, or improving the quality of grafted wine grape varieties are being tested in a trial comparing Pinot Noir clone 2A 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 and 2003 crops will be evaluated in 2004, and the 2004 crop is currently being harvested.

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

Michael Qian - OSU

Robert Martin - USDA-ARS

To respond with industrial raspberry research priority, we have developed several transgenic raspberry lines with good resistance to RBDV. This study was aimed at evaluation of fruit quality of advanced transgenic

raspberry lines, and comparison of these selections with wild type 'Meeker' cultivar. The research was focused on flavor evaluation including aroma compound identification with gas chromatography/olfactometry-mass spectroscopy of wild type "Meeker', and quantitative comparison of volatile composition and aroma profile of transgenic lines with wild type 'Meeker' raspberry. Our research efforts started with the identification of aroma compound in the wild 'Meeker' raspberry. Seventy-five aromas were identified (some tentatively). The potentially important aroma compounds in wild type 'Meeker' raspberry included 2,5-dimethyl-4-hydroxy-3-(2H)-furanone, hexanal, a-ionone, b-ionone, b-damascenone, c*is*-3-hexenal, methional, *cis*-3-hexenol, linalool, butanoic acid, ethyl 2-methylpropanoate, geraniol, and 4-(*p*-hydroxyphenyl)-2-butanone. In addition, comparison of volatile composition of transgenic lines with wild type 'Meeker' raspberry has been attempted. Preliminary results showed that out of the five transgenic lines, some variations were observed in some lines. It appeared that there were 3 transgenic lines having similar volatile compositions as the wild types. Fruits from 2004 are under study to confirm the results.

Domestication of Western Huckleberries

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

Prior to World War II, huckleberries harvested from the wild represented large, profitable industries in the northwestern United States. Due to increasing labor costs, reduced access to public lands, and declining wild populations, these industries have decreased significantly. Efforts are underway to revive the industry and provide fruit growers with profitable alternatives. We are doing this by developing improved plant materials and techniques for cultivating huckleberries and bilberries, or managing them in wild stands, as is done for lowbush blueberries. This project has produced 13 selections from three species that will be tested as potential cultivars. Forty-one additional selections from three species are in advanced trials. Biochemical analyses have identified the volatile flavor components, anthocyanins, phenolic acids, and other antioxidants for northwest native species, highbush blueberries, and/or half-high blueberries. Soil requirements have been determined and additional soil trials are underway. Trials are also underway to determine optimum light exposure. Seed and in vitro propagation protocols have been developed, as well as techniques for rooting in vitro cultured microshoots and growing the plants to maturity.

PEST MANAGEMENT

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

Lynell Tanigoshi

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. Further-

more, 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.

Biology and Management of Cutworms in Washington Vineyards

David G. 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 and beneficial insects 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.

Biological Control of Spider Mites in Washington Viticulture

David G. 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 2001and 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.

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

Project Year: 2003 first year Project Duration: terminated due to nonfunding

Walter Mahaffee - USDA-ARS-HCRL

Gary Grove - WSU, Irrigated Agriculture Research & Extension Center

Effects of fluctuating Temperature. Several types of experiments where conducted to determine the effects of fluctuating temperature on conidial germination and infection. The experimental design was a randomized block design with supra-optimal temperature/exposure serving as the treatment and replication in time serving as the blocks (three replications were done). Temperatures were randomly assigned to growth chambers for each replication to minimize growth chamber effects and three plants were examined for each supra-optimal temperature/exposure time combination. Plants used in all experiments consisted of greenwood rooted cuttings of Pinot Noir or Cabernet Sauvignon in 10cm x 10cm x 10cm pots filled with Sunshine mix number 3. Plants were maintained disease free in a greenhouse where sulfur was vaporized nightly for 4 hours.

RESULTS AND DISCUSSION

Short exposures to supra-optimal temperatures resulted in significant reductions in infection of grape leaves by *E. necator*. Preliminary modifications to the Gubler/Thomas model, utilizing this data, indicated that the current model algorithms greatly over estimates the risk of infection during July in Washington. The over estimation could result in 1-2 unnecessary pesticide applications.

Regression analysis indicated that a 50% or greater reduction in infection occurred when spores were exposed to =34.5°C (94°F) for = 2 h, and =33°C (91.5°F) for = 6 h . Similarly, exposure to supra-optimal temperatures for 4 h after a period of conducive temperatures resulted in a significant decrease in infection frequency and probably colony death when exposed to =38°C (100°F) for = 4 h . It will be interesting to see how infection is affected under optimal humidity (80%RH). In work with hop powdery mildew we found that high RH reduced the impact of exposure to supra-optimal temperatures. Thus, it is likely that under the low humidity conditions common in Pacific Northwest Vineyards that exposure to supra-optimal temperatures will have a greater effect.

Three Plant Viruses Detected in Nematode Vectors by RT/PCR

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

Tomato ringspot virus (ToRSV) *Tobacco ringspot virus* (TRSV) and *Tobacco rattle virus* (TRV) are transmitted to healthy plants by viruliferous nematodes in the soil. These viruses cause diseases in economically important vegetable and fruit crops and have been controlled with mixed results. As soil fumigants are being phased out or banned because of environmental concerns, interest in alternatives, such as crop rotation to eliminate viruses from nematodes, has increased. To provide new tools to examine the effectiveness of these alternatives, we developed a method for extraction of viral RNA from nematodes, and a sensitive nested Reverse Transcriptase/Polymerase Chain Reaction (RT/PCR) detection assay. The RNA extraction procedure incorporates enzymatic digestion of the nematode cuticle with collagenase, followed by disruption with tiny glass beads. The sensitivity of the RT/PCR assay was optimized by the use of specific primers for RT, use of PCR primers for 3' regions of viral RNA that detect both RNA molecules, and use of nested PCR. This assay has been developed for detection of ToRSV or TRSV in *Xiphinema americanum* or TRV in *Paratrichodorus allius*. With this method, viruses can be detected in nematodes fed on infected plants or from field collected nematodes where the percentage of viruliferous nematodes is unknown. In a comparison, this RT/PCR assay was more sensitive than a

cucumber bioassay that has been used as the standard assay for determining if nematodes are viruliferous. Also, the RT/PCR assay can be completed in two days compared to six weeks for the bioassay on cucumbers.

Differentiation and Detection of Blueberry Scorch Strains

Robert R. 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 120 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 was one new field of BlSV in OR (2004) and one in WA (2003) 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. Much effort this year went into working with grower of the newly identified field with scorch in Oregon to work demonstrate that control can be obtained by combining aphid control with testing. It will take a few more years to successfully eradicate the virus from this field. 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. Two strains of the virus from B.C. have been sequenced and showed about 83% identity at the nucleotide level to the strains sequenced from New Jersey. These two isolates are as diverse from each other as they are from the New Jersey isolates. Sequence information from strains in OR/WA show as much diversity from the New Jersey and B.C. isolates as observed among those isolates. On limited sequencing it appears that the cranberry isolates are about as diverse from the blueberry sequences as they are from each other. It appears that Blueberry scorch is caused by a group of widely diverse strains of a virus. 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. An isolate from blueberry was successfully transmitted to cranberry using the common blueberry aphid, Ericaphis fimbriata, the transmission from cranberry to blueberry is being done by colleagues in B.C.

Organic Management of Raspberry Root Rot

Carol Miles - Extension Horticulturist, WSU Research & Extension Unit; Peter R. Bristow - Plant Pathologist, WSU Research & Extension Center

We conducted two studies at WSU Vancouver Research and Extension Unit on a commercial field of red raspberry *Meeker* to: 1) test organic methods to control root rot; and 2) explore the potential interaction of manure with Ridomil. Biological methods of root rot control were compared to the conventional chemical fungicide (Ridomil) to provide all growers with a means to compare the efficacy of these options for disease management. Study 1 was established in the fall of 1999 and included 7 treatments: *Trichoderma* (T-22); *Gliocladium* (G-41); gypsum; dairy manure; dairy manure inoculated with *Trichoderma*; Ridomil Gold; and an untreated check. Berry yields in plots that received G-41 were moderate in 2000 and high in 2001 and 2002. Although these differences were not statistically significant, there was a promising trend for *Gliocladium* to be as effective as Ridomil to partially alleviate pressure from root rot. In this study the effects due to treatment were overshadowed by a location effect of root rot in the field, and by fall 2002 plants throughout the study area were in severe decline and the study was abandoned. Study 2 was established in 2002 and included 8 treatments: poultry manure; dairy manure; poultry manure + Ridomil; dairy manure + Ridomil; fertilizer + Ridomil; *Gliocladium* (G-41); BioVita; and fertilizer only (control). Throughout the three years of this study, the control plots (fertilizer only) consistently produced the smallest berry yields, but differences in yield due to treatments were not statistically significant. In all three years, plots treated with poultry manure without Ridomil produced the largest yields

of all of the manure-treated plots, as well as the largest 50-berry weights. Plots treated with dairy manure + Ridomil had the second highest yields of the manure treatments. These results suggest that Ridomil activity may be influenced by the type of manure. Biovita and Gliocladium both showed trends of positive influence on raspberry yield. Differences in fifty-berry weights were statistically significant in 2003, but not in 2002 or 2004. Biovita-treated plots produced the largest 50-berry weights in 2003, followed by Gliocladium. These treatments also produced large berries in 2004. Plots treated with poultry manure produced the largest 50-berry weights in 2002 and 2004. Berry yields were smaller throughout the field in 2003 as compared to 2002 and 2004 likely due to freezing rains in the spring. Yields were largest in 2004, and berry weights were highest in 2002. At this time the soil and berry samples have not been assessed for potential pathogen levels.

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

J. L. Parke[1], R. G. Linderman[2], K. E. Hummer[3] and E. M. Hansen[1].

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[2]USDA-ARS Horticultural Crops Research Laboratory

[3]USDA-ARS National Clonal Germplasm Repository

Phytophthora ramorum, cause of sudden oak death and ramorum foliar blight in west coast states and in Europe, has a broad range of natural hosts, including certain *Vaccinium* species. 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 pathogen. Over 165 *Vaccinium* accessions from the National Clonal Germplasm Repository have been tested to date. A wide range of disease phenotypes within the genus has been observed, from highly susceptible to highly resistant. Most *Vaccinium corymbosum* cultivars are relatively resistant compared to some other *Vaccinium* species. Susceptibility is affected by leaf age, time of year, and source of isolate (European genotype vs. N. American genotype). Unlike rhododendron and camellia, artificial infestation of potting media did not result in root infection or the development of above-ground disease symptoms in preliminary tests with *Vaccinium.* Fungicides have been tested for their efficacy in protecting greenhouse-grown plants, as well as wild *V. ovatum* plants as a means of limiting disease spread from infested forests.

Applications of New Pest Strategies in Cranberries

Kim Patten - WSU, Long Beach Research and Extension Unit

Peter Bristow - WSU

On large-scale farm trials, Callisto provided good efficacy for aster, lotus and rushes; fair efficacy for silverleaf, and poor efficacy for yellow weed and false-lily-of-the-valley. No phytotoxicity was noted. Use of diluted vinegar (2 to 5% acetic acid) applied as a soil drench at rates of 10 to 13 l/m^2 just prior to budbreak (mid- to late April) resulted in good control of false lily-of-the-valley (*Maianthemum dilatatum*), but some crop damage was observed. Based on efficacy and crop safety, Matrix and Raptor are two new promising herbicides for cranberries. On large-scale farm trials, Admire provided fair to good control of black-vine weevil. Two supplemental post-fruit set applications of Diazinon were critical for fall fruit worm management. The insecticide clothianidin may be a promising insecticide for cranberry girdler control. The fungicide chlorothalonil was applied on three dates between early July and early August by chemigation (300 gal/A). The volume of rinse water (0, 300, 600, and 900 gal/A) had no impact on the incidence of fruit rot at harvest or after eight weeks of refrigerated storage. This suggests that chlorothalonil, once dry, is not readily washed off. The level of disease control

achieved by chemigation was similar to that obtained with a mist blower (10 gal/A), a carbon dioxide-powered sprayer (30 gal/A) or a hand pump sprayer (300 gal/A). In another field trial, fungicides were applied on different dates to provide protection from fruit-rotting fungi for various periods between bloom and fruit ripening. Chlorothalonil was most effective when applied during June (bloom and early fruit set). Azoxystrobin also reduced the incidence of fruit rot at harvest and after refrigerated storage when applied in July, suggesting that it has some "kick-back" activity. In a variety trial planted in 1994, sand (~2 cm) was applied to one-half of each plot in winter 2000-01 to stimulate root growth and the formation of new uprights in eleven cultivars. Sanding increased upright density in 2003 but had no impact on the incidence of fruit rot at harvest (field rot) or after eight weeks in refrigerated storage (storage rot).

Epidemiology and Management of Plant-parasitic Nematodes in Winegrapes

Ekaterini Riga, Nematologist - Washington State University, 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 and to find alternative methods of controlling nematodes because as of 2007 Nemacur will not be available to growers any more. An additional field experiment was established in 2003 in which organically derived nematicides were applied, on their own and in combination with half the recommended rate of synthetic nematicides. Five-vine plots were arranged in a randomized block design with five replicates. Treatments, rates, and application timing are listed in the proposal: 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 (we are reporting here mid-season nematode densities as after harvest nematode samples will be collected end of October 2004). Plant response was evaluated by fruit and pruning weight (will be collected in winter 2005). Nematicides will be applied and data collected for one 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) There was a great degree of variability in the distribution of nematodes and in vine vigor across the vineyard. Because of this variability, treatment differences between population densities of nematodes (at mid-season) and of fruit yields often were not significantly different. However, consistent trends were observed in both experiments.

2) Nemacur, Vydate, and DiTera treatments produced fruit yields 19 to 40% greater than the control. Highest fruit yields also were harvested in plots treated with Nemacur or Nemacur in combination with one of the biological nematicides.

3) Non-plant parasitic nematode populations (NPPN) at mid-season (August) were the lowest in plots treated with Nemacur and Vydate. The same trend was observed in plots treated with Nemacur or Nemacur in combination with one of the biological nematicides similar trend was observed for the species of plant-parasitic nematodes in plots that received treatments that included Nemacur. Soil samples will be collected after harvest (end of October); the samples will be processed to quantify the nematode population densities by the end of November. The effects of treatments on nematode population densities may be greater at the end of the growing season than at mid-season. These data will be presented at the meeting. A third year field experiment using organic nematicides on their own and in combination with half the recommended rate of synthetic nematicides might yield data that will even out the nematode variability.

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

James R. Fisher and Rebecca Chitkowski

The overall objective for this three-year study (2003 – 2005) is to determine if increased plant vigor and irrigation affect grape phylloxera (GP) establishment, delay the outward appearance of symptoms of GP, and maintain plant health when infested with GP. This study includes a field and greenhouse research design to achieve this objective. The objective for year two was to continue vineyard management, set up greenhouse studies, and collect second year phylloxera. There are two studies, a greenhouse study and a field plot study. For the greenhouse study, grapes were placed under a line drip irrigation system that kept pots with self-rooted grapes at one of 4 moisture levels (0.1, 0.8, 2, and 15 bars). Pots were either infested with 200 grape phylloxera eggs or were not infested. Moisture did not have a significant effect on populations (P = .06), but, those at 2 bars produced a higher number than drier or wetter regimes. In the field study, vigor was regulated with fertilizer (none vs added) and the drip irrigation system Phylloxera numbers were sporadic in the infested pots. However, phylloxera were found on the infested plants but no significant differences in the number of phylloxera per gram among treatments were found. The data are inconclusive at this time as to whether the treatments have an effect on phylloxera populations. In addition to the logistic problems in the greenhouse maintenance that affected plant health and moisture regimes, many aspects of the methodology will be improved. The experimental procedure has been modified for the 2005 study to consider the previous pitfalls.

PRODUCTION / PHYSIOLOGY

Investigation of Potential Climatic and Nutritional Causes of Grape Chlorosis

Joan R. Davenport and Robert G. 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 and within a 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, 2003 and 2004 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 soil and 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.

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 5th 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. 420 A and 5BB imparted the highest vigor and Riparia Gloire the lowest.

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. They also imparted the highest vine vigor.

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 25% of ETc (crop evapo-transpiration) on one side of the root system switched every two weeks (PRD, partial root-zone drying). Each treatment was replicated five times in groups of twelve vines in a complete randomized experimental design.

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. There were no differences in pruning weights and wood carbohydrate reserves during winter dormancy.

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

Julie Tarara[1] and Jorge Perez Peña[2]

[1] USDA-ARS; [2] WSU, Irrigated Agriculture Research & Extension Center

Wine grape growers in the arid parts of the Northwest have adopted “regulated deficit irrigation” (RDI) whereby they deliberately apply less water than the vine would be predicted to use, with a primary goal of controlling canopy vigor to ensure fruit exposure to sunlight, and a secondary goal of reducing berry size to improve the skin:juice ratio in red-fruited varieties. What is not well understood, for example with respect to tannin concentration in the finished wine, is the timing at which one should apply additional water deficits to control berry size while still achieving “good” phenolic profiles in the fruit—those desired by winemakers. We do not yet understand the extent of water deficit that may be applied without compromising photosynthesis and the vine’s ability to ripen the crop. Given the short growing season in the Northwest, both delayed ripening and delay in “hardening off” vines may be unacceptable. Three regimens of deficit irrigation were applied in a commercial vineyard (‘Cabernet Sauvignon’) in eastern Washington. Large enclosures were used to measure vine photosynthesis and water use several times during the season. The water deficits were sufficient to reduce photosynthesis and transpiration versus the ‘standard’ RDI, but they did not delay harvest. It is possible that at lower crop levels (e.g., 4 to 5 t/a), mature vines adjust to water deficit and still produce enough carbohydrates to ripen the crop and supply roots and woody structures.

Alternative Production Systems for 'Marion' Blackberry

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

The objectives of this study were 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; and 3) 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 reached 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 were trained in February, as is more common in the industry to try to avoid cold injury. There were 5 replicates arranged in a randomized complete block design. Plots were 20' long. Plants were not cropped in 2001and primocanes were trained as they grew. In 2002, the 2' and 3' in-row spacing produced 10.0 and 9.3 tons/a, respectively, compared to 7.2 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. In October/November 2003, we had cold temperatures at the NWREC that caused injury to all treatments except the 5' EY where the canes were still on the ground. Thus, the yield of all the AY treatments was reduced to the level of the 5' EY treatment and there was no treatment effect on yield. All treatments produced about 4.5 tons/acre. There was no treatment effect on the number of brambles per kg of machine-harvested fruit in any year.

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

Pilar Bañados and Bernadine Strik, Ph.D graduate student and Professor - Department of Horticulture, OSU

The effect of nitrogen (N) fertilization rate on growth, yield and N partitioning in mature field-grown 'Bluecrop' was studied. Depleted ^{15}N-$(NH_4)_2SO_4$ (ammonium sulfate) was applied in the first year (2002) and non-labeled fertilized in the second year (2003). Three N fertilizer rates (0, 100 and 200 kg N ha^{-1}) and two in-row spacing treatments (0.45m and 1.2m) were studied. The N fertilizer was applied as a triple split (33%:33%:33%) from April through June. Plants were destructively harvested from the field and divided into parts that were analyzed for dry weight, N and ^{15}N concentration (%) and nitrogen derived from fertilizer (NDFF) calculated. Nitrogen fertilization rate had no effect on plant dry weight, but plants at 1.2m were larger than those at 0.45m. Plants fertilized with 200 kg N ha^{-1} had a higher total N content in July and September than unfertilized plants. Percent NDFF increased from 3% in April to 23% in September, with no treatment effect. Fertilizer recovery was initially slow (only 1 to 2% recovery two weeks after the first split), but increased to 23% to 43% in September depending on in-row spacing and N rate. Net fertilizer recovery (the N fertilizer recovered by plants - the N fertilizer present in harvested fruit and leaves at senescence), was higher in plants spaced at 1.5' (24% to 33% when fertilized with 200 or 100 $kg \cdot ha^{-1}$ of N, respectively) than those spaced at 4' (17% regardless of N rate). Yield was not affected by N fertilization rate in either year, but was 35% higher at 0.45m than at 1.2m. Total N harvested in the fruit averaged 12 and 9 $kg \cdot ha^{-1}$ for the 1.5' and 4' spacing, respectively. The amount of fertilizer N harvested in the fruit ranged from 2 to 6 $kg \cdot ha^{-1}$. Fruit from unfertilized plants averaged 0.63 %N whereas fruit from fertilized plants averaged 0.84 and 0.92 %N when fertilized with 100 or 200 $kg \cdot ha^{-1}$ of N, respectively.

Cover Crops to Supply N for Organic Grape Production

Robert G. Stevens and Joan R. Davenport - Irrigated Agriculture Research and Extension Center, WSU

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 were either fall planted for spring incorporation or spring planted for fall incorporation. In addition, controlled plots with and without conventional fertilizer were established to compared with 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) placed within the plots to monitor cumulative N release. Plots were harvested for yield and BRIX to establish baseline data. In 2004, vetch had better establishment and was more competitive in a weedy environment than the yellow sweet clover. Yield and N availability data from the 2004 season is currently being collected and analyzed.

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

Krista Shellie - USDA-ARS

A 1-acre trial was established in spring 2002 within a 30 acre block of *'Merlot'* at Skyline Vineyards (southern Idaho). Weekly irrigations during 2002, 2003, and 2004 were varied in duration to deliver four differing amounts of water: 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. Vine water stress was monitored weekly by measuring midday leaf water potential. Wine produced from each trial plot and grapes were analyzed for quality components. Irrigation treatments began during early stage 1 of berry development, after canopy establishment. Over the three years of this study, yield was consistently lower when vines were irrigated at 35% FVET (~ 5 t/acre) compared to 70% (~6 t/acre) or FVET (~8 t/acre). Despite a large annual difference in yield (4.6, 5.0 and 9.2 t/acres, respectively for years 02, 03, 04), highest vine water stress always resulted in lowest yield. Yield reduction was associated with berry size, cluster weight, and clusters per vine. Fruit harvested from the most water stressed vines (35% FVET and 35-70% FVET) had the highest concentration of total phenols and monomeric anthocyanins and produced wine of greatest intensity. Results from this research indicate that targeted water stress between bloom and veraison reduces berry size and is associated with enhanced quality. Relieving vine water stress after veraison by increasing irrigation to 70% of FVET decreased differences between exposed clusters on opposite sides of the canopy and resulted in more uniform quality. Release from post-veraison water stress (35-70% FVET) also resulted in a similar level of glucose, fructose and tartaric acid as non-water stressed vines (FVET) with similar high levels of total phenols and monomeric anthocyanins as water stressed vines.

Blueberry Performance on Marginal Soils with Short Growing Season Conditions

Cindy A. 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 plant died the first winter. Four of six 'Polaris' plants died and 3 of 6 'Meader' and 'St. Cloud' plants died. Plants began leafing out May 20th, 2002. The 'Northblue' and 'Bluetta' cultivars received a higher winter hardiness rating than the other seven cultivars. Six of the 9 cultivars bloomed the first season after establishment, with an average of 11 flowers per plant (range 2 to 25 flowers per plant). Fruit were present on 'Chippewa' and 'Northblue' plants. Growth/vigor rating showed 'Hardyblue', 'Northblue', and 'Chippewa' as the top cultivars. All plants within the trial have an upward plant habit. The next few years we will determine which cultivars best survive, flower and fruit in the soil and climate conditions found in Camas County.

Dynamics of Grape Berry Growth and Physiology of Fruit Volume Change

Markus Keller, Associate Horticulturist/Viticulturist - WSU

Funding Source: USDA Northwest Center for Small Fruits Research

Grape growers and winemakers often complain about a "dilution of grape quality" or even splitting of berries from volume increase due to late-season irrigation or rainfall. It is unclear whether this change in berry size is due to an increase in soil moisture or to absorption of water directly through the berry skin. We have built two large pressure chambers to pressurize the root system of pot-grown Merlot and Concord vines, enabling us to determine the influence of soil moisture on changes in berry volume. Soil moisture was altered using drip irrigation and drydown-rewatering cycles. In addition, we are using dye to trace water movement in the vines' water-conducting "pipelines" (xylem). We found that pre-veraison berries behaved like leaves, and their volume responded very rapidly and reversibly to changes in soil moisture. Post-veraison berries, on the other hand, responded little to soil moisture. Application of irrigation water after veraison merely prevented weight loss. Post-veraison Concord, but not Merlot, berries split when root pressure was applied, even as late as 30 Brix. We also found that the xylem connection between the berries and the rest of the vine remained intact after veraison, but the berries gradually (with increasing Brix) stopped using this pathway for water uptake. Although our results have direct practical implications in terms of changes in berry volume in response to late-season irrigation, the reason and physiological basis for the observed behavior remain unknown and require further study before they can be fully exploited by growers.

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

Markus Keller, Associate Horticulturist/Viticulturist - WSU

We are investigating both genetic (variety, rootstock) and seasonal effects on grapevine yield formation. In addition, we want to find out if plant hormones (cytokinins) produced by rootstocks can influence flower development and fruit set. We used a modified air-conditioner either during budbreak or during bloom to test the effects of bud or flower cluster temperature on flower and fruit development of field-grown Cabernet Sauvignon. In addition, we are measuring yield formation and fruit composition in a rootstock trial with Merlot, Chardonnay, and Syrah on their own roots or six different rootstocks. A rootstock trial with pot-grown Syrah was also conducted in conjunction with our Australian collaborator to test the influence of root-derived plant hormones on growth and

yield formation. We found that warmer bud temperatures in spring were associated with earlier budbreak, dramatically accelerated shoot growth, improved fruit set, and higher yield. However, berries had slightly lower soluble solids and titratable acidity, and higher pH, while color was unaffected. Cooling clusters during bloom retarded bloom time and cluster development, decreased fruit set, berry weight, fruit soluble solids and pH, and increased titratable acidity, but did not affect color and shoot periderm formation by harvest. Graft survival in the WSU-Prosser rootstock trial following the cold events in the 2002/03 and 2003/04 winters was much better in Merlot and Chardonnay than in Syrah. Scion survival also varied with rootstock, with 110R performing very poorly. Vines were re-grafted in June of 2004. Yield on the surviving vines was highly variable, and fruit composition is currently being analyzed. Hormone analysis suggested that cytokinins at budbreak but not at fruit set were influenced by rootstock. The highest yielding rootstock (Ramsey) produced the most cytokinins, and the lowest-yielding (5BB) produced the least cytokinins. Moreover, higher cytokinin concentrations also were associated with earlier budbreak, increased vigor, and higher flower numbers. A significant influence of rootstock on fruit composition was also observed, and differences were strongly related to rootstock-driven effects on yield.

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

Esmaeil Fallahi, Professor of Fruit Physiology - University of Idaho, Parma Research and Extension Center

Table grape, even at a small scale would fit perfectly in the operation of any wine grape and small fruit grower and will have excellent local market and export potential. In addition to this factor, pome and stone fruit markets fluctuate widely. Among the contributing factors for this fluctuation are the competitive nature of the global fruit market and the use of CA storage, which has resulted in extending the time of availability of fruit in the market and reducing or eliminating the window for the PNW market. Therefore, a large number of growers are seeking an alternative fruit crop, and table grapes seem to be an excellent alternative fruit crop for growers in Washington, Idaho, and Oregon. In the first phase of this project, we have found some varieties that can be successfully grown under the climate conditions of southern Idaho. In the project proposed in this proposal, we will evaluate adaptation, vine growth, maturity, quality, berry size, and consumer preference of new selections and cultivars in cooperation with the University of Arkansas Table Grape Breeding Program and other institutions. We will also study the effects of cluster thinning, cluster cutting, GA application, and girdling on berry size and other quality factors in those desirable and selected cultivars that show promising performance in our conditions. This project is considered as "number 1" priority for Idaho and several PNW fruit growers. Variety and quality evaluations and other objectives of this project are also on the top of "Table and wine Grapes Priority List' developed by the Northwest Center for Small Fruit Research. There are indications that with practices such as girdling and cluster cutting we can produce table grapes with excellent cluster and berry sizes in the region. In the first phase of objective 1, 22 promising grapes out of 120 selections from the University of Arkansas Table Grape Breeding Program are selected and will be planted at the University of Idaho vineyard, north of Parma Idaho. The selections from the University of Arkansas are: A-1105, A-1966, A-2034, A-2126, A-2304, A-2310, A-2335, A-2392, A-2412, A-2473, A-2480, A-2485, A-2486, A-2494, A-2497, A-2514, A-2560, A-2600, A-2610, A-2612, A-2640, and A-2653. With cooperation of Dr. John Clark at the University of Arkansas, these selections are chosen based on their desirable characteristics such as seedlessness, color, flavor and texture. In addition to these selections, several new cultivars, including 'Lady Finger', 'Autumn Royal', and 'Emerald' and several others are planted during the first year of this proposed project. The planting space is 6 ft x 9 ft. The ground was prepared and fumigated with Telone 2 before planting. A drip irrigation system was installed during spring of 2004. For Objective 2, Table grapes of this objective were planted at the University of Idaho Parma Research and Extension Center, Parma, Idaho. For the first phase of this project, 26 selections and cultivars were planted at 8 x 9 ft spacing in 1994 and 1995, and in the second phase, 9 more varieties were planted in April 1997. In year 2000 and 2001, several new releases and cultivars were added to this experiment. The cuttings were taken from the University of Arkansas grape breeding program, North Willamette Station, Plant Foundation Material Services, Davis, California, various private breeders, and grape cultivar collectors. Cuttings were rooted in peat moss in the greenhouse. A bi-lateral cordon system was installed and vines were trained on wires. A drip irrigation system was installed in this block. Table grape cultivars in this experiments are: Canadice, Challenger, Concord, Concord Seedless, Delight, Einset, Fantasy, Fiesta, Flame 1, Flame 2 (cold hardy), Fresno, Himrod,

Interlaken, Mars, NY36095, NY36289, NY36661, NY47616, NY65.479.1, NY65.483.2, Pasargad, Red Globe, Reliance, Ruby, Vanessa, V52139, Saturn, Lake Mount, Venus, Exotic, Italia, Emerald, Crimson, Calmeria, Jupiter, Emporer, Rouge Deloire-4, and Neptune. Several viticultural attributes such as vine growth, berry quality including berry maturity, color, tenderness, peel slip ness, cluster size and soluble solid concentrations of some of these cultivars will be measured every year for three years. For Objective 3, girdling, GA application, cluster removal, and cluster cutting will be performed on the selected cultivars that are showing promising results under the climatic conditions of this experiment to increase berry size. Effects of these practices on berry maturity and grape quality attributes, including soluble solid concentrations, berry color, berry size, cluster size, peel and berry texture will be evaluated. Preliminary work shows that these practices can drastically increase fruit size and we would like to fully evaluate the impact of these practices on all grapes that have shown promising results.

Effect of Mulch and Pre-Plant Soil Amendment on Soil Nitrogen Availability in Highbush Blueberry

Wei Q. Yang and Judy Kowalski - North Willamette Research and Extension Center, OSU

In a two-year study, the decomposition rates (changes in carbon to nitrogen ratio) of two kinds of sawdust used for blueberry production were determined. The effects of sawdust age and nitrogen application rates on carbon to nitrogen ratio (C:N ratio) of two sawdust types were evaluated. When nitrogen was not applied, the C:N ratio in fresh and aged sawdust decreased 30% and 10% respectively over an one-year period, indicating fresh sawdust decomposed faster than aged sawdust when used as a surface mulch. However, the C:N ratios between soils amended with aged and fresh sawdust were similar when no nitrogen was added, suggesting the age of sawdust does not affect the decomposition rate once the sawdust is incorporated into the soil. It was found that two nitrogen application rates (150 kg/ha vs. 50 kg/ha) had an equal affect on the C:N ratio of both sawdust types. Nitrogen application had no affect on the C:N ratio of both sawdust types when both sawdust were used as soil amendments. Clearly, the decomposition rates of the sawdust were influenced by sawdust age and nitrogen application rates.

WINE PROCESSING

Inducement of Malolactic Fermentation in Musts from the Pacific Northwest

C.G. Edwards, Food Scientist - WSU

Research was initiated to study the complex interactions between wine yeast (*Saccharomyces*) and malolactic bacteria (*Oenococcus*). Frequently, these interactions hamper the growth of the bacteria and therefore delay malolactic fermentation in wines. Alcoholic fermentations were induced in the synthetic grape juice by seven different yeast strains. At regular intervals, 100 mL samples were removed from the fermenters and analyzed. It was found that many strains of *Saccharomyces* produce enough SO_2 during alcoholic fermentation to inhibit *Oenococcus*. However, some yeasts were capable of inhibiting *Oenococcus* but did not produce large amounts of SO_2. Rather, these yeasts produce protein-based molecules that are inhibitory to *Oenococcus.* Research continues to determine the structure of these protein(s).

Characterization and Formation of Off-Flavor in Oregon Wine

Michael Qian - OSU

Variations in climate, soil type, cultivation, soil moisture, and fertilizer practices can have significant impact on fruit ripening, fruit composition at harvest, fermentation behavior, and wine quality. Vine stress, such as limited availability of water and nitrogen, can cause inadequate levels of yeast fermentable nitrogen of the must and slow and stuck fermentations. It can also cause sulfide, UTA and other vine stress related off-flavor problems in wines. Volatile sulfur compounds often cause reduced off-flavor in wine. In order to understand the sulfur off-flavor formation in wines, a quantitative method was developed to determine specific concentrations of volatile sulfur compounds in wines. The sulfur compounds were extracted using solid phase microextraction (SPME) and analyzed using GC-Pulsed Flame Photometric Detection (GC-PFPD). Calibration curves were established for the following sulfur compounds: hydrogen sulfide (H_2S), methanethiol (MeSH), ethanethiol (EtSH), dimethyl sulfide (DMS), diethyl sulfide (DES), dimethyl disulfide (DMDS), diethyl disulfide (DEDS), dimethyl trisulfide (DMTS), and methionol. The SPME-GC/PFPD method developed in this study is fast, relatively easy and both highly sensitive and selective for the analysis of sulfur compounds in wine. Sulfur compounds in some red wines as well as white wines were analyzed. In addition, we saw the off-flavor wine had much more volatile sulfur compounds than the normal wine.

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

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The preliminary experiments focused on headspace stability of four targeted volatile sulfur compounds, methanethiol (MeSH), ethanethiol (EtSH), dimethyl disulfide (DMDS) and diethyl disulfide (DEDS) in Oregon Pinot noir. In addition, the time necessary for the headspace of base Pinot noir to be re-established was also examined. The headspace analysis by gas chromatograph (GC) showed that DMDS and DEDS were stable in base Pinot noir wine. However, MeSH and EtSH were not stable in wine. They were converted to disulfides and other sulfur compounds in 30 minutes. Both GC and sensory results revealed that the headspace of base wine could be re-established within 2 hours. Therefore, timing has to be strictly controlled while serving wine samples spiked with MeSH and EtSH during sensory evaluation. Base wine samples could be reused at least once in two-hour interval to save valuable base wine.

Three sensory experiments will be conducted from November, 2004 – July, 2005. The experimental procedures were developed based on preliminary results.

Limiting Reductive Character Formation In Wines From The Pacific Northwest

C.G. Edwards, Food Scientist/Professor - WSU

Research was initiated to find ways to minimize problem alcoholic fermentations like H_2S formation. So far, the project has focused on two vitamins, biotin and pantothenic acid, given their roles in the metabolism of *Saccharomyces*. To evaluate the nutritional status of musts, grape samples were taken from vineyards and wineries in Washington, Oregon, and Idaho from 2001 to 2003. In general, most of the grape musts in the Pacific Northwest contain adequate amounts of biotin and pantothenic acid needed for problem-free fermentations. However, several musts were deficient in one or more vitamins (<1 µg/L biotin or <150 µg/L pantothenic acid). Year had a great impact on these concentrations as evidenced by grape musts from 2003 having much lower concentrations of biotin and pantothenic acid than those obtained in 2001 or 2002. Active dry forms of commonly utilized yeast strains have been prepared at a commercial pilot processing plant under newly devised conditions based on the yeast nutritional research performed. In fall 2004, these yeasts will be evaluated under commercial conditions at a regional winery using two different grape musts believed to be deficient in nutrients (at the time of this report, the fermentation trial had not yet started).

A New Technology for Simultaneous Tannin and Pigments Analysis in the Northwest Wine Industry

Moris L. Silber, MD, PhD, Research Professor - NRS, WSU

Year: 2002/03

Taste and color are the most important palatable qualities in wines that depend on the quantity of tannins (proanthocyanidins) and pigments (anthocyanins), the two most abundant classes of phenolic compounds in grape berries and red wines. They contribute bitterness and astringency, and color to red wines and are major sensory and quality components. Therefore, monitoring tannin and pigments during growing grape berries and processing red wines is very important in winery practice. Until present, tannins and polymeric pigments have been determined separately in tedious multiple steps. Conversely, we have designed a new analytical technology for simultaneous measurement of both tannins and pigments in one bioassay. Overall, the procedure is simple, accurate, high sensitive, reproducible, and low-cost. It is easily available and requires limited training of the personnel. The method is currently undergoing modification for in-the-field application. Briefly, the protocol of the new bioassay for tannin plus pigments is as follows.

1. Samples of grape/wine of a particular variety were obtained from IAREC and Stimson Lane at Prosser. Initial absorbencies of 50% aqueous MeOH extracts of grapes/must and wine samples diluted 2 with dH_2O were measured at 520nm, the principal absorbency band for phenolics. Tannin and LPP of the samples were precipitated with our new alkaline CBB-BSA reagent, and the absorbency at 520nm of the supernatants was remeasured to determine SPP. The supernatant probes were bleached with SO_2, and the absorbency at A_{520} remeasured. Using published extinction coefficients, the amounts of tannin, LPP, and monomeric fractions of anthocyanin pigments were quantified.

2. The SPP fraction was calculated by measuring the absorbency at 520 nm of the supernatants obtained beyond the equilibrium point (EP).

3. Ascertain the similarities/differences between data obtained from other laboratories (Kennedy et al., 2001, 2000; Vrhovsek et al., 2001; Rivas-Gonzalo et al., 1992; Macheix et al. 1990).

Red wine samples of different varieties produced under different experimental and industrial conditions have been analyzed during this research year and a database information on tannin/pigments content in red wines extended.