2007
Raspberry Research Proposals
&
2006 Progress Reports
to the
Washington State Raspberry Commission

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Commission	Meetings	Election of Officers
WA Red Raspberry Comm.	February, April, September, November, December	Fall

Summary
Budget Requests

LAST YEAR FUNDING REQUESTS (2006)

Ongoing Projects 2006)

Project No.	Short Title	Lead Scientist	Amount Requested
13C-3755-5641	Raspberry Breeding	Moore	.....$16,000
131C-3543-4370	Integrating Insect & Mite	Tanigoshi	.....$16,319
	Raspberry Cultivar Development	Kempler	... ..$ 4,800
13C-3419-3297	AY Raspberry for Perrenial Weed	Miller	

New Projects 2006

Short Title	Lead Scientist	Amount Requested
Development of Value-Added Dried Raspberry	Clary	.....$19,392
New Stategies to Replace Nemacur	Riga	.....$10,325
Postemergence Canada Thistle	Miller	.....$ 9,975
Using An Alternate Year	Miller	.....$ 7,645
Effects of Drip Tape Placement	Walters	.....$ 5,575
Irrigation Deficits	Walters	,,,,,,,,,$ 7,581
Field Evaluation	Walters	.....$16,314

CURRENT YEAR FUNDING REQUESTS (2007)

Ongoing Projects (2007)

Project No.	Short Title	Lead Scientist	Amount Requested
13C-3755-5641	Raspberry Breeding	Moore	$30,500
Development of Value-Added Dried Raspberry		Clary	.$20,415
13C-3543-4370	Insect/Mite Management	Tanigoshi	$12,762
New Stategies to Replace Nemacur		Riga	$5,149
Red Raspberry Cultivar Development		Kempler	$6,900
Postemergence Canada Thistle		Miller	$ 3,770
Effects of Drip Tape Placement		Walters	$5,913
Irrigation Deficits		Walters	$9,437

New Projects (2007)

Short Title	Lead Scientist	Amount Requested
Raspberry Market & Product Development	Wahl, Clary	$130,480
Literature Review	Power	$6,000
Bioavailability & Action of Antioxidants	Park	$76,830
Consumer Response to Health Info	McClusky	$35,113
Raspberry Health Benefits	Wieck	$27,898
WSU Food Product Development Team	Clark	$1,500

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This booklet contains confidential and proprietary information, which is the property of Washington State University. Information contained in the proposal is both potentially patentable and subject to trade secret protection under applicable State and Federal Laws, including Wash. Rev. Code §§ 19.108.010-940, 5 U.S.C. § 552 (b), and 35 U.S.C. §202(c)(5) & § 205. The proposal is submitted for the limited purpose of evaluation for funding only, and does not constitute a publication of any ideas contained therein. It may only be duplicated as strictly necessary for evaluation. Any further publication of this proposal or any idea contained therein requires the express written consent of Washington State University.

ONGOING PROJECTS:

EXECUTIVE SUMMARY SHEET

PROJECT TITLE: Red Raspberry Breeding, Genetics and Clone Evaluation

INVESTIGATOR: Patrick P. Moore

PROJECT NUMBER: 13C-3755-5641

PROJECT DURATION: continuing

CALENDAR YEAR: 2007

PROPOSED BUDGET: $30,500

OTHER SUPPORT: Northwest Center for Small Fruit Research $90,000
October 1, 2006-September 30, 2007 (for both strawberries and raspberries)

Oregon Raspberry and Blackberry Commission $1,500 for 2006-2007

IDENTIFICATION OF PROBLEM OR NEED: New cultivars are needed that are machine harvestable and RBDV resistant or root rot tolerant to replace/supplement Meeker.

BENEFITS: New cultivars would give growers more options for their growing/market conditions. New cultivars may be more productive than previous cultivars, require fewer sprays or grow on marginal sites.

ECONOMIC JUSTIFICATION: Cultivars that are RBDV resistant or root rot tolerant would extend the profitable life of a planting or allow production on marginal sites. More productive cultivars could provide higher yields.

EVALUATION AND ACCOUNTABILITY: The scientist is responsible for evaluation and reporting of this project to the agricultural industries and scientific community. Field days will be held for growers, processors, propagators and other researchers, allowing evaluation of selections. Reports with harvest data will be prepared each year. Will prepare reports for the Raspberry Breeding Program Support Committee and the Plant Propagators meeting.

PROJECT: 13C-3755-5641
TITLE: Red Raspberry Breeding, Genetics and Clone Evaluation
CURRENT YEAR:2007
TERMINATING YEAR: continuing
PERSONNEL: Patrick P. Moore, Scientist,
WSU Puyallup Research and Extension Center, Puyallup, WA

JUSTIFICATION: The Pacific Northwest (PNW) raspberry industry is dependent upon the research programs that it supports. The PNW breeding programs have been an important part of this research, developing cultivars that are the basis for the industry in the PNW. New cultivars are needed that are more productive, machine harvestable, cold hardy and resistant to root rot while maintaining fruit quality. Replacement cultivars for 'Willamette' for early season production, for 'Meeker' for late season production and new cultivars that extend the season are needed. With over 95% of the Washington production used for processing, new cultivars need to be machine harvestable.

There has been a history of cooperation between the breeding programs in Oregon, British Columbia, and Washington. This cooperation needs to continue. Cultivars developed by these programs will be of value to the entire PNW raspberry industry.

OBJECTIVE: Develop summer fruiting red raspberry cultivars with improved yields and fruit quality, and resistance to root rot and raspberry bushy dwarf virus (RBDV). Selections adapted to machine harvesting or fresh marketing will be identified and tested further.

WORK PLAN: This is an ongoing project that depends on continuity of effort. New crosses will be made each year, new seedling plantings established, new selections made among previously established seedling plantings, and selections made in previous years evaluated.

1. Plantings that are currently in the field (seedling plantings, replicated yield plots and breeding plots) will be maintained. Plants in the greenhouse and screenhouses will be maintained.

2. Crosses will be made for summer fruiting cultivar development. Primary criteria for selecting parents will be machine harvestability, RBDV resistance, root rot tolerance, yield and flavor. Other traits are fruit firmness, fruit size, fruit color, harvest season, fruit rot resistance, and growth form. Selections identified in the machine harvesting trials as being machine harvestable will be used extensively as parents.

3. Seed from the 85 crosses made in 2006 will be sown in 2006-2007. The goal will be to plant 108 plants for each cross, but will depend on the number of seeds, germination rate and field space.

4. Selections will be made among the seedlings planted in 2004 (3,300 seedlings) and 2005 (9,700 seedlings). Seedlings will be subjectively evaluated for yield, flavor, color, ease of harvest, freedom from pests, appearance, harvest season and growth form. Based on these observations, seedlings will be selected for propagation and further evaluation. Typically, the best 1% or less of a seedling population will be selected.

5. Seedlings selected in 2006 will be propagated for testing. Shoots for all selections will be collected and placed into tissue culture. Selections that are not successfully established in tissue culture will be propagated by root cuttings and grown in the greenhouse. Shoots will then be collected from these plants for tissue culture propagation.

6. The replicated plantings established in 2004 and 2005 at WSU Puyallup will be hand harvested for yield, fruit weight, fruit rot and fruit firmness.

7. Fruit of promising selections will be frozen for display at grower meetings and subjective evaluation of fruit quality.

Machine Harvesting Evaluation

1. Ten plants of each of the selections in #5 above will be planted in a grower planting for machine harvesting evaluation.

2. Three plants of each selection will also be planted at WSU Puyallup for observation, use as a parent or future propagation.

3. The machine harvesting trial established in 2005 will be harvested for the first time in 2007. The machine harvesting trial established in 2004 will be evaluated for the second time in 2007. Evaluations will be made multiple times through the harvest season.

4. Fruit of the most promising selections will be run through an IQF tunnel and evaluated, if possible.

5. Samples of fruit from selections that appear to machine harvest well and appear productive will be collected and analyzed for soluble sugars, pH, titratable acidity, anthocyanin content and total phenolics.

6. Selections that appear to machine harvest well will be planted in replicated plantings at WSU Puyallup for collection of hand harvest data, screen for root rot tolerance and RBDV resistance.

ANTICIPATED BENEFITS AND INFORMATION TRANSFER:
This program will develop new raspberry cultivars that are more productive or more pest resistant. Modifications to the evaluation process will place increased emphasis on developing machine harvestable cultivars with a goal of IQF quality fruit. Such cultivars may result from crosses made this year or may already be under evaluation.

PROPOSED BUDGET:
Funds from the Northwest Center for Small Fruit Research and support provided by WSU Agriculture Research Center will be used to provide technician support for the program.

The funds requested will be used for timeslip labor; field, greenhouse, and laboratory supplies; and travel to research plots and to grower meetings to present results of research.

Budget:	**2006-2007**	**2007-2008**
01 Timeslip Labor	9,000	9,000
03 Service and Supplies[1]	5,010	19,010
04 Travel	1,000	1,500
07 Benefits		
Timeslip	990	990
Total	**$16,000**	**$30,500**

[1] Includes $14,000 for expenses for the following test plantings for evaluation of raspberry selections.

Maintenance of test plantings	
Machine harvesting trial established in 2004– Sakuma Bros.	$3,000
Machine harvesting trial established in 2005 – Honcoop Farms	$3,000
Machine harvesting trial established in 2006 – Honcoop Farms	$3,000
IQF evaluation planting established in 2005 – Thoeny Farms	$1,000
Establishment and maintenance of new test planting	
Machine harvesting trial to be established in 2007 – Sakuma Bros.	$4,000

Current Support

Name (List PI #1 first)	Supporting Agency and Project #	Total $ Amount	Effective and Expiration Dates	Title of Project
Moore, P.P.	Northwest Center for Small Fruit Research	$90,000	2006-2007	Small Fruit Breeding in the Pacific Northwest
Moore, P.P.	Oregon Raspberry and Blackberry Commission	$1,500	2006-2007	Development of New Raspberry Cultivars for the Pacific Northwest

Progress Report

Project: 13C-3755-5641
Title: Red Raspberry Breeding, Genetics and Clone Evaluation
Personnel: Patrick P. Moore, Scientist, WSU Puyallup Research and Extension Center
Reporting Period: 2006
Accomplishments: Eighty-five crosses were made in 2006. In 59 of the crosses, selections identified as appearing to be machine harvestable were used, nine crosses used root rot tolerant selections and 17 crosses were for germplasm purposes. Approximately, 9,600 seedlings were planted from the crosses made in 2005. Eighty-seven selections were made in 2006. 35 selections were made for cultivar development among the 5,500 seedlings that were planted in 2003. This is in addition to the 35 selections made in this field in 2005. **WSU 1252**, **Cascade Bounty, WSU 1250** and **WSU 1181** were the parents most represented among the new selections in this field. Fifty-one selections were made among the 3,300 seedlings planted in 2004. Forty-two of these were for cultivar development. **Cascade Dawn, Cowichan** and **Chief** were the parents most represented among the new selections in this field. One selection in the 2003 planting and nine in the 2004 planting was made for germplasm purposes.

The 2004 replicated planting at Puyallup was hand-harvested for the first time in 2006 (Table R1). This was a planting of late season raspberries. **Esquimalt** had the highest yield followed by **WSU 1226** and **Tulameen**. **WSU 1226** had the largest fruit, the firmest fruit, and the latest midpoint of harvest. The last harvest in these plots was August 10. In the first 10 days in August, **Autumn Bliss** had 0.94 t/a, WSU **1226** had 1.06 and **Coho** had 0.91. Some of these raspberries will provide considerable overlap with fall fruiting raspberries. Some plots in this planting established slowly and yields for some selections may be higher and later in 2007.

A new machine harvesting trial was planted at Randy Honcoop's. One hundred raspberries were included in the new planting, with 77 WSU selections, 20 BC selections and 3 cultivars. The planting established in 2004 at Sakuma Bros. was machine harvested for the first time in 2006. Observations were made on four harvests. Eight WSU selections appeared to machine harvest well. Samples were collected on 2-4 dates for these 8 WSU selections plus 3 cultivars and 6 BC selections. These samples will be analyzed for soluble solids, total anthocyanins, pH, titratable acidity and total phenolics. The 2005 IQF trial at Sakuma Bros was also harvested in 2006. This planting has 9 WSU selections (from the 2002 and 2003 machine harvesting trials) and 5 cultivars. All selections appeared to machine harvest well.

Fruit samples from both of these trials were run through an IQF tunnel. It was possible to track samples through the plant and make observations with samples of less than one flat. Two selections from the 2004 machine harvesting trial (**WSU 1447** and **WSU 1582**) and two selections from the IQF trial (**WSU 1499** and **WSU 1502**) appeared to have potential for IQF. Although there were defects, the fruit quality was better than **Meeker** or **Coho** harvested from the same plantings. **WSU 1499** and **WSU 1582** both have a parent that is RBDV resistant and may inherit RBDV resistance.

Publications/Presentations:
Moore, Patrick P. 2006. 'Cascade Dawn' Red Raspberry. HortScience 41:857-859
Jan. 2006 Fresh Market Cultivars of Small Fruit, WWHA, SeaTac, WA

Jan. 2006. Strawberry and Raspberry fruit display. Northwest Food Processors, Portland, OR.

Feb. 2006. Recent WSU Raspberry Cultivars and Progress on Machine Harvesting Evaluations. LMHIA. Abbotsford, BC.
March 2006 Vancouver Small Fruit Workshop, Vancouver, WA.
June 2006. Raspberry Field Day, Puyallup, WA.
July 2006. Machine Harvesting Open House, Burlington, WA

2006 harvest data of 2004 planted raspberries, Puyallup, WA

	Yield (t/a)		Fruit rot	Fruit firmness	Fruit weight	Harvest season			
	total	after 8/1	(%)	(g)	(g)	5%	50%	95%	Length of harvest season
Esquimalt	11.3 a	0.34 ab	9.9 a	186 bc	3.8 c-f	7/1 a-c	7/13 bc	7/28 a	26 ab
WSU 1226	9.7 ab	1.06 a	8.1 a	243 a	5.5 a	7/7 a	7/19 a	8/2 a	27 ab
Tulameen	9.0 ab	0.30 ab	14.1 a	184 bc	4.6 bc	6/29 bc	7/11 c	7/27 a	28 ab
Meeker	8.1 a-c	0.09 b	7.7 a	144 c	3.1 ef	7/2 a-c	7/12 c	7/25 a	23 b
Coho	7.3 a-d	0.91 ab	6.1 a	189 bc	3.6 d-f	7/3 a-c	7/14 a-c	8/3 a	31 ab
Kitsilano	7.1 a-d	0.66 ab	6.5 a	148 c	2.9 f	7/4 ab	7/18 ab	8/3 a	30 ab
C. Delight	6.3 a-d	0.14 ab	16.3 a	176 bc	4.8 ab	6/30 a-c	7/12 bc	7/26 a	26 ab
WSU 1611	3.9 b-d	0.23 ab	21.7 a	216 ab	3.5 d-f	6/28 bc	7/13 bc	7/31 a	33 ab
BC 90-6-2	3.9 b-d	0.45 ab	8.4 a	191 bc	4.3 b-d	6/28 bc	7/11 c	8/4 a	37 a
Autumn Bliss	1.6 cd	0.94 ab	8.0 a	185 bc	4.1 b-e	-	-	-	-
WSU 1603	1.0 d	0.03 b	13.4 a	157 c	3.3 ef	6/27 c	7/9 c	7/24 a	27 ab

Autumn Bliss harvested only for primocane (fall) crop.
Plots harvested through 10 August

Project No: 13C-3455-6633

Title: Irrigation deficits at critical raspberry developmental stages and cover crops to reduce nitrate leaching potential.

Year Initiated 2006 Current Year 2007-2008 Terminating Year 2008-2009

Personnel:

Thomas Walters, WSU Dept. Horticulture and Landscape Architecture

Justification and Background:

Water deficit impacts. Raspberry growers need to irrigate to maximize yields and quality. Although rainfall is abundant in western Washington State, it is usually lacking in the summer, when the plants' water requirements are the greatest. Shallow-rooted berry plants are unable to reach enough water deep in the soil, and they become water-stressed, causing yield reductions in the current year and in the following year.

Under-irrigated berry crops have poor vegetative growth, reduced fruit yield and smaller fruit (Kirnak et al., 2003 ; MacKerron, 1982). Over-irrigation brings risks of poor plant performance, soil-borne disease and nitrate leaching into groundwater. An interested person can generally predict how much water is enough (by using evapotranspiration models), and monitor if enough water is getting to the plants (by monitoring soil moisture and plant water status). but we don't really know if there are critical stages at which adequate water is essential. Are there critical stages at which we must meet the crop's water needs? Are there other times at which subjecting plants to water stress is not harmful, or is actually beneficial?

Growers sometimes estimate the need for irrigation by sampling the soil several inches below the surface. However, deeper sampling is required. Raspberry roots extend over 3 feet deep, and moisture near the soil surface does not guarantee adequate moisture deeper in the soil. Crop irrigation needs are generally predicted on the basis of evapotranspiration (ET); the evapotranspiration rates of individual crops (ET_c) are defined in relation to the evapotranspiration of a reference crop via a crop coefficient. Crop coefficients vary with the plant developmental stage, and fruit crop coefficients are generally highest during fruit expansion and ripening. Crop coefficients for raspberries were developed by the US bureau of Reclamation in 1975, and are available through the Agri-Met Agricultural Weather Network (http://www.usbr.gov/pn/agrimet). However, berry production practices and varieties have changed a great deal since that time, and the coefficients are likely outdated. Recently released raspberry varieties (such as 'Cascade Bounty') have high fruit yields without a correspondingly larger canopy. Older canopy coverage-based models may not be appropriate for these varieties.

A clear understanding of raspberry water requirements coupled with appropriate practices to meet these requirements would allow improve berry yields, prevent the spread of soil-borne disease with reduced chemical usage, avoid groundwater contamination, and use water resources wisely. The impact of these measures would be felt throughout berry-growing regions.

Minimizing nitrate leaching in raspberry production. Berries in Western Washington are generally grown in soils with extremely high water tables; in some cases, these soils are quite sandy, and are therefore prone to leaching. Nitrate contamination of groundwater wells has been repeatedly documented in areas of berry production in NW Washington (Mitchell et al., 2005). These reports point to human causes of contamination, including dairy and poultry operations, and possibly berry producers' use of dairy and poultry manure, as well as inorganic nitrogen fertilizers. In other crops, including strawberry, excessive irrigation and fertilization exacerbate nitrate leaching into the environment (Guimera et al., 1995)

Recommended practices to avoid nitrate contamination of groundwater include: use of deep-rooted crops to scavenge residual nitrogen, evaluation of soil and irrigation water nitrate levels to appropriately adjust recommended fertilizer levels, evaluation of leaf tissue to determine whether current fertilizer programs are appropriate and consider conservation tillage practices (British Colombia Ministry of Agriculture, 2005; Canessa and Hermanson, 1994). In the case of raspberries, deep-rooted nitrogen scavengers may be feasible in the current production system, as long as these do not interfere with machinery needed to manage the crop. Groundcover management significantly affects nitrate leaching in apple orchards (Merwin et al., 1996). Careful attention to the form, amount and timing of N application may also reduce leaching. Blackberries took up soil N from late April through July (Mohadjer, 1999). Split applications of N are recommended for raspberries, and up to three N applications are suggested for on very gravely soils (British Colombia Ministry of Agriculture, 2005; Pritts and Handley, 1994), but data is lacking on the actual effect of this practice on nitrate leaching. Post-season foliar N testing is considered to be an effective means of evaluating whether appropriate levels of N have been made available to the raspberry plant in the previous growing season (British Colombia Ministry of Agriculture, 2005), but the testing is not widely employed. A post-harvest soil nitrate test can assess the risk of nitrate leaching in the following winter, and can also be a guide to N requirements for the next year's crop, if the N is captured with a cover crop (British Colombia Ministry of Agriculture, 2005).

Objectives:

Year 1: Evaluate irrigation deficit effects on current year's growth and yield. Evaluate cover crop growth and initial Nitrate uptake effects

Year 2: Evaluate irrigation deficit effects on following year's yield, and repeat treatments of year 1. Evaluate cover crop N uptake effects into following growing year, and repeat treatments of year 1.

Year 3: Complete evaluations of year 2 treatments, publish berry irrigation guide.

Procedures:

Water deficit impacts at critical growth stages. In raspberry and blueberry, we will use existing plantings at the Vancouver, WA research and extension center, or at an alternate site in a grower's field. Established raspberry plantings will be drip-irrigated 2 times per week to 100% ETc levels from April 15-Sept 15. Reference ET will be taken from the nearest Agri-Met station (Forest Grove, OR), and the Agri-Met crop coefficients will be used to calculate ET_c. Soil moisture will be monitored with watermark sensors and automated dataloggers in two replicates of the fully irrigated plots. Irrigation practices will be adjusted as needed to maintain fully irrigated plots at close to field capacity at 24" soil depth and at approximately 50% of field capacity at 12" depth. Individual plots will be subjected to moisture stress (approximately 50% ET) during bloom, harvest, and post-harvest periods. Plant water potential, vegetative growth, yield, initiation of floral buds for the following season, root rot development, and yield in the following season will be evaluated. Winter-hardiness will be evaluated if conditions permit (if winter injury is present in the plots). Individual plots will contain 10 plants and be approximately 35 feet in length. Data will be taken from the middle 8 plants of each plot. Including the fully irrigated control, there will be 4 treatments: 1) fully irrigated control 2) 50% ET Bloom to harvest, 3) 50% ET Harvest, 4) 50% ET post-harvest. These will be laid out in a randomized complete block design, with 5 replicates and a total of 20 plots. There will be 1400 row-feet in the trial; perhaps up to 1800 row-feet with boarder rows. At 10' spacing, this is approximately 0.41 A. Treatments will be made through the 2006 and 2007 growing seasons; evaluations will be made into the 08 growing season, if possible.

Minimize Nitrate leaching. Raspberry cv. 'Meeker' plants being established on a silt loam soil at Mount Vernon NWREC will receive 1) 60 lb N per acre in a single application in April, 2) the same amount of N split between two applications in April and May, 3) 120 lb/A N split between 2 applications and 4) 60 lb/A N as dairy manure applied early in April. Plant vegetative growth and foliar N will be evaluated throughout the season. Foliar N and soil nitrate will be evaluated on or about August 1 to determine whether these treatments provide appropriate amounts of N to the plants, and the extent to which they

predispose soil to nitrate leaching. It is anticipated that the 120 lb N applied to treatment 3 will result in significant residual nitrate in the soil. A barley or oat cover crop will be established in half of the plots to establish the cover crop's ability to recover excess nitrates from the soil. The biomass and %N of the cover crop will be evaluated mid-October. Soil nitrate in cover-cropped and bare plots will be evaluated mid-October 2006 and mid-March 2007. Effects of N treatments will be applied in randomized complete blocks and evaluated as a one-way ANOVA; cover crop treatments will be applied as a split-plot design within the N treatments and analyzed accordingly.

Within established raspberry fields, cover crops of barley, oats and crucifers will be established immediately after post-harvest operations (ca August 15). Soil nitrate levels in cover-cropped and bare areas will be evaluated the following spring (ca April 1) to evaluate the capacity of the cover crops to hold Nitrogen over the winter.

References:

British Colombia Ministry of Agriculture, F.a.F. 2005. Berry production guide for commercial growers 2005-2006 edition. Lower Mainland Horticulture Improvement Association, Abbotsford, BC.

Canessa, P.and R.E. Hermanson. 1994. Irrigation Management Practices to Protect Ground Water and Surface Water Quality State of Washington.

Guimera, J., O. Marfa, L. Candela, and L. Serrano. 1995. Nitrate leaching and strawberry production under drip irrigation management. Agriculture, ecosystems and Environment. 56: 121-135.

Kirnak, H., C. Kaya, D. Higgs, I. Bolat, M. Simsek, and A. Ikinci. 2003 Effects of preharvest drip-irrigation scheduling on strawberry yield, quality and growth. Australian Journal of Experimental Agriculture. 43: 105-111.

MacKerron, D.K.I. 1982. Growth and water use in the red raspberry (*Rubus idaeus* L.) I. Growth and yield under different levels of water stress. Journal of Horticultural Science. 57: 295-306.

Merwin, I.A., J.A. Ray, T.S. Steenhuis, and J. Boll. 1996. Groundcover management systems influence fungicide and nitrate-N concentrations in leachate and runoff from a New York apple orchard. J. Amer. Soc. Hort. Sci. 121: 249-257.

Mitchell, R.J., R.S. Babcock, H. Hirsch, L. McKee, R.A. Matthews, and J. Vandersypen. 2005. Water Quality: Abbotsford-Sumas Final Report.

Mohadjer, P. 1999. Nitrogen partitioning in 'Marion' and 'Kotata' blackberries grown in alternate-year production., Oregon State University, Corvallis, OR.

Pritts, M.P.and D. Handley. 1994. Bramble Production Guide.

Anticipated Benefits and Information Transfer:

Results will be presented to Washington raspberry growers at field days, grower meetings and at commission meetings. The results will also be incorporated into an extension bulletin on irrigation practices for berry crops in Washington. This knowledge will help growers more closely understand raspberry water requirements, especially at critical times in the plant's development. Results of the cover crop studies will also be shared with the Mitchell lab at Western Washington University to help them make their nitrate leaching models more accurately reflect field realities.

Budget:

Amount allocated by Commission for previous year: $10,258

Request for FY 2007-2008

Salaries[1/]	$3,560
Labor costs at Vancouver(time-slip)	$2,000
Operations (goods & services) [2/]	$700
Travel[3/]	$600
Projected Needs	
Meetings	
Other	$500
Equipment[4/]	$500
Employee Benefits-RA[5/]	$1,317
Employee Benefits-Time-slip[5/]	$260
Total	**$9,437**

[1] Research Associate, 0.10 FTE.
[2] Harvester maintenance.
[3] To and from plots in Vancouver.
[4] Soil moisture monitoring supplies
[5] RA benefits rate 37%; time-slip benefit rate 13%.

Other support of project*:
Approximately 0.75 FTE of a Research Associate is provided to the small fruit horticulture program by the Agricultural Research Center in the first two years.

A substantial amount of equipment costs for this project (for example, mechanical harvester, vehicle, balances) are covered by the Agricultural Research Center of Washington State University. WSU is also providing facilities and locations at Vancouver and Mount Vernon.

* Budget data provided in "Other support of project" is for informational purposes only, for the Commission to understand the scope of the project. These estimated costs are not presented as formal cost-sharing and therefore do not constitute a cost-share obligations on the part of Washington State University. Moreover, there is no requirement for WSU to document this other support of project as part of any cost-share or matching obligation.

Current & Pending Support

Instructions:
1. Record information for active and pending projects.
2. All current research to which principal investigator(s) and other senior personnel have committed a portion of their time must be listed whether or not salary for the person(s) involved is included in the budgets of the various projects.
3. Provide analogous information for all proposed research which is being considered by, or which will be submitted in the near future to, other possible sponsors.

Name (List PI #1 first)	Supporting Agency and Project #	Total $ Amount	Effective and Expiration Dates	% of Time Committed	Title of Project
	Current:				
Walters	Pending: NARF	$7,718	2006	0.2	**Evaluation of Small Fruits at WSU Mt. Vernon**

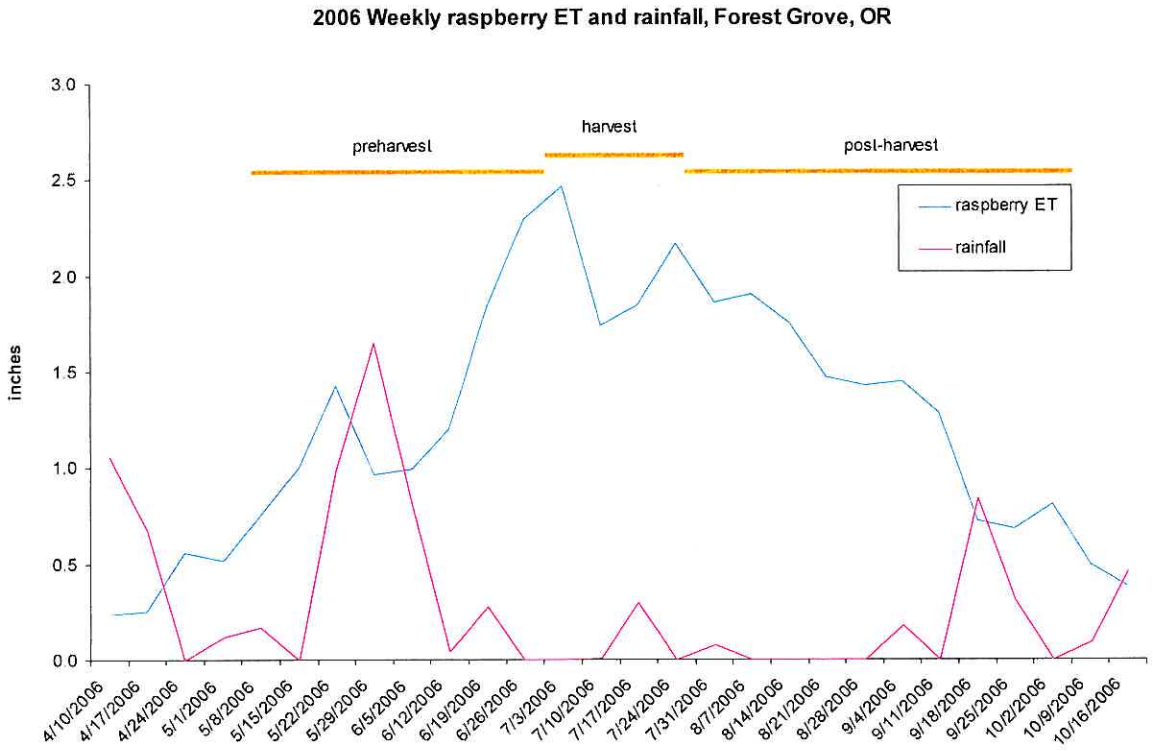
Project No: 13C-3455-6633

Title: Irrigation deficits at critical raspberry developmental stages.

Progress Report 2006

The trial was established in a planting of 'Meeker' at WSU-Vancouver REC. There were four treatments, each replicated four times in a randomized complete block design. The existing drip irrigation system was modified to allow individual treatments to be irrigated independently. Irrigation requirement was calculated based upon blueberry Evapotranspiration, less rainfall, calculated using data from the nearby Agri-Met station in Forest Grove, OR.

Although rainfall was sufficient to keep up with Evapotranspiration during part of May, there was insufficient rainfall throughout June, July and August to keep up with the blueberry crop's needs (Figure 1).



The irrigation system was adequate to keep up with evapotranspiration for most of the summer, except for the hottest times of the summer. Thus, during the harvest period, crop ET was 6.4 inches, and the irrigation system was able to supply 5.0 inches to the fully irrigated plots (Table 1, below)..

Fully irrigated control plots (treatment 3) were irrigated to 100% Evapotranspiration. Deficit irrigation plots received less water during the preharvest, harvest, or postharvest periods (Table 1). Yields were evaluated in a total of 13 harvests, but no significant differences in the treatments were noted. Fruit size was recorded in five harvests, but no significant differences were noted. Preliminary measurements of primocane length indicate that the fully irrigated plots had the longest primocanes. Analysis and evaluations of this season's plant growth, and of bud development in the treatments are ongoing.

Table 1. Rainfall, Blueberry Evapotranspiration and applied irrigation (Acre-inches) to fully irrigated and deficit irrigated (**bold type**) plots.

					Irrigation applied by treatment			
Deficit Period	Begin	End	Rainfall	ET	1	2	3	4
preharvest	1-May	29-Jun	3.77	11.7	5.7	5.7	5.7	**2.8**
harvest	30-Jun	21-Jul	0.31	6.3	**2.5**	5.0	5.0	5.0
postharvest	22-Jul	9-Oct	0.87	12.4	9.9	**4.9**	9.9	9.9

Project No: 13C-3455-5633

Title: Effects of drip tape placement on spread of raspberry root rot caused by *Phytophthora fragariae* var. *rubi*

Year Initiated 2006 Current Year 2007-2008 Terminating Year 2008-2009

Personnel:

Thomas Walters, WSU Dept. Horticulture and Landscape Architecture, Mount Vernon
Gary Grove, WSU Dept Plant Pathology, Prosser

Cooperators:

Patrick P. Moore, WSU Dept Horticulture and Landscape Architecture, Vancouver

Justification and Background:

Washington State raspberry production ranks first or second in the nation annually, with an annual crop value of $36-46 Million dollars Berry crops are a strong part of the cultural identity of Washington, and there is ample evidence of the health benefits of berry consumption (Network, 2005; Wrolstad, 2005).

Raspberry growers need to irrigate to maximize yields and quality. Although rainfall is abundant in western Washington State, it is usually lacking in the summer, when the plants' water requirements are the greatest. Shallow-rooted berry plants are unable to reach enough water deep in the soil, and they become water-stressed, causing yield reductions in the current year and in the following year.

However, irrigation practices can worsen raspberry root rot problems by generating soil conditions favorable to *Phytophthora* root rot during the summer months. Irrigation practices have large effects on *Phytophthora* disease development in other crops. Drip emitters on the surface and in the row enhanced development of *Phytophthora* root rot of pepper (Café-Filho and Duniway, 1996). Subsurface emitters gave better disease control without reducing yields in noninfested plots. The frequency of irrigation has also been shown to affect *Phytophthora* diseases of squash (Café-Filho et al., 1995) and tomato (Ristaino et al., 1988): more frequent irrigations favor more severe disease development. The development and dispersal of *Phytophthora* spores is favored by cycles of soil moisture, as would likely be caused by common irrigation practices (Ristaino and Johnston, 1999). When irrigation was managed so that soil moisture in the root zone of peppers was neither excessively high nor excessively cyclical, *Phytophthora* blight of peppers was successfully controlled. In red raspberry, cultural practices that affect soil moisture, such as hilling and mulching, also affected Phytophthora root rot development (Wilcox et al., 1999).

Root rot development in susceptible pepper varieties was sensitive to irrigation scheduling, but resistant varieties tolerated even very moist conditions (Café-Filho and Duniway, 1995). Early season *P. capcisi* inoculum in pepper fields was highest near the drip line (Ristaino et al., 1992). Inoculum buildup might be avoided if irrigation was alternated between two drip tapes. Resistant varieties are probably the most promising long-term solution to Phytophthora root rot diseases of strawberry (Martin and Bull, 2002) and raspberry (Duncan and Cooke, 2002). The new WSU raspberry varieties 'Cascade Bounty' and 'Cascade Delight' appear to have a high degree of root rot resistance (Moore, 2004), but their response to irrigation treatments is unknown.

Objectives:

Year 1: Determine the effects of irrigation water timing and placement on the incidence and spread of Raspberry root rot, caused by *Phytophthora fragariae* var. *rubi*.

Year 2: Confirm the results of year 1, and establish the effect of deep vs. shallow irrigation cycling.

Year 3: Refine the effect of deep vs. shallow irrigation cycling on spread of raspberry root rot, and publish an extension bulletin summarizing best irrigation practices for raspberry.

Procedures:

New raspberry plantings were established at the Mount Vernon (moderate root rot pressure) and Puyallup (high root rot pressure) research stations. Irrigation treatments include: drip tape 4" below the surface, 18" above the surface directly above the crowns, and two tapes on the surface 6" offset from the crowns. Irrigation will maintain soil moisture at near soil capacity at 24" soil depth and to approximately 50% of soil capacity at 12". The same volume of water is administered to all of these treatments. Soil moisture will be monitored with Decagon ECH20 sensors at 12" and 24" in two replications. Recording tensiometers are installed in the middle of the row at 6" and at 12" depth. The plots at Mount Vernon will be inoculated (either zoospores produced from culture or infected planting stock), and disease progress will be monitored through the 2006 and 2007 seasons. Several plants will be removed from each plot in the winter of 2006 to evaluate root biomass, disease incidence and severity. A sampling of diseased plants will be sent to the OSU plant disease clinic for positive identification of *P. fragariae* via PCR. Primocane numbers, diameter and length will be recorded, as will fruit yield. These plots will be 10 plants (35 feet) feet long. There are 3 treatments x 2 varieties ('Meeker' and 'Cascade Bounty') and 5 replicates, for a total of 30 plots, or approximately 0.62 A. at each location. Plots will be established in a randomized complete block design; data will be analyzed with a two-way (irrigation treatment and variety) ANOVA.

In parallel pot studies at Mount Vernon, overhead and subsurface irrigation treatments will be administered to infected planting stock in the greenhouse. Pots will be brought to the capacity of the potting mix every third day. Half of the plants will be sacrificed at the end of the growing season, and primocane and root biomass will be evaluated. Disease incidence and development will be evaluated.

Additional studies (planned for 2007 and 2008) will evaluate the effect of irrigation cycling depth on disease development and spread. In these studies, irrigation cycles will be deep (initiated at -50 mPa water potential at a 12" depth), moderate (initiated at -30mPa water potential at a 12" depth) or shallow (initiated at -10 mPa water potential at 12" depth) applied either applied via an automated irrigation scheduler.

References:

Café-Filho, A.C.and J.M. Duniway. 1995. Effect of furrow irrigation schedules and host genotype on Phytophthora root rot of pepper. Plant Disease. 79: 39-43.

Café-Filho, A.C.and J.M. Duniway. 1996. Effect of location of drip irrigation emitters and position of Phytophthora capsici infections in roots on Phytophthora root rot of pepper. Phytopathology 86: 1364-1369.

Café-Filho, A.C., J.M. Duniway, and R.M. Davis. 1995. Effects of the frequency of furrow irrigation on root and fruit rots of squash caused by *Phytophthora capsici*. Plant Disease. 79: 44-48.

Duncan, J.M.and L.E.M. Cooke. 2002. Work on raspberry root rot at the Scottish Crop Research Institute. Acta Horticulturae. 585: 271-276.

Martin, F.N.and C.T. Bull. 2002. Biological control of root pathogens of strawberry
Phytopathology 92: 1356-1362.

Moore, P.P. 2004. 'Cascade Delight' Red Raspberry. HortScience. 39: 185-187.

Ristaino, J.B., J.M. Duniway, and J.J. Marois. 1988. Influence of frequency and duration of furrow irrigation on the development of Phytophthora root rot and yield in processing tomatoes. Phytopathology 78: 1701-1706.

Ristaino, J.B., M.J. Hord, and M.L. Gumpertz. 1992. Population densities pf Phytophthora capsici in field soils in relation to drip irrigation, reinfall and disease incidence. Plant Disease. 76: 1017-1024.
Ristaino, J.B.and S.A. Johnston. 1999. Ecologically Based Approaches to management of Phytophthora blight on bell pepper. Plant Disease. 83: 1080-1089.
Wilcox, W.F., M.P. Pritts, and M.J. Kelly. 1999. Integrated control of Phytophthora root rot of red raspberry. Plant Disease. 83: 1149-1154.
Wrolstad, R.E. 2005. Anthocyanins, Polyphenolics and Antioxidant Properties of Pacific Northwest Berries. 2005 International Berry Health Benefits Symposium, Corvallis OR.

Anticipated Benefits and Information Transfer:

Results will be presented to Washington raspberry growers at field days, grower meetings and at commission meetings. The results will also be incorporated into an extension bulletin on irrigation practices for berry crops in Washington. This knowledge will help growers to design raspberry drip irrigation systems significantly reduce Phytophthora root rot pressures through attention to their irrigation practices. Better yields and less disease will help berry production remain an economically viable activity in the state, and will contribute to rural economic health.

Budget:

Amount allocated by Commission for previous year: $7,041

Request for FY 2007-2008

Salaries[1/]	$2,670
Time-Slip	$1000
Operations (goods & services)	$250
Travel[2/]	$375
Projected Needs	
Meetings	
Other	$250
Equipment[3/]	$250
Employee Benefits-RA[4/]	$988
Employee Benefits-Time-slip	$130
Total	**$5,913**

[1] Research Associate, 0.075 FTE.

[2] To and from remote plots in Puyallup or in growers' fields; also two visits from G. Grove to Mt Vernon/Lynden and Puyallup/Vancouver.

[3] Posts, wire, Watermark soil moisture sensors and dataloggers, drip tape, filters, automated irrigation system.

[4/] RA benefits estimated 37%; time-slip 11%.

Other support of project:
Approximately 0.75 FTE of a Research Associate is provided to the small fruit horticulture program by the Agricultural Research Center in the first two years.

A substantial amount of equipment costs for this project (for example, mechanical harvester, vehicle, balances) are covered by the Agricultural Research Center of Washington State University.

A proposal for matching funds will be made to the Washington State Pesticide Commission. **The budget above is my request to the Raspberry Commission; completion of all the work described will require matching funds from the Washington State Pesticide Commission**.

Note: *Budget data provided in "Other support of project" is for informative purposed only, for the commission to understand the scope of the project. This estimated support is not presented as formal cost-sharing and, therefore, does not constitute a cost-share obligation on the part of Washington State University. Moreover, there is no requirement for WSU to document this "Other support of project" as part of any cost-share or matching obligatio*

Current & Pending Support (1 of 2)

Name (List PI #1 first)	Supporting Agency and Project #	Total $ Amount	Effective and Expiration Dates	% of Time Committed	Title of Project
Walters	Current: WA State Blueberry Commission	$10,401	2006	0.1	Irrigation deficits at critical blueberry developmental stages
Walters	NARF	$7,617	2006	0.2	Evaluation of Small Fruits at WSU Mount Vernon
Walters	WA State Strawberry Commission	$4449	2006	0.1	Irrigation systems evaluation
Walters	Washington Red Raspberry Commission	$10,258	2006	0.1	Irrigation deficits at critical raspberry developmental stages and cover crops to reduce nitrate leaching potential
Walters	Washington Red Raspberry Commission	$7,041	2006	0.1	Effects of drip tape placement on spread of raspberry root rot caused by *Phytophthora fragariae* var. *rubi.*
Walters	Washington State Pesticide Commission	$7,041	2006	0.1	Effects of drip tape placement on spread of raspberry root rot caused by *Phytophthora fragariae* var. *rubi.*

Current & Pending Support (2 of 2)

Name (List PI #1 first)	Supporting Agency and Project #	Total $ Amount	Effective and Expiration Dates	% of Time Committed	Title of Project
Walters	Pending: NARF	$8,000	2006	0.1	Evaluation of Small Fruits at WSU Mount Vernon
Walters	WA State Blueberry Commission	$9,493	2007	0.1	Irrigation deficits at critical blueberry developmental stages
Walters	WA State Blueberry Commission	8,608	2007	0.1	Blueberry cultivar evaluations

Project No: 13C-3455-5633

Title: Effects of drip tape placement on spread of raspberry root rot caused by *Phytophthora fragariae* var. *rubi*

Personnel: Thomas Walters, WSU Dept. Horticulture and Landscape Architecture, Mount Vernon
Gary Grove, WSU Dept Plant Pathology, Prosser

Cooperator: Patrick P. Moore, WSU Dept Horticulture and Landscape Architecture, Vancouver

Reporting Period: 2006

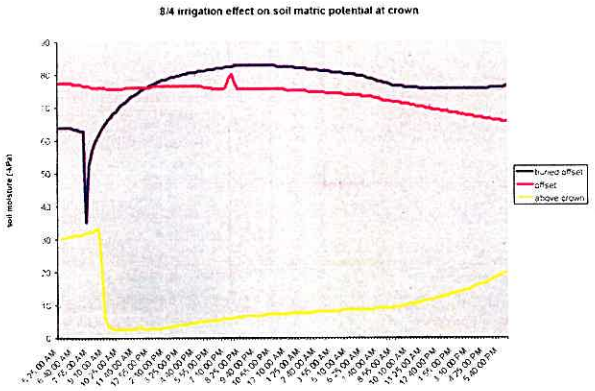
Accomplishments: The trial blocks for this project were established at WSU-Puyallup and WSU-Mount Vernon. Recording tensiometers installed near the crown of the raspberry plants document that the soil at the crown stays much wetter for much longer when the drip line is above the crown. This may substantially affect the development of raspberry root rot.

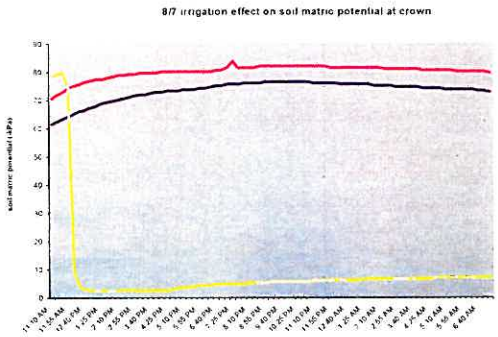
Results: Each block has plots of industry standard 'Meeker' and highly resistant variety 'Cascade Bounty'. Drip irrigation lines are placed above the crown, above and offset 6" from the crown, or buried to the side of the crown. All plots receive the same amount of water.

Crop establishment and growth at both locations has been good. 'Cascade Bounty' plots have been especially vigorous at both locations. No differences in vegetative growth were noted among the irrigation treatments. Measurements of cane caliper, height and number will be made this winter. Plants at Puyallup will be cut down (no harvest of the second-year or 'baby' crop), but the second year crop will be harvested at Mount Vernon.

The figures below show data from recording tensiometers placed at the crown. Each x-axis represents time (nearly one day) from the start of an irrigation. The Y-axis is soil matric potential, with lower being wetter. Data from August 4 is shown on the left; on the right is data from August 7. In each case soil moisture is much higher (the line is lower) for the plot with the drip line directly above the crown.

Soil moisture potential plays an important role in the reproduction and dispersal of many Phytophtora species; as our research progresses, we will learn more about its importance to raspberry root rot.





Publications: none yet, but results will be included in presentations at grower meetings in the winter of 2006-2007, and in a berry irrigation extension bulletin to be published.

Project Nos: 13C 3419 3297

Title: AY Raspberry for Perennial Weed Control

Personnel: Timothy W. Miller, WSU NWREC
Carl R. Libbey, WSU NWREC

Reporting Period: 2006-07

Accomplishments: This trial evaluated six non-selective weed control herbicides for control of Canada thistle and other perennial weeds using an Alternate Year (AY) bearing system.

Results:

The trial was conducted in a raspberry field near Burlington, WA (Sakuma Brothers Farm, cooperator) infested with thick patches of Canada thistle (*Cirsium arvense*) and spotty infestations of white clover (*Trifolium repens*), and common dandelion (*Taraxacum officinale*). Herbicides were applied to primocanes and weeds May 2, 10, and 18 and June 1 (all POST, preharvest). Remaining Canada thistle stems were removed by hand July 1. Berries were sampled July 20, and postharvest herbicides were August 7 (all POST). Weed control was evaluated May 4 and 12 and again on August 11. Tested conventional herbicides were Gramoxone Extra (paraquat), Goal (oxyfluorfen), and Rely (glufosinate), and tested organic herbicides were Weed Pharm (vinegar product containing 20% acetic acid), Matran 2 (clove oil), and Interceptor (pine oil). The experimental design was a randomized complete block with four replicates.

Fruit yield did not differ by herbicide treatments (Table 1), but fruiting was very spotty due to severe winter injury in the test row. Many gaps in the raspberry row were evident in May, and many of these gaps worsened during the growing season. Raspberry primocane growth following winter injury was poor enough to warrant removal of most of the block in late August. This project, therefore, will not be continued into the non-bearing year (2007).

Initial Canada thistle control in August was good with three applications with Gramoxone and Rely (75 and 80%, respectively), but poor with three applications of Goal or five applications with Weed Pharm, Matran 2, and Interceptor (35, 58, 30, and 33%, respectively)(Table 1). As noted above, the raspberry block was destroyed in late August, consequently full evaluation of Canada thistle control from these treatments cannot be accomplished. Initial control of white clover in August was excellent with Gramoxone (90%), but poor with other treatments. Similarly, initial control of common dandelion was poor with all tested products. Based on these data, it does not appear that non-selective herbicides provide good enough perennial weed control to expect successful control during the bearing year of an AY system. Continued testing of non-selective herbicides for this use does not therefore appear to be warranted.

Table 1. Initial Canada thistle control and yield following application of several non-selective herbicides in raspberry.

Treatment[a]	Rate	Canada thistle control			Fruit yield[b]
	product/a	5/4/06	5/12/06	8/11/06	g/crown
Gramoxone Extra	2 pt	78	73	75	606
Goal 2XL	12.8 fl.oz	45	72	35	1336
Rely	1 gal	8	85	80	486
Weed Pharm (vinegar, 20% acetic acid)	100%	45	68	58	1100
Matran 2 (clove oil)	20%	60	50	30	1019
Interceptor (pine oil)	20%	35	53	33	697
Non-treated	---	0	0	0	791
$LSD_{0.05}$	---	21	23	33	ns

[a]Herbicides were applied May 2 (all), May 2 (organics only), May 18 (organics only), June 4 (all treatments), and August 7 (all treatments). All non-organic treatments mixed with non-ionic surfactant at 0.25%, v/v; all organic herbicides mixed with Humisol and crop oil concentrate (both at 2%, v/v).
[b]Berries sampled July 20.

Table 2. Initial control of white clover and common dandelion following application of several non-selective herbicides in raspberry.

Treatment[a]	Rate	White clover control			Common dandelion control		
	product/a	5/4/06	5/12/06	8/11/06	5/4/06	5/12/06	8/11/06
Gramoxone Extra	2 pt	85	78	90	83	80	---
Goal 2XL	12.8 fl.oz	50	75	55	68	80	38
Rely	1 gal	51	93	70	29	81	40
Weed Pharm (vinegar, 20% acetic acid)	100%	30	78	50	35	77	---
Matran 2 (clove oil)	20%	62	60	32	72	61	15
Interceptor (pine oil)	20%	60	60	55	48	60	25
$LSD_{0.05}$	---	36	29	31	33	25	ns

[a]Herbicides were applied May 2 (all), May 2 (organics only), May 18 (organics only), June 4 (all treatments), and August 7 (all treatments). All non-organic treatments mixed with non-ionic surfactant at 0.25%, v/v; all organic herbicides mixed with Humisol and crop oil concentrate (both at 2%, v/v).
[b]Berries sampled July 20.

Project No: 13C 3419 7297

Title: Postemergence Canada Thistle Control in Red Raspberries

Year Initiated: 2006-07 **Current Year:** 2007-08 **Terminating Year:** 2007-08

Personnel:

Timothy W. Miller, Extension Weed Scientist, WSU NWREC
Carl R. Libbey, A/P Technician, WSU NWREC

Justification:

Canada thistle (*Cirsium arvense*) has long been weedy in western Washington. This perennial weed species frequently becomes established in perennial crop ground and, once established, is extremely difficult to control. Canada thistle spreads primarily by creeping perennial roots which grow through the row, by it is also easily spreads as root fragments through cultivation and by its plumed seed. The weed often will outlive the raspberry crop, is difficult to control in the break crop between raspberry plantings, so it generally remains a problem in the subsequent raspberry planting. Yet another difficulty with Canada thistle in raspberry is the physical interference to berry drop using machine harvesters, which may result in berry loss. Canada thistle also impacts harvest of hand-picked fruit, as any fruit picker with unprotected fingers can testify, and reduces the efficiency of hand harvest by making berries harder to find and pick.

It is important to gain new tools for controlling established Canada thistle in established raspberries. At the 2004 IR-4 food use workshop, Stinger was mentioned as potentially gaining registration for use in raspberry. I have tested two products aimed at controlling Canada thistle, Casoron (dichlobenil, applied postemergence rather than during the dormant season) and Stinger (clopyralid, applied postemergence) at WSU Vancouver in 2001 and near Burlington WA in 2006. Other berry studies I have conducted have shown that Stinger provides superior Canada thistle control, while the initial data from both studies indicate that late spring/early summer applications of Stinger causes only slight injury to raspberry, and that a similar application timing for Casoron was also highly effective with little visible raspberry injury. Because these raspberry blocks were quite thin due to disease or winter injury, the raspberry yield data was quite variable. Testing these products on healthy raspberries as if being applied to thistle-infested raspberry plants will provide information on effect of these products on yield as well as on primocane growth. Clearly, more reliable crop injury data resulting from applications of these products is needed to document that they are safe for use in raspberry if registrations are to result.

Objective: To test postemergence Stinger and Casoron for control of Canada thistle in established raspberries.

Procedures:

Plots will be established in 2007 in Canada thistle-infested raspberries as well as healthy raspberries near Mount Vernon. Herbicide applications at both sites will be made at two rates each for Casoron and Stinger and at two timings (early- and late-postemergence in late spring and early summer). Canada thistle control will be evaluated, as will herbicide effects on raspberry yield, berry size, and primocane growth. Additional herbicides will be tested as available.

Should the Red Raspberry Commission identify other perennial weed species they would like herbicide testing performed with, I will make an effort to perform those trials. Similar budget and procedures would be used for those additional species.

Anticipated Benefits and Information Transfer:

If positive, data from this experiment will be used to support a new herbicide registration in raspberries for Stinger and to fine-tune the existing label for Casoron. The data resulting from these studies will be disseminated through extension bulletins and during grower meetings sponsored by extension faculty and the agricultural industry.

Budget:

Amount allocated to PI by Red Raspberry Commission for FY 2006-07: $ 9,975

	Requested 2007-08
Salaries	
A/P technician (Carl Libbey)	$ 1,500
Time-slip	1,000
Operations (goods & services)	250
Travel	
Projected needs[a]	350
Meetings	0
Other	0
Equipment	0
Employee Benefits	
A/P technician (36%)	540
Time slip (13%)	130
Total Request	$ 3,770

[a]Travel will be used for plot work at an off-station site near Mount Vernon, WA.

Other Support of Project:

Herbicides are typically provided by herbicide manufacturers.

Project No: 13C-3419-7297

Title: Postemergence Canada Thistle Control in Red Raspberry

Personnel: Timothy W. Miller, WSU NWREC
Carl R. Libbey, WSU NWREC

Reporting Period: 2006-07

Accomplishments: This trial evaluated weed control and crop injury for two herbicides applied at two timings each for postemergence control of Canada thistle (*Cirsium arvense*).

Results:

The trial was conducted in a raspberry field near Burlington, WA (Sakuma Brothers Farm, cooperator) infested with thick patches of Canada thistle (*Cirsium arvense*). Plots were situated on top of these dense patches and herbicides were applied postemergence to Canada thistle plants up to about 8 inches tall (EPOST, May 2) and up to about 3 feet tall (LPOST, May 18). Primocanes at the time of treatment were about 6 and 18 inches tall, respectively, but were sheltered to a large degree by Canada thistle foliage. Weed control was evaluated May 12 and August 7. Canada thistle stems from all plots were removed by hand July 1. Berries were sampled July 20. The experimental design was a randomized complete block with three replicates.

Fruit yield did not differ by herbicide treatments, but fruiting was very spotty due to severe winter injury in the test row. Raspberry response to winter injury was poor enough to warrant removal of the block in late August.

Initial Canada thistle control in August was excellent with Stinger at either timing (98 and 96% control with EPOST and LPOST treatments, respectively). EPOST Casoron granules provided good knockdown, but Canada thistle had largely re-grown by the August evaluation. Sprayable Casoron was not applied at a high enough rate to fairly evaluate it, but continued testing appears to be warranted. As noted above, the raspberry block was destroyed in late August, consequently full evaluation of Canada thistle control from these treatments cannot be accomplished.

Table. Canada thistle control and raspberry yield after treatment with Stinger or Casoron (2006).

			Canada thistle control		Primocane injury		Fruit
Treatment[b]	Timing	Rate	5/12/06	8/7/06	5/12/06	8/7/06	yield
		product/a	%	%	%	%	g/crown
Stinger	EPOST	5.3 fl.oz	73	98	12	0	287
Casoron 4G	EPOST	100 lbs	50	10	12	0	289
Stinger	LPOST	5.3 fl.oz	---	96	---	3	540
Casoron (sprayable)	LPOST	3.2 fl.oz	---	43	---	5	239
Non-treated	---	---	0	0	0	0	823
$LSD_{0.05}$	---	---	9	20	3	ns	ns

[a]Herbicides were applied May 2 (EPOST) and May 18 (LPOST).
[b]Berries sampled July 20.

Project No.: 13C-3543-4370

Title: Integrating Insect and Mite Management in Red Raspberry

Year Initiated: 2004 Current Year: 2006 Terminating Year: 2007

Personnel: **Lynell K. Tanigoshi**, Entomologist[1]
Jeanette R. Bergen, Agricultural Research Technologist II[1]
[1]Washington State University, Vancouver Research and Extension Unit
Todd A. Murray, Extension Coordinator, IPM Project
Washington State University Whatcom County

Reporting period: 2006

Accomplishments:

Western raspberry fruitworm.
Laboratory bioassays.
Precision Potter Tower spray bioassays were used to apply and evaluate efficacy of six insecticides for adult western raspberry fruitworm mortality assessment. Raspberry leaves were uniformly sprayed, air-dried and their stem placed in a water filled vials capped with cotton plugs. After drying, 5 adult western raspberry fruitworms were placed on respective treated leaves and placed in Petri dishes and held at room temperature. Adult mortality was assessed every 24 hours (Table 1).

Table 1.

Treatment	lb(AI)/acre	Percent Mortality 1DAT	2DAT	3DAT	6DAT
Actara 25WG	0.06	91a	100a		
Provado 1.6F	0.05	40b	77ab	100a	
Diazinon 50W	1.00	100a			
Capture 2EC	0.10	43b	83ab	94a	94a
Success 2SC	0.09	77ab	94ab	100a	
AzaDirect	0.025	43b	71b	89a	91a
Untreated check		0c	oc	14b	49b

Mean within columns followed by the same letter are not significantly different (Turkey HSD test, $P<0.05$).

Field trials.
A ground emergence trap was developed and tested to measure adult emergence from the debris and soil around randomly selected hills of canes. The trap consists of a four-inch tall section of 8" diameter PVC pipe set atop the soil. An 8 inch^2 section of window screen, coated on the undersurface with Tanglefoot®, is placed on top of the pipe section. Emerging western raspberry fruitworm beetles become trapped on the window screen. Prebloom drench applications of malathion, diazinon and Capture (bifenthrin) at a rate of 0.1 lb(AI)/acre and an untreated check were applied on 8 April 2006, at two red raspberry farms in Lynden and one in Fife to evaluate the efficacy of drench applications to control overwintering adult fruitworm emergence. Three posttreatment evaluations were made.

The three experimental fields exhibited economic levels of fruitworm in 2005 but no detectable levels occurred in 2006. However, preliminary trials with our newly designed ground emergence trap captured multiple species of

ground emerging beetles and flies. These drench treatments will be repeated next year along with further refinements to the emergence traps.

Clay colored root weevil.

Laboratory bioassays.

Clay colored weevils (CCW) were collected from the Lynden area in mid-May and treated with 1x and 2x concentrations of Capture. Individual red raspberry trifoliate leaves were placed in a water filled vial cap with a cotton plug. Each treatment consisted of 35 weevils placed on individual leaf arenas uniformly sprayed with 1ml aqueous suspensions of Capture applied with a Precision Spray Tower at both concentrations (Table 1). Under these ideal lab conditions, the results for both concentrations of Capture suggest potential for the onset of resistance. This issue will be researched in greater detail in 2007 using similar bioassay techniques but with larger sample sizes and multiple collection dates.

Table 1.

		Percent Mortality			
Treatment	lb(AI)/acre	1DAT	2DAT	5DAT	7DAT
Capture 2EC	0.10	0a	0a	25a	38a
Capture 2EC	0.20	0a	0a	50a	50a
Untreated check		0a	0a	0a	0a

Mean within columns followed by the same letter are not significantly different (Tukey HSD test, $P<0.05$).

Field trials.

On 13 April 2006, the drench application was applied to a 4 year-old, 'Meeker' field. The one acre treated block (green block) was cultivated into eight rows, each 600 ft in length. Remaining rows adjacent to this block were chosen as the untreated check. The application was applied with a Rear's PTO pull along, over-the-row boom, equipped with 8030 flat fan nozzles @ 70 psi, delivering 300 gpa. Capture was applied at a rate of 0.1 lb(AI)/acre.

On 18 April 2006, root weevil populations were assessed using the standard beating tray method at 20 randomly selected sites in both the Capture and the untreated check. One CCW/20 trays was collected in the Capture block and 2 CCW/ 20 trays were collected in the untreated check (Table 2). The grower repeated the drench trial 26 April 2006 on eight rows west of the green block. This new block (pink) covered 0.5 acre cultivated into 4 rows, each 600ft in length (21 post lengths). Capture was applied at the above rate of 0.1 lb(AI)/acre. The results of both trials indicate that Capture applied as a drench, remains effective against clay colored weevil adults for over three weeks, when applied as a basal applied prebloom drench.

Drench trial.

		CCW adults/20 beat trays			
Treatment	Rate	18-Apr	3-May	10-May	19-May
Capture -pink	0.1 lb(AI)/acre	1	6	7	0
Capture-green	0.1 lb(AI)/acre		6	1	0
Untreated check		2	14	13	15

Mean within columns followed by the same letter are not significantly different (Tukey HSD test, $P<0.05$).

Root weevils. Other than spotty clay colored weevil infestations in the north Lynden area, the black vine, strawberry and rough strawberry root weevils were generally economically managed throughout the red raspberry growing regions.

Winter moth.

Laboratory bioassays.

Potter Spray Tower applications to 3 inch tips of blueberry showed excellent contact/stomach activity at 3oz. and 5 oz. rates of Avaunt and diazinon at 2 days posttreatment (Table 3).

Table 3.

		Percent Mortality	
Treatment	Product/ acre	1DAT	2DAT
Avaunt 30G	3.5oz	77a	100a
Avaunt 30G	5.0oz	83a	100a
Diazinon	2 lb	93a	100a
Untreated check		3b	7b

Means within columns followed by the same letter are not significantly different

Laboratory bioassays.

Experimental Avaunt (indoxacarb) at 2 rates was compared with Diazinon for efficacy to winter moth larvae feeding on red raspberry foliage in Ridgefield, WA. (Table 4). After 2 days posttreatment, all marked and destructively sampled winter moth domiciles showed 100% morality for the 5 oz rate of Avaunt and the standard 2 lb/acre for diazinon.

Table 4.

		Percent Mortality		
Treatment	Product/ acre	1DAT	2DAT	5DAT
Avaunt 30G	3.5oz	70a	80a	100a
Avaunt 30G	5.0oz	70a	100a	
Diazinon	2 lb	90a	100a	
Untreated check		0b	10b	0b

Means within columns followed by the same letter are not significantly different (Tukey HSD test, $P<0.05$).

Orange tortrix.

Laboratory bioassays.

The residual activity of these newer formulations of DiPel and Xentari were bioassayed in the laboratory with field aging of both formulations to 3rd instar orange tortrix larvae (Table 5). Both formulations of Bt provided significant residual activity 13 days posttreatment. Under the preharvest conditions of these field tests in mid-June, XenTari showed higher larval mortality in the laboratory compared with DiPel.

Table 5.

			Percent Mortality		
Treatment		Product/ Acre	1DAT	4DAT	5DAT
XenTari	Bt- aizawai	1 lb	76a	80a	100a
DiPel	Bt- kurstaki	1.5 lb	17b	87a	92a
Untreated check			0c	3b	9b

Percentages within columns followed by the same letter are not significantly different (Tukey HSD test, $P<0.05$).

Percent Mortality

Treatment		Product/ Acre	8DAT	11DAT	13DAT
XenTari	Bt- aizawai	1 lb	78a	84a	90a
DiPel	Bt- kurstaki	1.5 lb	56a	56b	66b
Untreated check			4c	8c	10c

Percentages within columns followed by the same letter are not significantly different (Tukey HSD test, $P<0.05$).

Field trials.

Dry flowable formulations of the biological insecticides DiPel® and XenTari® were field tested against malathion for second generation orange tortrix control in Woodland, WA. Recommended rates for each insecticide were applied to 0.5 acre, non-replicated plots on 14 June 2006 at 125 gpa. A second treatment, as above, was applied on 22 June. Visual searches for webbed feeding sites on primocanes were made on each side of each row for all rows in the study. These new formulations of Bt performed very well when compared with malathion (Table 6). Our knowledge of orange tortrix population dynamics in the Woodland bottom area and its association with pheromone trap catch accumulations enabled us to time these treatments at time of second generation hatch and the propensity of early instars to migrate to terminal primocane foliage.

Table 6.

Bt trial for orange tortrix control.

Treatment	Rate lb(AI)/acre	% alive compared with Malathion	Number of live larvae
DiPel	1 form.	24%	6
XenTari	1.5 form.	16%	4
Malathion	2-Jan	100%	25

Project No.: 13C-3543-4370

Title: Integrating Insect and Mite Management in Red Raspberry

Year Initiated: 2004 Current Year: 2006-2007 Terminating Year: 2007

Personnel: **Lynell K. Tanigoshi**, Entomologist[1]
Beverly S. Gerdeman, Research Associate[1]
[1]Washington State University, Mt. Vernon Research and Extension Center

Justification: A review of insecticides and miticides in the *Pacific Northwest 2006 Insect Management Handbook* lists 11 synthetic pesticides recommended for effective insect and mite control in red raspberry. Seven of them are "older", broadspectrum, synthetic organic insecticides, specifically, the organophosphates (Malathion, Diazinon, Guthion), the carbamate Sevin and pyrethroids (Asana, Brigade/Capture, permethrin). The remaining ones include the recently registered Brigade/Capture for economic control of root weevils and a few specific compounds that have been classified by the EPA as reduced-risk, OP replacements and biopesticides. EPA's FQPA guidelines and current trends in chemical registration portend 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.

Objectives:

1. Continue evaluating prebloom timing, monitoring for drench applications of Capture to the crown of red raspberry for control of overwintering adults of the western raspberry fruitworm, *Byturus unicolor* and clay colored weevil, *Otiorhynchus singularis*. Other registered and experimental insecticides will be evaluated in the lab and field.

2. Investigate the 2006 reported incidence of economic levels of the yellow spider mite, *Eotetranychus carpini borealis*, and twospotted spider mite, *Tetranychus urticae* with surveys and monitoring throughout the 2007 season including postharvest.

Procedures:
1. With the recent FMC supplemental label for Capture 2EC as a pre-bloom or post-bloom drench application at the rate of up to 400 gallons/acre, we have an excellent broad-spectrum treatment that possesses potential to control overwintering adults of the western raspberry fruitworm, clay colored and rough strawberry root weevils and mature larvae of the strawberry crown moth and raspberry crown borer. Multiple field sites will be selected in Whatcom-Skagit counties for prebloom drench trials to control the raspberry beetle and root weevil adults. Raspberry fruitworm adults will be monitored with our beetle emergence traps while root weevils will be sampled using the standard beating tray and visual searches within developing crowns. Based on empirical field observations and timed with good field conditions prior to mid-April, we will make drench applications using an over the row hydraulic sprayer equipped with two Turbo Floodjet nozzles delivering up to 400 gallons/acre. Malathion and Diazinon will be applied as comparative drench standards with an untreated check. Treatments will be replicated five times in plots measuring 2-3 post lengths arranged in a RCB design.
2. Using the current successful model integrating biological control of spider mites with traditional chemical means of controlling insects, at pre- and post harvest, reports of economic injury levels of spider mites by mid-July in previous seasons, will be investigated. In California, it has been established that injudicious application(s) of pyrethroid insecticides will flare-up spider mite populations. Safety ratings we reported for Asana and Capture during 2003 and 2004 showed them to be moderately harmful (i.e. 33-66% mortality) to the predatory mite, *Neoseiulus fallacis*. In addition, our field observations indicate complete elimination of several species of ladybird beetles in June when preharvest pyrethroid/OP insecticides are applied. These beneficial beetles are known to be important early season predators of aphids and spider mites. We will also perform laboratory bioassays and limited field trials of potential acaricides already registered or in the EPA registration pipeline that may eventually fit well in our insect/mite IPM program (e.g., Savey, Acramite).

Anticipated Benefits and Information Transfer:
Pending registrations of additional insecticides and miticides with different modes of action (e.g., neonicotinoids, carbazates, pyridine compounds), a root weevil, worm and spider mite control program that integrates biological and

chemical control for spider mites infesting red raspberry may be realized. Evolving toward increased biological control and reduction in pesticide usage. Results from this project are expected to advance grower understanding of control methods for the adult, overwintering stage of the western raspberry fruitworm and susceptible overwintering adults of the clay colored weevil with a proven pyrethroid applied as a prebloom drench treatment. In cooperation with WSU Whatcom and Skagit County Cooperative Extension personnel, research information will be disseminated at regional and national grower's meetings as well as through local, regional and national publications. Newsletters and WSU Mt. Vernon REC's website will update industry on new developments as appropriate.

Budget:

			2007
00	Salaries[1]	$6,200	
01	Wages[2]	3,000	
03	Goods and services[3]		500
04	Travel[4]		500
07	Employee benefits (36% of 00)	2,232	
	Employee benefits (11% of 01)	330	
Total			**$12,762***

[1]Research Associate
[2]Time slip assistance
[3]Lab and sprayer supplies and equipment
[4]To and from plots in vicinity of Mt. Vernon REC
*We would like this grant to be submitted to the Washington State Commission on Pesticide Registration for an equal match of 12,762.

Title: Red Raspberry Cultivar Development

Year Initiated: 2001 **Current Year:** 2007-2008 **Terminating Year:** 2009

Personnel:
Chaim Kempler (Research Scientist) and Brian Harding (Technician).
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Collaborators: Pat Moore, WSU Puyallup.
Chad Finn, ARS-USDA Corvallis.

Project Description:
This program develops red raspberry cultivars, with an emphasis upon creating varieties exhibiting suitability for machine harvesting, suitability for processing, dark fruit, winter hardiness, and resistance to RBDV, root rot, and aphids. Of particular importance is to speed up the release of cultivars that are disease and pest resistant, to replace the industry standard, Meeker.

Justification:
The Agriculture and Agri-Food Canada (AAFC) breeding program supports the berry industry throughout the Pacific Northwest (PNW) and produces new berry varieties that enhance production. Of particular importance to the industry is the development of cultivars displaying disease and pest resistance, such as resistance to raspberry bushy dwarf virus (RBDV), root rot, fruit rot and raspberry mosaic virus (RMV). The RMV complex can be a limiting factor in raspberry production but can be simply controlled by introducing resistance to its aphid vector. Reaction to the aphid vector *(Amphorophora agathonica)* of the RMV is used by the Pacific Agri-Food Research Centre (PARC) program as a primary screen in the seedling stage. All the cultivars that are released from this program are resistant to the common biotype of *A. agathonica*. A resistance-breaking biotype of *A. agathonica* has been found in North America but is not causing problems, as it does not colonize very well on resistant cultivars and is not yet a vector of RMV. Raspberry bushy dwarf virus (RBDV) causes symptoms that adversely affect fruiting and growth in susceptible raspberry cultivars and selections. The combination of RBDV with raspberry mosaic virus (RMV) has been shown to be particularly detrimental to growth and fruiting. The most common strain of the RBDV virus has been controlled by breeding for resistance. Of cultivars released in the past, Haida and Nootka, and Chilcotin are resistant to RBDV. Cowichan, released in 2001, has given some hope to the industry that there is a cultivar that is suitable for mechanical harvesting and that escapes RBDV. Close to a million Cowichan plants have already been planted across the PNW since its release. The advance testing shows that Cowichan meets expectations; Cowichan escapes RBDV, machine harvests very well, is high yielding, stands up well to spring frost and winter injury and establishes very well in the first year after planting. It produces good quality fruit with good flavor that is also suited for the fresh market. However, although it grows very vigorously, it lacks root rot resistance needed for success in infected soils, or heavy and poorly drained soils. Chemainus (BC89-33-84), a recently released variety, has more than half a million test plants growing across the PNW. This cultivar produces large, glossy, dark, firm fruit that is suited both for processing and the fresh market and machine harvests very well. Its fruit is very suited for the IQF processing market. Saanich (BC89-34-41) is the most recently released PARC cultivar and has been extensively planted throughout the PNW. Saanich attracts attention mainly for its high yield, its exceptionally good fruit quality which is very suited for IQF, and its suitability for mechanical harvesting. It is also very slow to become infected with RBDV. Its reaction to root rot is unknown. The prediction is that in 2-3 years the sale of PARC released cultivars will pass that of Meeker, the leading PNW variety for the last 30 years.

The PARC breeding program is using selections of *R. strigosus* as new sources of resistance to the root rot caused by *Phytophthora fragariae*. F1 to F3 are tested and used in back crosses to incorporate resistance into cultivars and advance selections. A hybrid between Tulameen and *R. strigosus* (BC90-19-34) has shown greenhouse and field resistance. Other resistant cultivars are used in crosses to improve root rot resistance with the goal of combining this resistance with resistance to RBDV.

Selections with improved fruit quality (size, firmness, and color) and with extended ripening dates will improve production and market appeal. Selections with fruit qualities suitable for processing will benefit the value-added processing sector of the industry. Other important traits include improved fruit size, increased fruit number per lateral, reduced spines, increased fruit firmness, fruit rot resistance, ease of harvest, low chilling requirements and winter hardiness. In BC, winter hardiness is a primary concern in the selection procedure. Unusually cold test winters that occur during the selection years allow for selection of more hardy genotypes. Selections that go dormant early and break dormancy late are probably the most desirable to select for cold hardiness.

The PARC breeding program has broadened its genetic base by drawing on different sources. Parents derived from various species are used. Furthermore, germplasm from other breeding programs around the world is used. This germplasm is tested and used to incorporate desirable traits into PARC selections. Also, a wide range of wild species are used. Three cultivars released from the program (Tulameen, Qualicum and Malahat) have the black raspberry, *Rubus occidentalis* L., in their derivation. In addition, Malahat is a descendant of *R. phoenicolasius* Maxim. Some of the potential cultivars that are now in growers' trials contain *R. occidentalis* in their derivation. Kitsilano has *R. crataegifolius* in its derivation, while BC90-6-2, BC90-8-11, BC90-8-20, and BC92-6-41 have the Dalhousie Lake selection of *R. strigosus* Maxim. in their derivations. BC90-19-34 is F1 cross between Tulameen and the 'Lake George' selection of *R. strigosus*, and BC90-2-45 has Kanata B in its derivation.

The PARC breeding program emphasises releasing potential cultivars to the propagators for multiplication and fast testing on growers' fields. We believe that the fastest way to introduce new cultivars to the industry is planting them on growers' fields.

Objectives:
To develop red raspberry selections, stressing suitability for machine harvesting, dark fruit, winter-hardiness, resistance to root rot, resistance to divergent aphid biotypes, and resistance to RBDV. Specific goals include:
-The fast release of potential cultivars to propagators to multiply for testing on growers' fields.
-Cultivars that combine resistance to pollen infection from RBDV and to root rot.
-Manageable plant habit that is suitable for machine harvesting and produces high yields, superior fruit quality, good flavour, size, firmness, small drupelets, ease of harvest, and fruit rot resistance.
-Winter hardy plants that withstand low temperatures and desiccating winds throughout winter months, and/or late breaking dormancy.
-Dark color fruit for processing that exhibits small drupelets that are suited for IQF.
-Large, firm, light color fruit that is suited for the fresh market.
-Aphid resistance, which controls the Raspberry Mosaic Virus Complex (RMVC).
-Resistance or tolerance to cane diseases (such as spur blight, cane *botrytis* and cane spot), spider mites, lesion nematodes, bacterial blight, crown gall and to leaf diseases such as rust and powdery mildew.
- Adequate replacement cane production.

Procedures:
Experimental Details: This will involve the harvest of sound and rotten fruit, the assessment of ease of harvest, fruit firmness determinations with a pressure gauge, postharvest rot determinations, soluble solid and acidity determinations, and observations of various pests and diseases under field conditions. Seedlings will be screened for aphids. Advance selections will be screened for root rot resistance. Evaluation will continue on all the selections in the test plots at the Abbotsford Sub-Station. The evaluation in the test plots will include yield and fruit quality determinations, ease of harvest and reactions to various pests and diseases, including fruit rot, cane disorders, aphids (which vector the mosaic virus complex), raspberry bushy dwarf virus and root rot (*Phytophthora fragariae)*. Any winter damage will be recorded relative to the standard cultivar Meeker.
Advanced selections will also be used in further breeding to develop a broad base of resistance.
Activities:
- Create 2007 crossing blocks – cross selections that stand up to root rot under field conditions with cultivars and potential cultivars that have RBDV resistant parents in their derivation and therefore might be resistant.
- Evaluate the seedling populations planted in 2004 and 2005.
- Continue propagation of advanced selections for WRRC and RIDC machine harvest evaluation.
- Establish replicated trials at the Abbotsford substation to assess advanced selections suitable for processing and machine harvest.
- Evaluate advanced selections in growers' fields throughout the PNW to assess productivity, machine harvesting, and resistance to root rot and RBDV.

- Release potential cultivars to the propagators.
- Supervise distribution of advanced selections to North American propagators and growers and subsequently monitor their performance.
- Evaluate Cowichan, Esquimalt, Chemainus, Saanich, BC90-6-2 and others on large growers' trials.
- Conduct collaborative research with Robert R. Martin, USDA-ARS, Corvallis, Mike Bernardy, PARC Summerland and Ron Wilen, University Collage of the Fraser Valley to develop a marker assistant process to identify RBDV resistance at the seedling stage. When available, this procedure can shorten the usual 10 years or more that it takes for testing of resistance into a simple screening process that can be done before the seedlings are planted in the field.

Anticipated Benefits and Information Transfer:
Six out of the twelve research priorities determined by the Red Raspberry Commission are addressed in the objectives of the PARC breeding program and are of major importance within this research proposal. It is well established that, when possible, breeding for resistance is the most sustainable and preferable way to address industry concerns and needs. The PARC program emphases the development and release of RBDV resistant cultivars (such as Cowichan) and cultivars that will withstand *Phytophthora* root rot pressure (Cowichan, Chemainus, BC90-19-8 and 92-6-41). All PARC releases are resistant to aphids, which cause insect contamination at harvest. Many of the PARC releases are suited for the fresh market, extend the harvest season and are tested for both pre- and post-harvest fruit rot.
The results of the evaluations will be directly available to the PNW red raspberry industry. In the coming years, the evaluations will help determine the commercial suitability of the latest releases and other selections. It will also allow the PARC breeding program to continue its breeding activities, identifying new potential cultivars to be released for propagation and further testing.

Budget: (2007/08)
Amount requested from the

Washington Red Raspberry Commission (WRRC)	**$CD 6.900 ($US 6,000)**
Raspberry Industry Development Council (RIDC)	$CD 15,000
Lower Mainland Horticultural Improvement Association (LMHIA)	$CD 4,000
AAFC MII commitment (approved-conditional to industry funding)	**$CD 44,818**

Resource commitments by	**MII**	**Industry(Cash)**	**Industry(in-kind)**
Salary	25,000	-	-
Benefits	5,000	-	-
Student salary	-	17,960	-
Travel	-	1,000	-
Operating	5,565	1,700	-
RIDC technical coordinator			2,500
RIDC use of growers land			5,000
RIDC plant propagation for growers trials			2,250
WRRC " " for the Abbot. Site			900
RIDC Virus testing			4,188
RIDC soil testing			480
WRRC trials 04/05 planting			2,200
WRRC trials 05/06 planting			1,700
WRRC technical coordinator			1,500
Admin cost on industry in-kind	3,108	-	-
Admin cost (15%)	5,845	3,140	-
Total	**$ 44,818**	**$ 23,800**	**$ 20,718**

Budget Summary

Contribution			
RIDC		15,000	
WRRC	(US$6,000)	6,900	
LMHIA		4,000	
Industry in-kind		20,718	
Total industry (Cash + in-kind)			**46,618**
AAFC-MII			46,618
Total for project			**93,236**
Administration cost (AAFC-PARC)			12,093
Total funds available to the program			**60,425**

Progress Report
Title: Red Raspberry Cultivar Development for the Pacific Northwest
Personnel: Chaim Kempler, Fruit Breeder, KemplerC@agr.gc.ca

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Reporting period: 2006
Funding in 2005 was received from the BC Raspberry Industry Research Council, Washington Red Raspberry Commission, and Lower Mainland Horticultural Improvement Association (LMHIA), royalties collected on PARC cultivars and Agriculture and Agri-Food Canada's Matching Investment Initiative (MII).

Accomplishments:
The latest releases from the PARC program performed very well on large growers' trials. Cowichan established very well with excellent vigorous growth. It machine harvests well and produces high quality fruit that is also suited for the fresh market; however, it does show some symptoms of susceptibility to root rot. Chemainus (tested as BC89-33-84) performed extremely well. It machine harvests very well, producing high quality fruit that is suited for both the fresh and the IQF processing markets. The latest named cultivar, Saanich (tested as BC89-34-41), has been tested on farmers' trials and has gained acceptance by commercial producers. It produces very high yields of high quality fruit that is machine harvestable and very suited for IQF processing.

This year machine harvest (MH) trials that were planted in 2004 were evaluated. A total of 6 selections were identified as promising; they are already being propagated for advanced, large-scale grower's trials. New MH trials were planted on the Honcoop (Lynden) and Janzen (Abbotsford) farms. The Janzen planting has established very well and will be ready for first year evaluation in 2007.

During the 2006 harvest season, the 2002 and 2004 plantings were evaluated for yield, fruit traits and harvest season. Harvest data is presented in Tables 2-3. In 2006, thirty-one selections had tested RBDV positive for the first time, and most of them will be discarded. Seventy new crosses were made; most with one or two parents that are resistant to root rot and RBDV. They are being propagated and will be planted in the spring of 2007 after a screening for resistance to aphids.

Notes on cultivars and potential new cultivars:

Cowichan (Newburgh x Qualicum):
Cowichan appears to be a very promising option that offers resistance to RBDV infection. Its parent, the Newburgh variety, was introduced in 1929 from a cross made between Newman and Herbert. Newburgh is not a very productive variety and has small fruit, but it is resistant to both RBDV and root rot and it is relatively winter hardy. Cowichan was produced from a cross between Newburgh and Qualicum. It is productive, has large fruit size and good fruit quality and a vigorous growth habit. The variety is very quick to establish and produces a high yield after the first planting year. Cowichan plants tested in greenhouse trials showed some resistance to root rot; however when planted into root rot infected and poorly drained land, Cowichan did not stand up against root rot and should be considered as moderately susceptible to root rot. In the research plots, it was very vigorous, establishing quickly and producing yields that are higher than Meeker. Cowichan ripens about three days earlier than Meeker and its mid-point harvest was five days earlier than Meeker. In field trials, although exposed to high pressure of RBDV for more than 10 years, it has tested negative to RBDV, while Meeker and other PNW varieties grown in the same field have shown very high infection rates. It can be assumed that Cowichan is resistant to RBDV. In large-scale growers' trials it has shown itself suitable for mechanical harvesting producing good quality fruit. Cowichan fruit appears to be also suited for the fresh market, producing large firm fruit with a deep red colour, very good flavour and an aroma comparable to that of Tulameen and Chilliwack. Plant growth is very vigorous with an upright habit and large number of primocanes. Floricanes produce long and strong laterals. Fruit is spaced well apart along the laterals. It appears to be relatively susceptible to cane botrytis (*B. cinerea*) and spur blight (*Didymella applanata*).

Chemainus Tested BC89-33-84 (BC82-5-84 x Tulameen):
A mid-season processing and fresh market type that produces large-sized, medium-dark color attractive berries with some resistance to fruit rot. The fruit is easy to harvest and will machine harvest very well with excellent quality fruit that can be used for IQF. The fruit is glossy, large, and firm, perfect in shape with fine drupelets, and so is very suitable for IQF and fresh markets. The plant has excellent vigor, producing plenty of replacement canes. Its primocanes are green with no spines and its laterals are short and strong with a good upright angle and well spaced fruit. It is not resistant to RBDV. The selection appears to have some field resistance to root rot showing good growth in comparison to Meeker and Malahat. Chemainus is gaining popularity in the PNW with large acreages that have already been planted.

Esquimalt Tested as BC89-2-89 (Comox x Glen Ample):
Esquimalt produces high yields of very large fruits that are firm and well adapted for fresh market and IQF. The selection is a cross between Comox and the Scottish variety Glen Ample. Fruit will ripen later than any other recommended PNW variety. Fruit is meaty and larger than Tulameen, light in color. The large fruit also have large drupelets that tend to break when harvested too green. The plant is very vigorous, with strong spineless canes and long, strong upright laterals. It is not recommended for machine harvest. It is not resistant to RBDV. It is susceptible to cane botrytis (*B. cinerea*) and its reaction to root rot is unknown.

Saanich Tested as BC89-34-41 [(Algonquin x Chilliwack) x (Nootka x Glen Prosen)]:
Named in the fall of 2005, Saanich is a very promising newly released cultivar from the PARC program. It is one of the most productive cultivars. It is suited for the fresh or processing market producing high yields with a fruit size that is slightly larger than Meeker. The excellent quality fruit are firm with a medium gloss, fine drupelets and a very pleasant sweet flavor that is comparable to Tulameen. Because of its small drupelet size, it will IQF extremely well holding its shape with no breakage. The canes are spineless with laterals that are short and bend easily without breaking and so are able to carry the high yield. In large grower's trials, the fruit released well from the receptacle and harvested very well mechanically. This selection, although exposed to high pressure of RBDV for many years, has been very slow to show RBDV infection. It was released because of its productivity, suitability for machine harvesting and exceptionally high fruit quality that is suited for IQF. It produces medium-sized, medium-light-red firm fruit. Its very sweet flavour that might also make it suited for specialty fresh fruit markets.

BC90-6-2 (BC86-41-15 x BC83-15-15):
BC90-6-2 was selected from a cross between a root rot resistant *R. strigosus* derivative and a selection from a cross between Comox and Algonquin. We have noted it for its short internodes, compact plant habit, extremely late production season and its very large, meaty fruit. Fruit is round, firm and dark red in color which makes BC90-6-2 suited also for processing. It machine harvests very well, producing high yields of dark, firm fruit that is not suited for IQF processing because its breaks when exposed to liquid nitrogen. It is very suited for the late fresh market due to its long harvest duration, late producing period and very large and very firm fruit. The dwarf growing habit of the plant might allow growing it with less support and saving on pruning labor.

New selections for growers' trials:

BC90-8-11 (BC86-41-15 x Qualicum):
This is a second backcross from a *R. strigosus* Dalhousie Lake 4 clone. It produces a large, mid-to-late season crop that is most suited for the fresh market but also might be acceptable for processing. The fruit is conical, large and meaty, firm and very attractive. The plant has an upright habit and fruit is well spaced and presented on the laterals.

BC90-8-20 (BC86-41-15 x Qualicum):
A productive mid-season selection that produces large fruit that is light in color and most suitable for the fresh market. This selection is not suited for mechanical harvesting. The large, low-gloss fruit strongly resembles Qualicum. Plant vigor is not excessive with leaves that are large and light green color. It is resistant to aphids and might also be resistant to the resistance-breaking biotype of aphid.

BC90-11-44 (Algonquin x Qualicum):
This is a very productive selection that produces over an extended harvest season. The attractive fruit is large size, glossy and firm with very fine drupelets. It is easy to harvest and performed well in mechanical harvesting trials. The fruit is suited for processing, IQF and fresh markets. This selection is not resistant to RBDV and is relatively susceptible to root rot.

BC92-5-47 (Kitsilano x BC86-40-6):
This selection is a productive mid-size fruit selection from a third back cross from the *R. strigosus* Dalhousie Lake 4 clone. It has performed well in MH trials and is yet to be tested on larger trials. The fruit is dark, firm, round shaped with fine drupelets and may be suited for IQF. Fruit color is dark as Meeker and tends to be dull with low gloss. It is not resistant to RBDV and its reaction to root rot is unknown.

BC92-6-41 (Chilliwack x BC86-41-15):
This selection was identified for its high field resistance to root rot. It is from a second back cross from the *R. strigosus* Dalhousie Lake 4 clone. This source is not known to be present in any other cultivar. BC92-6-41 produces high yields of fruit that are easy to harvest. Fruit is conical medium red color with low gloss. It still needs to be tested for mechanical harvesting and for suitability to IQF processing. It is productive and keeps good size over its long harvesting season. Limited numbers of plants are available from the propagators for planting on root rot infected areas for the 2007 season.

BC96-21R-56 [(Tulameen x *R. strigosus*) x (Meeker x (Glen Moy x Comox))]:
This selection is from a first back cross from *R. strigosus*, collected from 8th Lake State Park Campground, Adirondack State Park, NY. The parent was selected because of its resistance to root rot. In machine harvest trials it preformed very well, producing firm, not overripe dark fruit comparable to Willamette in color. Fruit size averages about 4 g, which is larger than Meeker. The fruit is round, meaty, glossy and has large drupelets. It will be propagated for additional testing.

BC96-22R-55 [(Tulameen x *R. strigosus*) x (Cherokee x Qualicum)]:
This selection is from a first back cross from *R. strigosus*, collected from 8th Lake State Park Campground, Adirondack State Park, NY. The parent was selected because of its resistance to root rot. In machine harvesting trials, it harvested very well, producing fruit as dark colored as Meeker. The fruit is attractive and large in sized (exceeding 5g). It is round shaped with large, coarse drupelets and a glossy red color. The plant growth habit is well adapted for machine harvesting, with short, strong, upright laterals. The harvest season of this selection starts about one week after Meeker's season and is short and concentrated.

BC96-37-1 [(Tulameen x *R. strigosus*) x Kitsilano]:
This selection is from a first back cross from *R. strigosus* from Lake George, Minn. And may be resistant to root rot. It produces a high yield of dark fruit that is suited for processing and mechanical harvesting. The fruit is small to midsize and round in shape with fine drupelets that make it suited for IQF, too. The fruit color is as dark as Meeker. It is susceptible to RBDV.

BC97-30-3 (Qualicum x Willamette):
In the machine harvesting trial, this selection harvested very well. The fruit size is larger and the color is darker than Meeker; the fruit is firm with small, fine drupelets. The fruiting season is similar to that of Meeker. It is not resistant to RBDV.

BC97-30-20 (Qualicum x Willamette):
This selection has dark small fruit that look like Willamette fruit and that machine harvest well.

BC1-37-4 [(WSU1020 x BC86-41-15) x Cowichan]:
This selection tested as suited for machine harvesting.

BC1-37-32 [(WSU1020 x BC86-41-15) x Cowichan]:
Large fruited selection that is suited for fresh market or IQF.

BC1-50-2 [Saanich x (Newburgh x Tulameen)]:
This is a very productive selection producing large firm fruit with fine drupelets that may be suitable for machine harvesting, IQF and fresh market.

A limited number of plants from this list will be available for trials from Sakuma Bros. in Burlington, WA., Tel.: (360) 757-6611, Ken M. Spooner Farms, Tel.: (253) 845-5717 and from PARC Agassiz (604)796-2221. You are encouraged to plant and test some of these experimental trial selections.

Plot	Clone	Yield (% of Meeker)	Harvest ability	Fruit color	Comments	
9	BC 90-12-50	90				Discard
11	BC 92-5-1	129		dark		Discard
30	BC 93-2-7	167				Discard
31	BC 96-18R-16	56	does not harvest		fresh market	Discard
76	BC 1-11-12	97	over rip	light		Discard
70	BC 1-11-5	96	over rip			discard
3	BC 1-17-1	97		very dark	off flavour, fresh market	discard
17	BC 1-17-4	82		med-dark		discard
4	BC 1-56-28	86	harvest well	dark	fresh market,	discard
29	BC 1-67-6					discard
57	BC 1-73-5	75		light		discard
67	BC 1-81-2	103	harvest well	dark		discard
39	BC 1-84-1	113		light	IQF small drupes	discard
59	BC 92-9-15	118	harvest well	light	Also fresh market	Growers Trials
32	BC 93-9-40	123	harvest well		good flavour,	Growers Trials
78	BC 97-30-20	57	very well	dark	Willamette like, IQF, suited for yogurt	Growers Trials
61	BC 1-16-8	high	very well	dark	large nice fruit, fine drupes, firm, IQF well	Growers Trials
13	BC 1-37-4	63	harvest well		fruit breaks, IQF	Growers Trials
26	BC 1-50-14	92	harvest very well		very suited for IQF	Growers Trials
43	BC 97-18-48	124			test again	
15	BC 1-19-1	65		dark	test again	
14	Tulameen	123				
25	Cowichan	70	harvest well	med-dark		
36	Willamette			Very dark		
68	Meeker	100		Dark		
	Saanich	very high	very well	med-dark	High yield excellent quality, IQF very well	

Table 1. Machine harvest evaluation of PARC selections planted in 2004 (Mt. Vernon, WA).

Table 2a. Yield, fruit weight, harvest season and harvest ease of raspberry cultivars harvested in 2006, Abbotsford BC

Clone	Rep	Total Yield (kg/hill)	Marketable Yield (tons/ac)	Early Yield[1] (%)	Fruit Weight (g)	5% Harvest (Date)	50% Harvest (Date)	95% Harvest (Date)	Harvest Duration (Days)
2002 Planting									
90-06-2	2	3.81	6.12	38.2	4.4	25-Jun	09-Jul	24-Jul	31
90-08-20	3	3.49	5.69	11.2	4.9	04-Jul	12-Jul	25-Jul	22
90-2-45	1	3.10	5.03	13.3	3.7	03-Jul	13-Jul	26-Jul	24
90-5-30	2	4.03	6.50	24.5	4.2	30-Jun	12-Jul	29-Jul	30
92-9-39	1	2.82	4.57	26.0	5.0	30-Jun	11-Jul	29-Jul	30
96-17-50	1	1.46	2.36	56.5	2.9	24-Jun	05-Jul	17-Jul	24
97-22-121	1	1.06	1.71	7.9	2.1	05-Jul	17-Jul	08-Aug	35
97-25-58	1	3.88	6.31	22.1	3.8	01-Jul	11-Jul	25-Jul	25
97-27-2	1	3.19	5.13	34.9	3.4	01-Jul	09-Jul	25-Jul	25
97-27-31	1	2.26	3.67	46.6	3.3	24-Jun	07-Jul	24-Jul	31
97-27-6	1	2.05	3.29	58.3	3.1	25-Jun	05-Jul	19-Jul	25
97-29-23	1	2.36	3.86	5.0	3.6	06-Jul	16-Jul	04-Aug	30
97-29-29	1	3.93	6.39	14.2	4.3	02-Jul	16-Jul	05-Aug	35
97-29-35	1	3.65	5.87	20.2	3.7	01-Jul	11-Jul	30-Jul	30
97-29-43	1	4.42	7.13	34.7	3.3	30-Jun	09-Jul	29-Jul	30
97-29-71	1	4.54	7.55	23.6	3.7	30-Jun	14-Jul	02-Aug	34
97-30-49	1	2.75	4.43	33.3	3.9	29-Jun	09-Jul	24-Jul	26
97-33-22	1	2.60	4.17	18.9	3.9	01-Jul	11-Jul	24-Jul	24
97-38-1	1	2.83	4.58	26.3	3.7	01-Jul	10-Jul	02-Aug	33
Chilcotin	1	3.54	5.70	14.1	3.0	02-Jul	17-Jul	05-Aug	35
Chilliwack	1	2.98	4.80	30.7	3.3	30-Jun	14-Jul	22-Jul	23
Cowichan	3	4.21	6.80	17.2	4.5	02-Jul	14-Jul	30-Jul	29
Meeker	2	3.63	5.85	8.7	2.9	04-Jul	15-Jul	29-Jul	26
Qualicum	3	4.38	7.10	20.3	4.5	01-Jul	12-Jul	26-Jul	25
Tulameen	3	3.05	4.92	14.8	3.7	02-Jul	13-Jul	04-Aug	33
C. Delight	2	4.57	7.53	6.5	4.5	06-Jul	15-Jul	29-Jul	25
WSU1112	2	2.82	4.57	4.7	4.9	06-Jul	17-Jul	05-Aug	31
LSD[2]		**2.11**	**3.39**	**13.2**	**0.78**	**3**	**6**	**6**	**5**

Plants were grown in hills with spacing of 3ft between the plants and row spacing of 10ft (3588 plants/ha). Plants were pruned to 6 canes per hill and topped to a height of 5ft.

[1]Early Yield harvested before July 10, 2006

[2]Data from replicated plots were subjected to analysis of variance with least significant difference (LSD) of 5% used to separate means

Table 2b. Yield, fruit weight, harvest season and harvest ease of raspberry cultivars harvested in 2006, Abbotsford, BC

Clone	Rep	Total Yield (kg/hill)	Marketable Yield (tons/ac)	Early Yield[1] (%)	Fruit Weight (g)	5% Harvest (Date)	50% Harvest (Date)	95% Harvest (Date)	Harvest Duration (Days)
2004 Planting									
1-11-8	1	6.03	9.88	5.2	4.8	05-Jul	17-Jul	07-Aug	34
1-11-10	1	4.28	7.03	9.2	5.0	03-Jul	18-Jul	07-Aug	36
1-9-11	1	3.82	6.21	14.5	4.1	01-Jul	16-Jul	01-Aug	32
1-3-13	1	3.95	6.34	30.5	2.8	29-Jun	09-Jul	24-Jul	26
1-11-15	1	4.46	7.32	18.7	5.2	30-Jun	11-Jul	28-Jul	29
1-17-1	2	3.44	5.62	27.9	4.7	30-Jun	08-Jul	21-Jul	23
1-17-4	2	3.56	5.72	54.4	3.2	25-Jun	04-Jul	16-Jul	22
1-37-21	3	3.97	6.61	2.8	5.7	06-Jul	14-Jul	31-Jul	26
1-37-4	2	2.73	4.40	49.7	3.7	26-Jun	05-Jul	22-Jul	27
1-39-8	1	3.96	6.66	13.2	4.9	02-Jul	11-Jul	28-Jul	27
1-48-39	1	6.57	10.61	24.9	4.3	30-Jun	09-Jul	25-Jul	26
1-49-3	1	6.87	11.22	17.1	4.6	01-Jul	12-Jul	28-Jul	28
1-50-14	2	3.99	6.42	19.2	3.2	29-Jun	13-Jul	30-Jul	32
1-50-2	1	5.58	9.09	8.0	4.5	04-Jul	13-Jul	01-Aug	29
1-56-25	1	6.85	11.08	13.0	4.6	02-Jul	16-Jul	10-Aug	40
1-56-28	1	3.74	6.04	11.2	4.3	02-Jul	14-Jul	04-Aug	34
1-64-8	1	5.63	9.14	0.9	4.7	09-Jul	22-Jul	10-Aug	33
1-65-39	1	4.73	7.66	0.9	3.4	08-Jul	19-Jul	02-Aug	26
1-67-24	1	3.49	5.74	44.2	4.6	29-Jun	06-Jul	23-Jul	25
1-81-15	1	4.77	7.78	11.8	3.7	02-Jul	16-Jul	04-Aug	34
1-81-2	2	4.45	7.18	33.0	2.9	27-Jun	09-Jul	26-Jul	30
1-82-3	1	8.85	14.73	9.5	4.4	03-Jul	13-Jul	30-Jul	28
1-86-24	1	4.12	6.90	13.5	3.6	29-Jul	12-Jul	29-Jul	31
1-86-7	1	3.59	5.78	27.6	5.2	29-Jun	09-Jul	24-Jul	26
1-87-7	1	3.53	5.71	78.5	4.5	22-Jun	01-Jul	10-Jul	19
1-88-6	1	3.38	5.55	19.2	3.9	3-Jul	12-Jul	29 Jul	31
87-22-18	2	6.06	9.77	25.2	3.7	30-Jun	10-Jul	28-Jul	30
87-22-8	2	4.21	6.77	25.6	3.7	29-Jun	10-Jul	30-Jul	28
90-19-34	1	3.71	6.21	11.8	2.8	02-Jul	16-Jul	03-Aug	33
90-4-23	1	3.89	6.33	63.9	4.0	24-Jun	03-Jul	20-Jul	27
90-6-2	2	4.63	7.48	30.2	5.2	25-Jun	10-Jul	05-Aug	42
91-17-11	1	4.92	7.95	6.8	3.8	04-Jul	17-Jul	01-Aug	29
92-6-41	2	4.91	7.97	16.3	3.5	01-Jul	11-Jul	26-Jul	27
97-18-48	1	5.39	8.72	6.3	3.6	04-Jul	19-Jul	10-Aug	38
97-30-20	1	2.46	3.96	35.1	3.2	29-Jun	08-Jul	22-Jul	24
C. Dawn	3	3.66	5.93	49.6	3.9	24-Jun	05-Jul	20-Jul	27
C. Bounty	2	3.42	5.49	22.3	3.3	29-Jun	10-Jul	27-Jul	29
C. Delight	1	4.86	8.42	5.4	5.3	05-Jul	13-Jul	29-Jul	25
Canby	1	2.72	4.37	52.6	3.2	26-Jun	04-Jul	17-Jul	22
Chemainus	3	3.99	6.42	35.0	3.8	28-Jun	09-Jul	23-Jul	26
Coho	1	5.35	8.61	7.1	3.9	04-Jul	15-Jul	31-Jul	28
Cowichan	3	3.05	4.93	42.5	4.5	28-Jun	10-Jul	21-Jul	24
Encore	1	2.61	4.19	30.9	4.4	30-Jun	08-Jul	21-Jul	22
Esquimalt	2	3.50	5.64	23.1	4.0	28-Jun	10-Jul	29-Jul	32
Malahat	3	2.60	4.18	67.1	3.8	23-Jun	29-Jun	15-Jul	24
Meeker	3	4.33	7.03	12.3	3.4	02-Jul	15-Jul	28-Jul	27
Nova	1	2.38	3.82	51.4	3.0	26-Jun	05-Jul	18-Jul	23
Qualicum	3	5.01	8.13	27.5	4.7	30-Jun	10-Jul	25-Jul	26
Saanich	3	4.19	6.79	34.5	3.4	29-Jun	09-Jul	29-Jul	30
Tulameen	3	5.31	8.60	17.2	5.0	01-Jul	13-Jul	04-Aug	34
LSD[4]		2.11	3.39	13.2	0.78	3	6	6	5

see foot notes on table 1c

Table 3. Fruit traits of raspberry cultivars and selections harvested in 2006, Abbotsford, BC.

Clone	Reps	Soluble Solids Concentration (brix)	Firmness (g/cm2)
87-22-18	3	9.2	215
87-22-8	3	11.2	248
90-19-34	2	9.4	87
90-5-30	2	10.4	178
90-6-2	3	9.1	320
92-6-41	3	9.7	172
97-30-20	3	11.5	195
1-3-13	3	10.4	175
1-9-11	3	10.0	133
1-11-10	3	9.8	195
1-11-15	3	8.2	115
1-17-1	3	11.1	187
1-37-21	3	8.3	397
1-37-4	3	10.7	225
1-50-14	3	12.9	305
1-53-41	3	10.0	243
1-64-8	3	10.3	203
1-81-15	3	9.8	219
1-81-2	3	10.8	204
1-84-1	3	10.9	176
1-86-28	3	10.1	202
1-87-7	2	11.3	162
1-88-6	3	10.8	357
WSU 1068	2	9.4	125
WSU 1162	2	8.9	95
Chemainus	3	9.7	194
Coho	3	10.6	291
Cowichan	3	10.1	210
Esquimalt	2	11.0	169
Malahat	3	11.0	164
Meeker	3	9.8	257
Qualicum	3	10.9	271
Saanich	3	9.5	175
Tulameen	3	11.9	240
LSD		**1.5**	**111**

2007 WRRC COMMISSION RESEARCH PROPOSAL

Project No:

Title: New Strategies to Replace Nemacur in Red Raspberries for Plant Parasitic Nematode Control

Year Initiated: 2006 Current Year: 2007 Terminating Year:2009

Personnel:
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5) Mr. Daryl Ehlers, Whatcom County Red Raspberry Grower
6) Mr. Dale Gies, Precision Seeds, Moses Lake, WA, djgies@atnet.net

Justification:

Plant-parasitic nematodes are major pests of red raspberries worldwide. Symptoms associated with nematode infested soils are gradual and lead to general reduction in cane vigor and fruit production and quality. Nematodes feeding on the roots can modify root growth (lesion and stunting), compete with the plant for carbohydrate, and predispose the plant to infection by other pathogens. In addition, dagger nematodes vector important viruses. In perennial crops, population densities of nematodes can build up from low levels to damaging levels during the plant lifetime. The three economically important nematodes for red raspberries are the lesion nematode, *Pratylenchus penetrans*, and the dagger nematodes, *Xiphinema bakeri,* and *X. americanum.* If root lesion nematodes left uncontrolled they will shorten the productive life span of an established raspberry field by 2 to 3 years, and dagger nematodes will weaken fields and reduce fruit quality and yield. These species are widespread throughout the region. Nemacur, the only post-planting nematicide registered for raspberry will not be available as of 2006. Therefore, a replacement is needed to protect the plants against the lesion nematode and the dagger nematodes. Oxamyl (Vydate) is a synthetic non-fumigant systemic nematicide and it has been tested in a wide variety of crops against lesion and dagger nematodes, and is registered for use on red raspberry in Canada. DiTera is a biologically derived natural product from the hyphomycete fungus *Myrothecium* spp., and it is composed primarily of proteins, sugars, and lipids. DiTera has been tested against a wide range of nematode species and it is shown good plant parasitic nematode control. Fosthiazate (Nemathorin) has been used for nematode control of field crops and its efficacy is considered better than Nemacur. *Brassica carinata* is mustard with high glucosinolate content that has nematicidal properties (Dr. Lucas, Bari, Italy, personal

comm.). *Muscador albus* is an entophyte which produces volatile compounds similar to fumigants. All of the above compounds will be tested in a red raspberry field with moderate to high nematode densities over a period of three years to evaluate efficacy against nematodes and effect of berry yield.

The purpose of our proposed research is to find alternative means to control both lesion and dagger nematodes in post-plant situations in red raspberries in the PNW. We propose to use three different rates of the synthetic nematicide, Vydate; and three biologically based nematicides (DiTera, *Muscador albus,* and *Brassica carinata*) in red raspberry fields (cultivars 'Nootka' and 'Willamette') with high lesion and dagger nematode densities. All of the above compounds have shown promising results in other crops, therefore the three year long study should provide the red raspberry industry with new nematicides to manage plant parasitic nematodes. In addition to the above treatments, throughout the course of the study we will incorporate new nematicides in the field trial, if they become available.

Objectives:

Evaluate the efficacy of post-plant applications of the synthetic nematicide, Vydate (three different treatments – one of them is a Canadian label), and biologically based nematicides, DiTera, *Muscador albus,* and *Brassica carinata* in red raspberry fields (cultivars 'Nootka' and 'Willamette') with high lesion and dagger nematode densities. This funding year all of the above chemicals will be tested.

Procedures:

A field experiment was established in October 2005, in Lynden, WA. A field with moderate to high nematode densities and two red raspberry varieties is used for our experimental trials. The experiment in the 'Nootka' block has been laid out in 3 adjacent rows and plots will consist of 8 m of row in a randomized block experimental design with five replicates. The 'Willamette' plots will be layout in a single row in October 2006. (Rates, treatments and application timing for 2006-2007 are listed below

		Application dates / NOOTKA variety			
Treatments	Rates/ May/07	Jun/07	Oct/06		Apr/07
Phenamiphos (Nemacur)*	1 gal/acre				
Oxamyl (Vydate)**	1 gal/acre				
Oxamyl	0.5 gal/acre early & late spring		X	X	
Oxamyl - Canadian label	1gal/acre by Oct 31st	X			
Fosthiazate*	0.6 gal/acre				
DiTera	8 lb/acre	X	X	X	X
Muscador albus	143 lb/acre		X		
Brassica carinata	143 lb/acre		X		
Control					

- * Applied in October 2005 and will not be re-applied in 2007, but nematode population data will be collected.
- ** Applied in March and April 2006 and will not be re-applied in 2007, but nematode population data will be collected and plants will be observed for recovery from phytotoxicity observed in 2006.

Application dates / WILLAMETTE variety

Treatments	Rates/	May/07	Jun/07	Oct/06	Apr/07
Phenamiphos (Nemacur)	1 gal/acre		X***		
Oxamyl (Vydate)	1 gal/acre			X	X
Oxamyl	0.5 gal/acre early & spring			X	X
Oxamyl - Canadian label	1 gal/acre by Oct 31st	X			
Control					

***Nemacur will be applied by the grower. We will collect soil samples for nematode analysis

All Vydate treatments, and DiTera will be applied in a 1 m band on the soil surface in the row. *Muscador albus* and *Brassica carinata* will be applied in a 0.4 m band on both sides of the plant row and incorporated by covering the band with several inches of soil to approximate a hilling operation. Soil used in this "hilling" be collected in the alleyways or brought in from the edge of the field and applied by hand. Oxamyl will be applied both on 'Nootka' and 'Willamette' red raspberries. Oxamyl and DiTera will be applied as aqueous sprays and immediately watered in with irrigation or rain. Soil samples will be collected for nematode analysis in the fall and spring prior to any nematicide application, in mid-season and after harvest. Yield estimates will be made by harvesting and weighing fruit in each plot several times during the season. Because all the materials are not registered for use in red raspberry, fruit will be destroyed. Nematicides will be applied and plant and nematode data will be collected for three years. In addition to this field trial, other chemical and biological nematicides may be included in the trials, as they become available. Preliminary greenhouse tests will access the effectiveness of the new compounds (E. Riga will perform these tests in her greenhouses). Data will be presented as number of nematodes per 250 cc per treatment and berry weight per meter of row and lbs per acre. All data will be analyzed using ANOVA.

Anticipated Benefits and Information Transfer:
We expect to find an appropriate replacement for Nemacur and to develop management strategies for controlling plant parasitic nematodes that affect red raspberry production in the Pacific Northwest. Results will be disseminated directly to the growers (E. Riga has an extension appointment in addition to her research appointment) and during annual Nematology meetings, industry meetings, field days, and through grower-oriented publications such as Capitol Press (OR) and Good Fruit Grower (WA). In addition, results will be published in peer-reviewed scientific journals.

Budget: Amount allocated by Commission for previous year (2006): $10,325

Request for FY 2007

Salaries[1/]	3,143
Operations (goods & services)	443
Travel[2/]	400
Employee Benefits[4/]	1,163
Total:	**5,149**

Other support of project:
This proposal has been submitted to the pesticide commission and NCSFR for matching funds (please see current and pending support). Funding from the Commission is important for this project because: 1) funding of this project from other sources is pending; and 2) additional funding will ensure completion of the project without having to cut corners.

[1/] RA grade II. The RA will assist T. Walters with field work.

[2/] E. Riga is located in WSU, Prosser. She will travel to Lynden to assist with the field trial. The travel funds will cover part of the travel expenses (i.e. car rental, gas and accommodation)

[4/] The benefits rate for the RA position is 37%.

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PROGRESS REPORT - 2006

Treatments were applied in a Red Raspberry field / Nootka (Mr. Ehlers): Phenamiphos (Nemacur); Cordon; DiTera; and Fosthiazate. Untreated vines were used as controls. In addition, treatments were applied in the greenhouse (E. Riga, WSU-IAREC): *Brassica carinata* (mustard meal) at 0.5% and 1.0% w/w; *Muscodor albus* 0.5%; and STO-007 at 1 ounce and STO-008 at 2 ounces per acre applied every two weeks. Untreated vines were used as controls.

Lesion Nematode Results from Field Trial: (ANOVA was performed on all data).
Mean followed by the same letter do not differ significantly at $P = 0.05$ according to Fisher's protected LSD procedures.
Number of Nematodes collected per 1 g (dry wt) roots: Vydate= 21a; Fosthiazate= 26a; Nemacur= 440b; DiTera= 1094bc; Condon= 1985c; and Control= 819bc.
Vydate and Fosthiazate had the lowest population densities of lesion nematodes ($P = 0.05$), Nemacur was intermediate and the control, DiTera, and Cordon had the greatest populations.
Nematodes collected from 50 g soil: Vydate= 3.60a; Fosthiazate= 6.08a; Nemacur= 37.5b; Condon= 141.8c; DiTera= 157.7c; and Control= 118.6bc.
Vydate and Fosthiazate had the lowest population densities of lesion nematodes ($P = 0.05$), Nemacur was intermediate and the control, DiTera, and Cordon had the greatest densities.

Root Mass: We will collect roots from standard cores in October to collect root mass data.

Yield Results: The total weight (in kilograms) from four harvest periods was as follows: Vydate= 3.7; Fosthiazate=5.2; Nemacur= 5.3; Condon= 5.2; DiTera= 5.4 and Control= 5.6. There is no significant difference between the weight of the control and the treatments, except Vydate that reduced yield (phytotoxicity was evident).

Dagger Nematode Results from Field Trial: There were no significant differences between population densities of dagger nematodes in soil collected in July 2006.

Lesion Nematode Results from Greenhouse Trials: Two greenhouse trials using *Brassica carinata* mustard meal, *Muscodor albus* and STO showed significant reduction to lesion nematodes in comparison to the controls. A third trial is in progress.

Summary: Vydate and Fosthiazate significantly suppressed root lesion nematodes in the roots; Nemacur was intermediate, while Condon and DiTera were not effective. The effects of treatments applied in 2006 on plant growth and yield should be more evident in 2007.

The following tasks will be completed Fall 2006:
Collect primocane data; Collect soil and root samples for fall nematode data; Fall application of Nematicides (Canadian label 1 gallon/A will be applied before Oct 31); Collect data from Greenhouse trials. In addition to Nootka, Willamette red raspberries will be incorporated in our trials.

Current & Pending Support

Instructions:
1. Record information for active and pending projects.
2. All current research to which principal investigator(s) and other senior personnel have committed a portion of their time must be listed whether or not salary for the person(s) involved is included in the budgets of the various projects.
3. Provide analogous information for all proposed research which is being considered by, or which will be submitted in the near future to, other possible sponsors.

Name (List PI #1 first)	Supporting Agency and Project #	Total $ Amount	Effective and Expiration Dates	% of Time Committed	Title of Project
	Current:				
E. Riga, J. Pinkerton, et al.	NCSFR	36,127	2006	20%	New Strategies to Replace Nemacur in Red Raspberries for Plant Parasitic Nematode Control
E. Riga	Washington State Commission on Pesticide Registration	11,000	2006	10%	New Strategies to Replace Nemacur in Red Raspberries for Plant Parasitic Nematode Control

	Pending:				
E. Riga, J. Pinkerton, et al.	NCSFR	36,127	2007	20%	New Strategies to Replace Nemacur in Red Raspberries for Plant Parasitic Nematode Control
E. Riga	Washington State Commission on Pesticide Registration	5,524	2007	10%	New Strategies to Replace Nemacur in Red Raspberries for Plant Parasitic Nematode Control

Title: DEVELOPMENT OF VALUE-ADDED DRIED RASPBERRY PRODUCTS

Personnel: Carter D. Clary, Ph.D. Assistant Professor
Esteban Mejia, Dewi Setiaty, Jennifer Brown – Graduate Students
Washington State University
P.O. Box 646414, Pullman, WA 99164-6414
509/335-6647 tel 509/335-8690 fax
cclary@wsu.edu www.mivac.com

Year Initiated 2006 Current Year 2006-2007 Terminating Year 2008

Accomplishments:

1. Samples of dried raspberries were successfully produced using microwave vacuum dehydration, heated air drying, a combination of both processes, as well as freeze drying. Color and integrity need to be improved.
2. Tree Top, Inc and NutriLoc Corp have been identified for commercializing the process and utilization of the dried fruit.
3. A plan is in development for construction of commercial drying units.

Results:

Raspberries were mechanically harvested at the WSU Vancouver Research and Extension Unit on July 12, 2006. The 100lb sample was transported to the pilot plant at Tree Top Inc. in Selah WA. A portion of the fruit was dried in a heated forced-air dryer at 190°F to an approximate moisture content of 50%. The fruit was then frozen and transported along with a fresh fruit sample to WSU Pullman for processing by microwave vacuum dehydration and freeze drying.

It was raining during harvest on July 12 which affected fruit integrity. This was compounded by a 4-hour ride to Selah. Nevertheless, we dried the fruit to develop the protocols for the different drying treatments. This plan was repeated July 19, 2006. Ultimately, six drying treatments were completed. Air drying and freeze drying were included in addition to microwave vacuum dehydration of fresh and dehydro-frozen fruit.

Dehydro-freezing offers the opportunity to provide a year-round supply of partially dried, frozen fruit. The potential advantage is reduction in costs related to microwave vacuum drying. If fruit can be dried with heated air to a moisture content of about 50%, then frozen, there is less time required in the microwave vacuum process compared to drying IQF fruit.

All samples were successfully dried to about 3 to 5% moisture content (wet basis). However, the integrity of the berries was compromised in most of the samples. This was due mostly to the delicate nature of raspberries and length of time from harvest to drying. The freeze dried fruit exhibited the best preservation of shape. It is important to note, however, that whole raspberries may not be the target for use as inclusions in breakfast cereal. Generally, more- smaller pieces are desired. The raspberry samples have been sent to Tree Top, Inc for evaluation of potential as breakfast cereal inclusions.

Our group met with Tree Top, Inc, Selah WA and NutriLoc, Vancouver BC to develop a plan for commercializing microwave vacuum dehydration. NutriLoc has the potential of building units that Tree Top would use to dry berries and fruits. A pilot unit is currently under construction.

Publications are under development.

Project No: 3055-4411 (0412) **Continuing Project Proposal** **October 13, 2006**

Title: NUTRITIONAL ADDED VALUE BY MICROWAVE-VACUUM, HOT-AIR AND FREEZE DRYING OF RASPBERRIES: ANTI-OXIDANT AND POLYPHENOL CONTENT

Year Initiated 2006 Current Year 2007-2008 Terminating Year 2008

Personnel: Carter D. Clary[1] and Neal Davies[2]
Department of Horticulture and Landscape Architecture, College of Agriculture, and Natural Resources and Department of Pharmaceutical Sciences, College of Pharmacy, Washington State University. Pullman, Washington, USA 99164-6414, and 99164-6534. Tel: 509/335-6647 and 509/335-8816 Fax: 509/335-8690 and 509/335-5902. cclary@wsu.edu ndavies@wsu.edu www.mivac.com

Justification:

Consumer demands for fresh, nutritional, safe and economical fruit products have increased in the last decade due in part to an increase in healthy eating. A significant demand for dehydrated fruits has been observed due to their shelf-stability, price and ease of transport. This has prompted a trend for new product development including dehydrated products that can provide healthier options to some currently marketed products.

A new area of interest in food processing involves the effect of processing steps on the content of important bioactive agents in foods. For that reason, the food industry is looking for drying technologies that are able to produce fruit products with high nutritional value to cover the world-wide market. For example, the cereal industry has increased their efforts in including a larger spectrum of dried fruits such as blueberries, strawberries, raspberries, apples and peaches in ready-to-eat (RTE) breakfast cereals to enhance the nutritional value. For instance, General Mills' Cheerios Berry Burst introduced in 2003 (Topher, 2003) has seen significant sales growth in the past few years which corresponds with expanding national and international market demand.

Microwave-vacuum drying (MIVAC®) is very attractive technique that preserves highly desirable food properties, utilizing significantly less drying time compared to freeze drying. Nevertheless, the cost of using freeze-drying and MIVAC® is often too high to be justified. Therefore, the combination of a conventional drying technique such as hot air drying with microwave-vacuum and/or freeze-drying is a potential opportunity to produce lower cost dried products while preserving nutritional and quality attributes.

The Pacific Northwest region is a large grower and producer of berries and other fruits that have the potential to be utilized by the cereal industry. If MIVAC® technology can be applied to pre-dried, then frozen raspberries (IQF); the fruit could be processed year-round in Washington State. Commercialization of this drying system is the key for utilizing Washington's ability to process agricultural products to maintain an advantage in domestic and international markets. Collaboration with Tree Top, Inc. is an example of potential commercialization of microwave vacuum dehydration technology in combination with conventional drying methods to dry sensitive fruits such as raspberries, strawberries, blueberries, cherries, and peaches. Various dehydration technologies cause the loss of nutritional value of food; to our knowledge there are no reports that have studied that address the retention of nutrients such as polyphenols or anthocyanins in fruits after drying

Objectives:

1. Quantify the effect of hot-air-, freeze-, and microwave-vacuum-drying individually, and in combination in the retention of total polyphenols, total anthocyanins, and individual polyphenols such as ellagic acid, quercetin, phloretin, r- and s-naringenin, kaempferol and their respective glycosides in fresh and dried raspberries.
2. Determine the antioxidant activity of dried and fresh raspberries.
3. Apply the results to scale the use of MIVAC® technology in combination with current commercial drying technologies in a continuous processing line.

Procedures:

Drying conditions: Hot-air drying: 4 hours at 190°F, freeze-drying: freeze at -10°F for 1 hour, vacuum pressure 20 militorrs, heating plate at 22°C, condenser at -60°C, drying time 48 hours, MIVAC®: drying temperature 150°F for 90 minutes, vacuum pressure 20 torr, microwave power 3 kW.

Individual Polyphenols: A Shimadzu HPLC will be utilized with the analytical column Chiral OD-RH column, mobile phase will consist of acetonitrile, water, and phosphoric acid (30:70:0.04, v/v/v), filtered and degassed pressure prior to use. Isocratic separation at ambient temperature with daidzein as internal standard, and flow rate of 0.4 ml/min (Yáñez and Davies, 2005). Preliminary data shows that separation of multiple polyphenols (Fig. 1), and quantification of polyphenols in raspberries is possible (Fig.2).

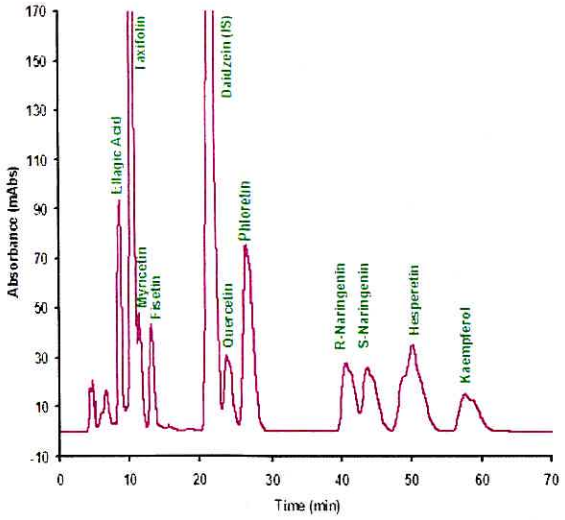

Fig.1 Representative Chromatogram

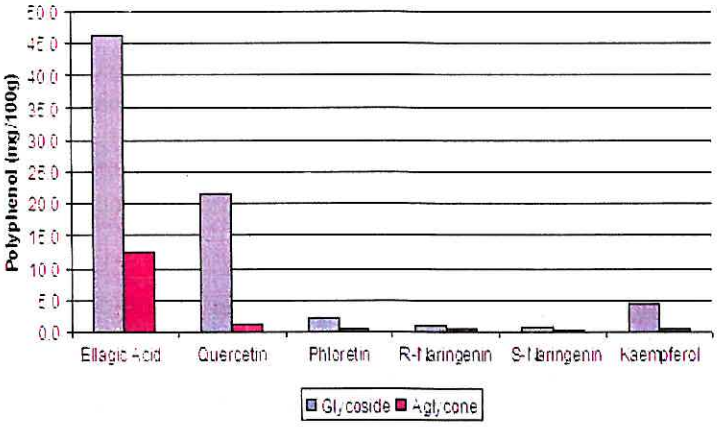

Fig.2 Polyphenol Concentrations in Raspberries

Total Polyphenols and Anthocyanins: The method of Jing et al (2001) and Vicente et al (2002) will be used. For this, five successive extractions of in 1 ml 1% HCl/methanol for 1 day at room temperature will be followed by absorbance reading at 280 nm for total polyphenols and 515 nm for total anthocyanins.

Antioxidant Activity: The Cayman Chemical Company (Ann Arbor, MI) kit will be used to quantify the ability of blueberry and raspberry extracts to inhibit the oxidation of ABTS (2,2'-Azino-di-[3-ethylbenzthiazoline sulphonate]) to ABTS·+ by metmyoglobin. The amount of ABTS·+ produced by these extracts will be monitored spectrophotometrically at 620 nm and expressed as Trolox equivalents.

Statistics: One-way analysis of variance, or analysis of variance based on ranks, with the Dunnett post hoc comparison with P-value of < 0.05 considered significant. Data will be presented as mean ± standard deviation (SigmaStat version 2.0; SPSS Science, Chicago, IL).

Anticipated Benefits and Information Transfer:

Optimum MIVAC® drying conditions described by Clary et al, 2005 and 2006, and commercial hot-air and freeze-drying conditions will be employed to dry raspberries. Dr. Clary's team will process the dried fruits in collaboration with Tree Top. Dr. Davies' team will perform extractions for HPLC analysis to determine individual and total polyphenol and anthocyanin concentrations. Dr. Davies' and Dr. Clary's teams will perform the in vitro anti-oxidant tests. These two measurements will allow a side-by-side comparison of the drying technologies individually and in combination.

Different technology combinations will be explored and the ones that preserve the highest concentration of nutrients will be further evaluated at Tree-Top, Inc. for market potential of commercial applications. This strategy will assess the economic effects of enhancing drying technologies to orient products to specific consumer preferences in the international marketplace. This will enhance the competitiveness of local Pacific Northwest raspberries processed in local processing plants.

Budget:

Budget **NUTRITIONAL ADDED VALUE BY MICROWAVE-VACUUM, HOT-AIR AND FREEZE DRYING OF RASPBERRIES: ANTI-OXIDANT AND POLYPHENOL CONTENT**	
Salaries	$7,759
Time Slip	4,500
Benefits	3,156
Operations	2,500
Travel	2,500
Projected Needs	
Meetings	
Other	
Equipment	
TOTAL	$20,415

Amount allocated by Commission for previous year: $19,392

Justification: Salaries are for one month of Carter Clary's salary. Time slip is for summer student support. Operations funds include fruit and processing supplies. Travel is for 3 trips to Lynden to visit raspberry growers and fields.

Other support of project:
A proposal has been submitted to the IMPACT Center at Washington State University entitled "Improving Nutritional Value of Dried Fruits Combining Microwave Vacuum, Hot-Air Drying and Freeze Drying Technologies" which may not support the entire project. Support from the Washington Red Raspberry Commission will ensure work on red raspberries.

This project will solidify the initial investigations between Dr. Clary's and Dr. Davies' teams that will enhance their expertise in fruit drying, and phytochemical analysis and activity respectively to provide a better understanding of the health benefits of raspberry and processed raspberry products. In addition, Dr. Davies and Dr. Clary will use this project as a starting point to continue looking at the effect of food processing on the nutritional value and health benefits of fruits and vegetables growth in the Pacific Northwest. These results will constitute an integral part of Mr. Esteban Mejia-Meza's doctoral thesis and will be presented at national and international conferences and published in peer-review journals.

References:

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Project #: New

Title: WSU Raspberry Market and Product Development Research Team

Year Initiated 2007 Current Year 2007-2008 Terminating Year 2009

Personnel: Thomas I. Wahl, Carter D. Clary, Neal Davies, Joseph R. Powers, Maria Rosales Soto, Juming Tang, Sohan Birla, Stephanie Clark, Jill J. McCluskey, Jean Soon Park, Karrie Kaspar, Christine Wieck

Justification, Objectives, and Procedures:

The Washington Raspberry Commission has developed a strategic marketing plan that outlines the steps needed to address the future marketing needs of the industry. Our proposal addresses a number of these needs by developing a multi-disciplinary research team that has the expertise to solve the underlying product development, processing or marketing issues. Our project includes a review of relevant product, health, and nutrition literature related to raspberries. We will then assist the Raspberry Commission in convening a round table of experts who will help refine the strategic directions needed to ensure the success of the raspberry industry. The round table will be facilitated by Roger Wasson who has been engaged by the commission.

Following the strategic directions defined by the round table, the WSU Raspberry Market and Product Development Research Team will further refine and adjust this proposal to address the strategic needs of the industry as defined by the outcomes of the round table.

The following proposed research projects are designed to integrate our expertise as well as to present our ideas on how to address the issues raised in the strategic marketing plan. It is our expectation that the proposals will be revised as needed based upon the recommendations of the round table and long-term research directions can be developed.

The proposals address the following issues:

1. "Literature Review and Roundtable" will collect and summarize the relevant literature related to raspberries and raspberry products and their health benefits. The graduate student involved will also help develop the round table. In addition, the student will establish the protocols for analysis of phytochemicals in raspberries that can be applied to ongoing raspberry research.
2. "Nutritional Added Value by Microwave-Vacum, Hot-Air, and Freeze Drying of Raspberries: Anti-Oxidant and Polyphenol Content" will quantify the effect of different drying technologies and determine the antioxidant activity of fresh and dried raspberries.
3. "Bioavailability and Action of Antioxidants from Raspberries to Humans" will evaluate the possible antioxidant and immune-enhancing effects of raspberries.
4. "Consumer Response to Health Information on Raspberries" will assess the importance of health benefits in the marketing of raspberries.
5. "Raspberry Health Benefits and Product Safety: Their Impact on Markets and Trade" will develop models to evaluate the demand for new products, the effects on the demand for raspberries from food borne disease outbreaks, the preferences for domestic versus imported raspberries, and the cost of compliance across countries to reach various product safety levels.
6. "The Washington State University Food Product Development Team" is a team of students who have successfully developed novel products for competitions and propose to create a raspberry-based product.

Anticipated Benefits and Information Transfer:

The benefits of approaching the call for proposals in this combined manner is to ensure that our scientists are collaborating and addressing the issues in an integrated manner. The combined team approach will also allow us to transform the project in a dynamic way as the strategic marketing plan evolves as a result of the round table.

We envision that the results of our research will be transferred directly to the commission as well as being published in scholarly outlets.

Detailed project proposals for year one follow (year two for the Clary proposal).

Budget: The total budget figures are for the first year of funding.

Total Budget/ Year 1 **WSU Raspberry Market and Product Development Research Team**	
Salaries	$47,452
Time Slip	14,656
Benefits	28,622
Operations	31,750
Travel	8,000
Projected Needs	
Meetings	
Other	
Equipment	
TOTAL/Year 1	**$130,480**

Justifications for each budget are included with each proposal.

Project #: New

Title: Literature Review/Roundtable: Raspberry Phytochemicals

Year Initiated 2006 Current Year 2007-2008 Terminating Year 2007

Personnel: J.R. Powers[1], Maria Rosales Soto[1], J. Tang[2], S. Birla[2]
[1]Department of Food Science and Human Nutrition and [2] Department of Biological Systems Engineering
Washington State University

Justification:
The raspberry industry needs to overcome major challenges to remain competitive including expansion of markets for fresh and processed raspberries. Consumers are concerned with both nutrient rich diets and minor food constituents that may benefit human health. One category of these minor constituents is antioxidant phytochemicals. Raspberries are a rich source of phytochemical compounds including phenolics such as ellagic acid. However, the current situation in the raspberry industry suggests that the positive health aspects of raspberries and raspberry products are not being translated into increased markets A comprehensive literature review and research roundtable will enable the raspberry industry to more effectively focus marketing efforts.

Objectives:

1. Collect and summarize literature relating to the influence of processing technologies on quality, phytochemical contents of raspberry and raspberry products and their health benefits.
2. Cooperate in holding a research round table dealing with raspberry health benefits.
3. Establish laboratory protocols for analysis of phytochemicals found in raspberries to be applied to ongoing raspberry research efforts.

Procedures:

The scientific literature dealing with the quality, chemical constituents and bioactivities and resulting health benefits of raspberries will be surveyed and summarized. In conjunction with a previously identified consultant we will coordinate the identification of key researchers with expertise relevant to promotion of the health benefits of raspberry and raspberry products.

During spring semester the graduate student tentatively assigned to this project (Fulbright scholar Maria Rosales Soto) will initiate raspberry laboratory work. Extraction and high performance liquid chromatographic techniques will be adapted to the analysis of raspberry phenolics. These techniques will be used for later raspberry experiments.

Budget **Literature Review/Roundtable: Raspberry Phytochemicals**	
Salaries	
Time Slip	
Benefits	
Operations	$5,500
Travel	500
Projected Needs	
Meetings	
Other	
Equipment	
TOTAL	$6000

Goods and Services include charges for interlibrary loan and access to data bases, copying as well as laboratory materials. Travel is for one local trip to western Washington to confer with growers and industry personnel.

Other support of project:
Maria Rosales Soto is currently supported as a Fulbright scholar.

Project #: New

Title: Bioavailability and Action of Antioxidants from Raspberries in Humans

Year Initiated 2007, Current Year 2006, Terminating Year 2009

Personnel: Jean Soon Park, Assistant Research Professor, Department of Food Science and Human Nutrition
Graduate Student: Karrie Kaspar, Ph.D. candidate (Nutritional Sciences)
Department of Food Science and Human Nutrition

Justification:

My ultimate goal is to identify the unique biological functions of red raspberry in promoting human health and well-being, compared to other berries and fruits. Increased oxidative stress can tip the oxidant:antioxidant balance to increase cancer, cardiovascular and eye disease, and aging. Therefore, dietary antioxidants are needed to remove these harmful oxidative products that can destroy cell membranes, proteins and DNA. Raspberries are known to contain several potent antioxidants.

Objectives:

Our present objective is to study the possible antioxidant and immune-enhancing action of dietary red raspberries in humans. As a first study, it is important to assess the uptake of raspberry antioxidants and measure markers related to their health-promoting effects.

Procedures:

Sixteen male subjects will be recruited from the Pullman/Moscow community. Subjects will be given a questionnaire prior to being enrolled in the study. Subjects must be non-smokers without a history of cancer, HIV, diabetes, or other metabolic diseases. Subjects will be fed Washington-grown red raspberries for 3 weeks. Dietary data will be collected via the 24h recall. Blood will be collected at baseline and at the end of 3 weeks to measure the following oxidative and immune markers:

1) Bioavailability:
    a. ellagic acid
    anthocyanins
2) Oxidative markers:
    a. total antioxidant capacity
    b. DNA damage
    c. protein carbonyl, and
    d. lipid peroxidation.
3) Inflammatory markers:
    a. C-reactive proteins.
4) Immune parameters:
    a. cytokines.

Anticipated benefits and information transfer:

Results from this study will provide direct evidence on the beneficial effects of red raspberries to humans. Therefore, the raspberry industry can make new claims on the health benefits of this wholesome fruit. In addition, it will increase the raspberry market nationally.

Results of the study will be made available to the raspberry industry through reports, manuscripts, and presentations as requested.

FUNDING REQUEST / BUDGET:

Item	Year 1	Year 2
Salaries		
Graduate Research Assistant[1]	13,231	13,760
Fringe benefits	8270	8,666
Summer Wages	3,500	
Fringe Benefits	403	
Honorarium [2]	2,000	
Phlebotomist	800	0
Diet analysis	350	350
Bioavailability	4500	1,000
Oxidative markers:		12,000
Inflammatory markers:	6500	
Publication		1,500
Travel [3]		
Total requested	**$39,554**	**$37,276**
Grand total	**76,830**	

Justification

[1] Salaries and summer wages will be for Karrie Kaspar, a PhD candidate in the program of nutrition.
[2] An honorarium of $125 will be paid to each subject (16 subjects x $125/subject = $2,000). The rest of the budget requests are for laboratory analysis, and do not include any equipment purchase.

List of other funding sources:

None

Project #: New

Title: Consumer Response to Health Information on Raspberries

Personnel: Dr. Jill J. McCluskey, Associate Professor, School of Economic Sciences and IMPACT Center Fellow in Food Marketing
Collaborator: Dr. Thomas I. Wahl

Justification:

The proposed research focuses on the effects of health information on consumers' preferences and purchasing behavior. Raspberries are a product with health benefits that may appeal to health-conscious consumers. The specific objective of this proposal is to analyzes the results of a choice experiment to explore the importance of health benefits in marketing of raspberries.

Methodology:

We use choice-based conjoint analysis to isolate health attributes for raspberries. Conjoint analysis is a stated preference technique that is used to isolate the effect of product attributes on consumer preferences. Compared to the traditional ratings- or rankings-based conjoint analysis, the choice-based conjoint approach has become an attractive alternative for measuring preference structures (see Elrod, Louviere and Davey 1992; Huber et al. 1992; and Louviere and Gaeth 1988). Conjoint analysis allows consumers to make decisions about products based on several product attributes. The choice-based approach involves respondents making one choice from each of several sets of stimuli derived from an experimental design (Louviere 1991). Adamowicz et al. (1998) found that the choice-based conjoint analysis had several advantages over typical contingent valuation methods. In particular, since this approach mimics what people do in the real world, its results are comparable to consumers' revealed preferences (Adamowicz, Louviere, and Williams 1994; Adamowicz et al. 1998). This mitigates the potential problem of "hypothetical bias" in which respondents say one thing and do something different.

In a microeconomic-econometric framework, the basic consumer choice problem is modeled as the estimation of a utility function $U = f(X_1,...,X_k)$, where U denotes utility for the good in question and $X_1,...,X_k$ represent the k attributes of the good. One method of estimating $f(X_1,...,X_k)$ is based on experimental data on consumer preferences. The approach is to construct a number of hypothetical alternatives and let a sample of respondents make preference judgments.

Consider an individual faced with a set of alternatives from which to choose, each of which consists of a different combination of levels of a set of multiple attributes. Suppose individual i faces J alternatives, indexed j=1,...,J and described by vectors of attributes X_j. The individual i has a utility function that can be written in the linear form,

$$U_{ij} = X_j\beta + \alpha_i + \varepsilon_{ij}, \qquad (1)$$

where X_j is the attribute vector of the jth alternative, β is the coefficient vector representing the weight of attribute in the valuation of alternative j. The variable α_i is an individual specific component, and ε_{ij} is stochastic and reflects the idiosyncracies of this individual in tastes for the alternative j (McFadden 1974). As respondents are randomly chosen, the unknown individual specific component can be interpreted as a random disturbance term.

The probability of an individual choosing the m[th] alternative is

$$P(m \mid C,\beta) = P(X_m\beta + \varepsilon_{im} > X_j\beta + \varepsilon_{ij} \quad \forall j \in C \,\&\, j \neq m), \tag{2}$$

where C denotes the choice set. In the case of independently and identically distributed extreme value disturbances, the probability of an individual choosing the m[th] alternative can be expressed as the following:

$$\mathrm{P}(m|\mathrm{C},\ \beta) = \frac{\exp(X_m\beta)}{\sum_{j\in C}\exp(X_j\beta)}. \tag{3}$$

This equation was estimated from the consumer choice data described below.

Data Collection:

We propose to collect survey data with in-person, intercept surveys in Seattle, Washington. The surveys will be conducted in grocery stores. At food stores there is an opportunity for respondents to make hypothetical decisions in the settings where they make their actual food purchase decisions. This intercept survey approach is used extensively in studies of food purchase decisions because of this realistic decision setting. Increasing the realism of the decision setting helps reduce the "hypothetical bias" which can be a problem in studies that use "stated preferences" or intended behavior, rather than actual market choices, or "revealed preferences."

To guarantee a representative sample, one would survey food buyers at a random selection of all food shopping sites in the community, weighted by proportions of the food budget. Such an ideal sample frame was beyond the resources of this survey. While precautions were made to make the sample as representative as possible within this framework, (respondents were randomly selected -- one of every three persons entering the area was approached), our sample is subject to possible selection bias. The potential for selection bias is not as great as a convenience sample (e.g., a shopping mall) at a site totally unrelated to the decision problem would have been, but care must still be taken in checking the representativeness of the sample and in extending the implications of the study to a general population from the more health-conscious consumers one presumably finds at the sample sites. As is common in current surveys, the respondents will be offered an incentive to increase participation rates.

The survey will solicit information regarding respondents' attitudes about the environment and food safety, their knowledge about the benefits of raspberries, and factors influencing their purchase decisions.

The survey will ask consumers to choose from among food products (including products containing raspberries) with different attributes in a choice experiment.

Expected Outcome:

We expect to find that consumers will pay a premium for raspberries compared with artificial flavorings. We also expect to determine the significant socio-economic characteristics that affect demand for this product in order to determine whether and how raspberries should be marketed.

Budget **Consumer Response to Health Information on Raspberries**	
Salaries	$13,231
Time Slip	3,828
Benefits	8,454
Operations	5,600
Travel	4,000
Projected Needs	
Meetings	
Other	
Equipment	
TOTAL	$35,113

Justification: Salaries and summer wages are for a PhD student. There is also $1000 time slip to pay survey personnel. Operations includes $5000 for survey incentives plus copying and phone charges. Travel includes per diem and travel expenses for the survey crew.

References

Adamowicz, W., J. Louviere, and M. Williams. 1994. "Combining Revealed and Stated Preference Methods for Valuing Environmental Amenities." Journal of Environmental Economics and Management 26:271-292.

Adamowicz, W., R. Boxall, M. Williams, and J. Louviere. 1998. "Stated Preference Approaches for Measuring Passive Use Values: Choice Experiments and Contingent Valuation." American Journal of Agricultural Economics 80:64-75.

Elrod, T., J. J. Louviere, and K. S. Davey. 1992. "An Empirical Comparison of Ratings-based and Choice-based Conjoint Models." Journal of Marketing Research 24:368-377.

Huber, J., D. R. Wittink, R. M. Johnson, and R. Miller. 1992. "Learning Effects in Preference Tasks: Choice-Based Versus Standard Conjoint." Proceedings of the Sawtooth Software Conference.

Louviere, J. J. 1991. "Experimental Choice Analysis: Introduction and Overview." Journal of Business Research 23:291-297.

Louviere, J. J. and G. J. Gaeth. 1998. "A Comparison of Rating and Choice Responses in Conjoint Tasks." Proceedings of the Sawtooth Software Conference.

McFadden, D. 1974. "Conditional Logit Analysis of Qualitative Choice Behavior." In: Frontiers in Econometrics, P. Zarembarka, Ed. Academic Press, New York, pp. 105-142.

Project #: New

Title: Raspberry Health Benefits and Product Safety: Their Impact on Markets and Trade

Personnel: Dr. Christine Wieck, IMPACT Center and School of Economic Sciences, Washington State University, Pullman, WA 99164-6214

Collaborator: Dr. Thomas I. Wahl

Justification:

The proposed research project focuses on the market and trade impact of raspberry health benefits and product safety of domestic and foreign products. Knowledge about these impacts contributes to developing the right strategies to promote the health aspects of raspberries and to achieve a level of product safety that benefits the whole industry.

The specific contribution of this research project is to develop a partial-equilibrium market model for the U.S. raspberry industry that allows us to quantify the market and trade effect of different scenarios regarding consumer reaction to health benefits and product safety as well as producer and trade responses to various SPS policies and import competition.

Market Situation:

While raspberry production in the U.S. increased significantly over the last years, imports are on the rise as well. The three main suppliers of U.S. domestic raspberries, Washington, California, and Oregon, face increasing pressure of imports originating from mainly Mexico and Chile supplying raspberries for the fresh market, and from Canada exporting mostly fresh and frozen raspberries for the processing industry. In addition, frozen raspberries are also supplied by a number of smaller producers such as Serbia, Poland, or China. Raspberries rank as the third most popular berry in the U.S. and observe steady annual per capita consumption increases. However, most of these increases result from higher consumption of the fresh product. Given that Washington raspberries are primarily grown for the processing industry, these positive trends did not reach the Pacific Northwest markets. (Economic Research Service, 2006)

Health Benefits and Product Safety and their Impact on Markets:

The consumption of red raspberries provides a number of health benefits to the consumer. An increased promotion of these benefits together with the marketing of new raspberry products will potentially stimulate overall demand.

Product safety of fresh and highly perishable produce is of heightened concern and outbreaks of foodborne illnesses affect not only the specific grower but the whole industry (see case studies in e.g. Buzby 2001). Domestic regulations as well as border inspections for imports are in place to prevent the marketing of contaminated or unsafe products.

However, compliance and control of these regulations is costly and difficult to enforce in the case of international production. Safety and sustainability of domestic production processes is easier to assess and more transparent to consumers. This may be a strategic advantage for the domestic raspberry industry compared to raspberries that are produced abroad and may lead to a shift in the consumption pattern over time.

In addition, import measures may be taken to prevent the introduction of sanitary or phytosanitary (SPS) diseases. These measures must comply with the WTO SPS Agreement and must be based on a scientific risk assessment. A cost-benefit analysis for new regulations may help to find the optimal level of protection with the lowest compliance costs and the least trade-restrictive policies. If temporary or permanent new SPS measures become necessary at the U.S. border, this will have impact on the domestic markets.

The last aspect in the context of market impacts of product safety relates to the consumer response to potential cases of foodborne illnesses in raspberries. Differences in the consumer reaction may have significantly different effects on the market development after the occurrence of a disease outbreak.

Knowledge about the market impact and cost implications under different scenarios contributes to developing the right strategies to promote the health aspects of raspberries and to achieving a level of product safety that benefits the whole industry.

Methodology:

In order to quantity the market effects related to health benefits and product safety, knowledge about consumer demand potential, as well as production costs and cost of compliance at different locations is necessary. In generating this information, a two-step approach can be used that focuses specifically on the situation in the Pacific Northwest.

Step one consists of the generation of specific information regarding demand and production developments under different scenarios:

- Demand potential of new products: Use of consumer demand surveys to generate consumer demand information about potential interest in new product developments (see McCluskey proposal).
- Demand reaction to foodborne disease outbreaks: Literature review and use of ex-post examples of demand reaction to outbreaks or use of consumer demand surveys.
- Information about preferences for domestic or imported raspberries (or raspberry products) when providing more information about quality and sustainability of domestic production compared to international production: Use of consumer demand surveys (eventually in cooperation with McCluskey proposal).
- Cost of compliance across countries to achieve different product safety levels: Use of producer surveys or cooperation with grower associations to gather the necessary information.

In step two, this information can be used to specify a partial equilibrium model for the U.S. raspberry market featuring domestic supply and demand as well as international trade that captures the main competitors on the U.S. market (e.g. Canada, Mexico, Chile). Examples of this modeling approach can be found in Calvin and Krissoff 1998, Nalampang et al. 2006, Peterson and Orden 2006. Necessary data of U.S. and foreign competitors will result from the World Trade Atlas (WTA various years).

Depending on the scope of the model, a regional differentiation of U.S. production or the processing into different raspberry products can be included. Information about production conditions, cost of compliance, and potential industry and consumer reactions to disease outbreaks, as well as information about the specification of the different scenarios can also be gathered in expert discussions, and cooperation with the growers associations.

Expected Outcome:

This model can be used to analyze different scenarios regarding

- The impact of health benefits on demand.
- The effect of a shift of consumption toward domestically produced products.
- The market impact of a disease outbreak and different scenarios regarding the consumer reaction.
- The effect of import measures preventing SPS problems or unfair trading practices on the domestic market.

Results of these simulations will include price and quantity (supply, demand, trade) forecasts for the different scenarios. Research results are expected to be presented at professional meetings and published in a peer-review journal in order to present methodology and results to a broader academic public.

Budget **Raspberry Health Benefits and Product Safety: Their Impact on Markets and Trade**	
Salaries	$13,231
Time Slip	2,828
Benefits	8339
Operations	2,500
Travel	1,000
Projected Needs	
Meetings	
Other	
Equipment	
TOTAL	$27,898

Justification: Salary is for a PhD student, school year and summer wages with benefits. $2,500 in operations is for purchase of world trade data on raspberries. Travel is for meetings with raspberry growers and travel to conduct surveys.

References:

Buzby, J.C. (ed). International Trade and Food Safety, Economic Theory and Case Studies, 2003, Agricultural Economic Report Number 828, USDA-ERS.

Calvin, L, Krissoff, B. (1998): Technical Barriers to Trade: A Case Study of Phytosanitary Barriers and U.S.-Japanese Apple Trade. *Journal of Agricultural and Resource Economics 23*: 351 – 366.

Economic Research Service (2006). Fruit and Tree Nuts Outlook - Commodity Highlight: Raspberries. Electronic Outlook Report FTS-323, pp. 16-23. USDA.

Nalampang, S., Tantiwongampai, W., Evans, E.A. (2006). Potential Impact of Avocado Imports from Mexico on the Florida Avocado Industry. Selected Paper presented at the AAEA Meetings, Long Beach, CA.

Peterson, E, Orden, D. (2006). Linking Risk and Economic Assessment in the Analysis of Plant Pest Regulations: The Case of U.S. Imports of Mexican Avocados. IFPRI.

World Trade Atlas (various years). Global Trade Information Services, Columbia, SC

Project #: New

Title: Washington State University Food Product Development Team

Personnel: Dr. Stephanie Clark, Advisor

The Washington State University Food Product Development Team, advised by Dr. Stephanie Clark, has been very successful in developing novel products for entry into various Food Product Development competitions since 1998. More than half of the products that the teams have developed have earned national recognition (12 out of 20 entries) for their novelty, creativity and feasibility. Involved in the product development process are market research, concept and process development, lab-bench and pilot scale processing, sensory evaluation, packaging design and financial planning for introduction of the product into the market.

Development of an appealing product is an important component of the proposed research. Volunteers are more likely to comply with research study requirements if provided with desirable products than with distasteful products. The history of success of the WSU Food Product Development Team shows that they can create tasteful products. A team of students devoted to raspberry-based product development will provide creativity and dynamism to the proposed team of experts in this collaborative venture.

Budget Stephanie Clark – Product Development	
Salaries	
Time Slip	
Benefits	
Operations	$1500
Travel	
Projected Needs	
Meetings	
Other	
Equipment	
TOTAL	$1500

Proposed budget: $1500
Ingredients, processing and packaging costs: $500
Sensory evaluation costs: $1000

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CURRENT AND PENDING SUPPORT
J.R. Powers

Instructions:

1. Record information for active and pending projects, including this proposal. (Concurrent submission of a proposal to other organizations will not prejudice its review by CSREES.)
2. All current efforts to which project director(s) and other senior personnel have committed a portion of their time must be listed, whether or not salary for the person involved is included in the budgets of the various projects.
3. Provide analogous information for all proposed work which is being considered by, or which will be submitted in the near future to, other possible sponsors including other USDA programs.

NAME (List/PD #1 first)	SUPPORTING AGENCY AND AGENCY ACTIVE AWARD/PENDING PROPOSAL NUMBER	TOTAL $ AMOUNT	EFFECTIVE AND EXPIRATION DATES	% OF TIME COMMITTED	TITLE OF PROJECT
	Active:				
Powers ,Tang, and Swanson	USDA CSREES Special Grants	28 646	6/2006-6/2007	15	Improving the International Competitiveness of the Washington/Oregon and Michigan Asparagus Industries (Advanced Processing Technologies for Asparagus)
Tang, Powers and Nindo	IMPACT	30 000	6/2006-6./2007	10	Small fruit juice processing
Kang, Powers and Marsh	IMPACT	25 391	07/2006-06/2007	3	Development of a new rapid method for the estimation of Escherichia coli in foods
Shultz, Clark Powers	WA Dairy Products	81178	1/2005-2/2007	15	Whey Protein Hydrolysate as a Source of Antihypertensive Bioactive Peptides
Tang, Nindo and Powers	WTC	122 131	6/2005-6/2008	10	Quality and shelf-life of reflectance window dried fruits, vegetables, and herbal products
	Pending:				
Kang et al	IMPACT	25 391	07/2007-07/2008	4	Development of a new rapid method for the estimation of Escherichia coli in foods
Tang, Powers and Nindo	IMPACT	33 825	07/2007-06/2008	15	Small fruit juice processing
Powers, Soto, Tang, Birla	WA Raspberry Comm	6,000	10/15/06-07/2007	5	This Proposal

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CURRENT AND PENDING SUPPORT

Juming Tang

Instructions:

1. Record information for active and pending projects, including this proposal. (Concurrent submission of a proposal to other organizations will not prejudice its review by CSREES.)
2. All current efforts to which project director(s) and other senior personnel have committed a portion of their time must be listed, whether or not salary for the person involved is included in the budgets of the various projects.
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NAME (List/PD #1 first)	SUPPORTING AGENCY AND AGENCY ACTIVE AWARD/PENDING PROPOSAL NUMBER	TOTAL $ AMOUNT	EFFECTIVE AND EXPIRATION DATES	% OF TIME COMMITTED	TITLE OF PROJECT
Tang, J., Wang, S. Mitcham, E., Armstrong, J., Johnson, J.	USDA CSREES, Methyl Bromide Transition Program	$225,000 for WSU	9/04-8/07	5%	Non-chemical control of insect pests in fruits and nuts using electromagnetic energy
Tang, J., Clark, S., McCurdy, A., Kang, D.H.	USDA CSREES	$250,000 for WSU	9/03-12/07	5%	Safety of foods processed by four Alternative Processing Technologies, a joint project with Ohio State University, NCState, and UC Davis.
Tang, J., Patil R., Swanson	USDA Cool Season Food Legume Program	$44,000 for WSU	2006-07	5%	Value-added processes for dry pea and lentils
Tang, J., Patil R., Swanson	WA Potato Commission	$30.000 for WSU	2006-07	5%	Value-added processes for potatoes
Tang, J., Wang, S.	USDA NRI	$330,000	2005-08	10%	Improving quarantine treatments for tropic fruit using thermal energy
Tang, J.	University of Alaska	$309,000	2005-07	10%	New thermal processing technologies for salmon
Tang, J, Clark, S., Rasco, B., Kang, D.H., Pitts, M., Cavaliery	US Army Natick Soldier Center	$250,000	2006-07	10%	Microwave sterilization technology
Tang, J. Powers JR, Nindo CI	IMPACT Center	$30,000	7/2006-6/2007	10%	Small Fruit Juice Processing: Strategies for Antioxidant Retention and Recovery of Pigments from Press Cake (1st year)

Tang, J., Barrios, D.J., Patil, R., Swanson, B., McCluski, J.J.	IMPACT Center	$33,000	7/2006-6/2007	10%	Consumer acceptability and nutraceutical benefits of legume-based extruded snacks and breakfast cereal-type products (1st year)
Pending					
Tang, J. Powers JR, Nindo CI	IMPACT Center	$33,825	7/2007-6/2008	10%	Small Fruit Juice Processing: Strategies for Antioxidant Retention and Recovery of Pigments from Press Cake (2st year)
Tang, J. Barrios, D.J., Sinha, L., Swanson, B., McCluski, J.J.	IMPACT Center	$40,491	7/2007-6/2008	10%	Consumer acceptability and nutraceutical benefits of legume-based extruded snacks and breakfast cereal-type products (2st year)

Instructions:

1. Record information for active and pending projects, including this proposal. (Concurrent submission of a proposal to other organizations will not prejudice its review by CSREES.)
2. All current efforts to which project director(s) and other senior personnel have committed a portion of their time must be listed, whether or not salary for the person involved is included in the budgets of the various projects.
3. Provide analogous information for all proposed work which is being considered by, or which will be submitted in the near future to, other possible sponsors including other USDA programs.

NAME (List/PD #1 first)	SUPPORTING AGENCY AND AGENCY ACTIVE AWARD/ PENDING PROPOSAL NUMBER	TOTAL $ AMOUNT	EFFECTIVE AND EXPIRATION DATES	% OF TIME COMMITTED	TITLE OF PROJECT
	Active:				
C. Clary, R. Cavalieri, J. Durfey, R. Folwell	WSDA	$333,000	9/06 – 6/07	15%	Evaluation of selective mechanical harvesting of asparagus
C. Clary, J. Tang	IMPACT	$23,748	8/05 – 6/07	10%	Improving value and quality of dried fruits using microwave vacuum technology (year 1)
C. Clary	Washington Technology Center & Tree Top, Inc.	$20,000	1/06 – 12/06	5%	MIVAC production of fresh and frozen prototype fruits for cereal inclusions – Phase I
C. Clary	WA Red Raspberry Commission	$19,393	1/06 – 12/06	5%	Development of value-added dried raspberry products
C. Clary J. Fellman	IMPACT	$36,000	7/06-6/07	10%	Improved Quality Attribute Retention in High-Value Horticultural Crops via Microwave-Vacuum Drying Technology
	Pending:				
C. Clary N. Davies Pharmaceutical Sciences	IMPACT	$46,225	7/07 – 6/08	10%	Improving Nutritional Value of Dried Fruits Combining Microwave Vacuum, Hot-Air Drying and Freeze Drying Technologies
C. Clary	Washington Technology Center & NutriLoc	$100,000	7/07-6/08	15%	Development of a continuous microwave vacuum dryer for commercial application

. Dr. Neal M. Davies

NAME (List/PD #1 first)	SUPPORTING AGENCY AND AGENCY ACTIVE AWARD/ PENDING PROPOSAL NUMBER	TOTAL $ AMOUNT	EFFECTIVE AND EXPIRATION DATES	% OF TIME COMMITTED	TITLE OF PROJECT
Davies NM	Active: Wisconsin Alumni Research Foundation	$50,000	September 1, 2006- February 28, 2007	10%	Modification of Micelle Core Properties Using Co-Excipients Carriers for Targeted Delivery of Paclitaxel and Geldanamycin
Davies NM	Food Science Corporation Vetri-Science	$35,000	July 1, 2006- September 1, 2005	1%	Glycoflex III and Canine Chondrocytes: Role of Cytokines and Matrix Metalloproteiases
Andrews PK Davies NM	Washington Tree Fruit Research Commission	$100,000	September 1, 2005- September 2007	5%	Identifying Disease Prevention Benefits of Apple Consumption.
Davies NM	Organic Center	$200,000	June 1 2006- May, 2008	5%	Nutritional and Biological Properties of Organic Food
Davies NM	Wisconsin Alumni Research Foundation	$55,000	December 1, 2005- December 1, 2006	5%	Modification of Micelle Core Properties using Co-Excipients Carriers for Targeted Delivery of mTOR Inhibitors
Davies NM	Food Science Corporation Vetri-Science	$35,000	September 1, 2005- September 1, 2006	5%	Pharmacometrics of Glycoflex III on Canine Chondrocytes
Andrews PK, Davies NM	Center for Sustaining Agriculture and Natural Resources Bio-Ag Program	$20,000	September 1, 2006- June 20, 2007	5%	Nutrient Quality and Disease Prevention benefits of Organic versus Conventional Tomatoes and Their Products
Davies NM	Pending: Pfeiffer Foundation	$75,000	Jan 1, 2007- December 31, 2007	10%	Chiral Flavonoids in Fruit: Implications for Organic Produce, Foor Processing and Nutrition

Current & Pending Support
J. S. Park

Instructions:
1. Record information for active and pending projects.
2. All current research to which principal investigator(s) and other senior personnel have committed a portion of their time must be listed whether or not salary for the person(s) involved is included in the budgets of the various projects.
3. Provide analogous information for all proposed research which is being considered by, or which will be submitted in the near future to, other possible sponsors.

Name (List PI #1 first)	Supporting Agency and Project #	Total $ Amount	Effective and Expiration Dates	% of Time Committed	Title of Project
J. S. Park (PI) & B. P. Chew (CoPI)	**Current:** The Iams Company	$ 294,041	2005-2006	25%	Inhibitory action of carotenoids against the growth of feline leukemia virus.
J. S. Park (PI) & B. P. Chew (CoPI)	The Iams Company	$ 179,964.	2005-2007	20%	Carotenoids on immunity: efficacy of a carotenoid mixture on immune response and antioxidative activity in cats.
J. S. Park (PI) & B. P. Chew (CoPI).	The Iams Company	$ 133,650	2006-2007	20%	Role of Dietary DHA on Cognitive function in young compared to old beagle dogs.
J. S. Park (PI) & B. P. Chew (CoPI).	The Iams Company	$ 12,000.	2006-2007	5%	The analysis of immune parameters.

J. S. Park (CoPI) & B. P. Chew (PI).	The Iams Company	$ 329,175	2005-2007	10%	Action of dietary astaxanthin against canine rheumatoid arthritis (CRA) and feline polyarthritis (FRA).
J. S. Park (CoPI) & B. P. Chew (PI).	The Iams Company	$ 117,040	2005-2007	5%	Cognitive Function In Dogs: Training and Testing Using "Delayed Nonmatching to Sample Task"
J. S. Park (CoPI) & B. P. Chew (PI).	The Iams Company	$ 16,819	2006	5%	Bioavailability of different forms of letein in dogs.
J. S. Park (PI), M. K. McGuire (CoPI) & B. P. Chew (CoPI).	**Pending:** Washington State Dairy Products Commission.	$ 26,800	2007-2008	5%	Role of dietary conjugated linoleic acid (CLA) in inhibiting leukemia virus replication and growth of virus-infected cells *in vitro*
J. S. Park (PI), K. Beerman (CoPI) & B. P. Chew (CoPI).	Washington State Dairy Products Commission	$ 53,650	2007-2009	10%	Effects of Whey Protein in the Prevention of Exercise-induced Oxidative Stress and Inflammatory Damage in Human Athletes.

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CURRENT AND PENDING SUPPORT

Thomas I. Wahl

Instructions:

1. Record information for active and pending projects, including this proposal (Concurrent submission of a proposal to other organizations will not prejudice its review by CSREES.)
2. All current efforts to which project director(s) and other senior personnel have committed a portion of their time must be listed, whether or not salary for the person involved is included in the budgets of the various projects.
3. Provide analogous information for all proposed work which is being considered by, or which will be submitted in the near future to, other possible sponsors including other USDA programs.

NAME (List/PD #1 first)	SUPPORTING AGENCY AND AGENCY ACTIVE AWARD/PENDING PROPOSAL NUMBER	TOTAL $ AMOUNT	EFFECTIVE AND EXPIRATION DATES	% OF TIME COMMITTED	TITLE OF PROJECT
Thomas I. Wahl	USDA-CSREES	$362,094	9/1/2006 – 1/31/2009	3%	Enhancing Competitiveness of Agricultural Products
Thomas I. Wahl	USDA-CSREES	$362,094	8/1/2005 – 1/31/2008	3%	Same
Thomas I. Wahl	USDA-CSREES	$325,779	7/1/2004 – 12/31/2006	.5%	Same
Thomas I. Wahl	WA Raspberry Commission				This proposal

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Expires 03/31/2004

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CURRENT AND PENDING SUPPORT

Christine Wieck

Instructions:

1. Record information for active and pending projects, including this proposal. (Concurrent submission of a proposal to other organizations will not prejudice its review by CSREES.)
2. All current efforts to which project director(s) and other senior personnel have committed a portion of their time must be listed, whether or not salary for the person involved is included in the budgets of the various projects.
3. Provide analogous information for all proposed work which is being considered by, or which will be submitted in the near future to, other possible sponsors including other USDA programs.

NAME (List/PD #1 first)	SUPPORTING AGENCY AND AGENCY ACTIVE AWARD/PENDING PROPOSAL NUMBER	TOTAL $ AMOUNT	EFFECTIVE AND EXPIRATION DATES	% OF TIME COMMITTED	TITLE OF PROJECT
Christine Wieck	Active: IMPACT Center, Washington State University:	29,966	8/2006 – 12/2008	0.05	The Effects of Reducing SPS Barriers to Trade on the Washington State Apple Industry
Christine Wieck	Washington Raspberry Commission				This proposal.