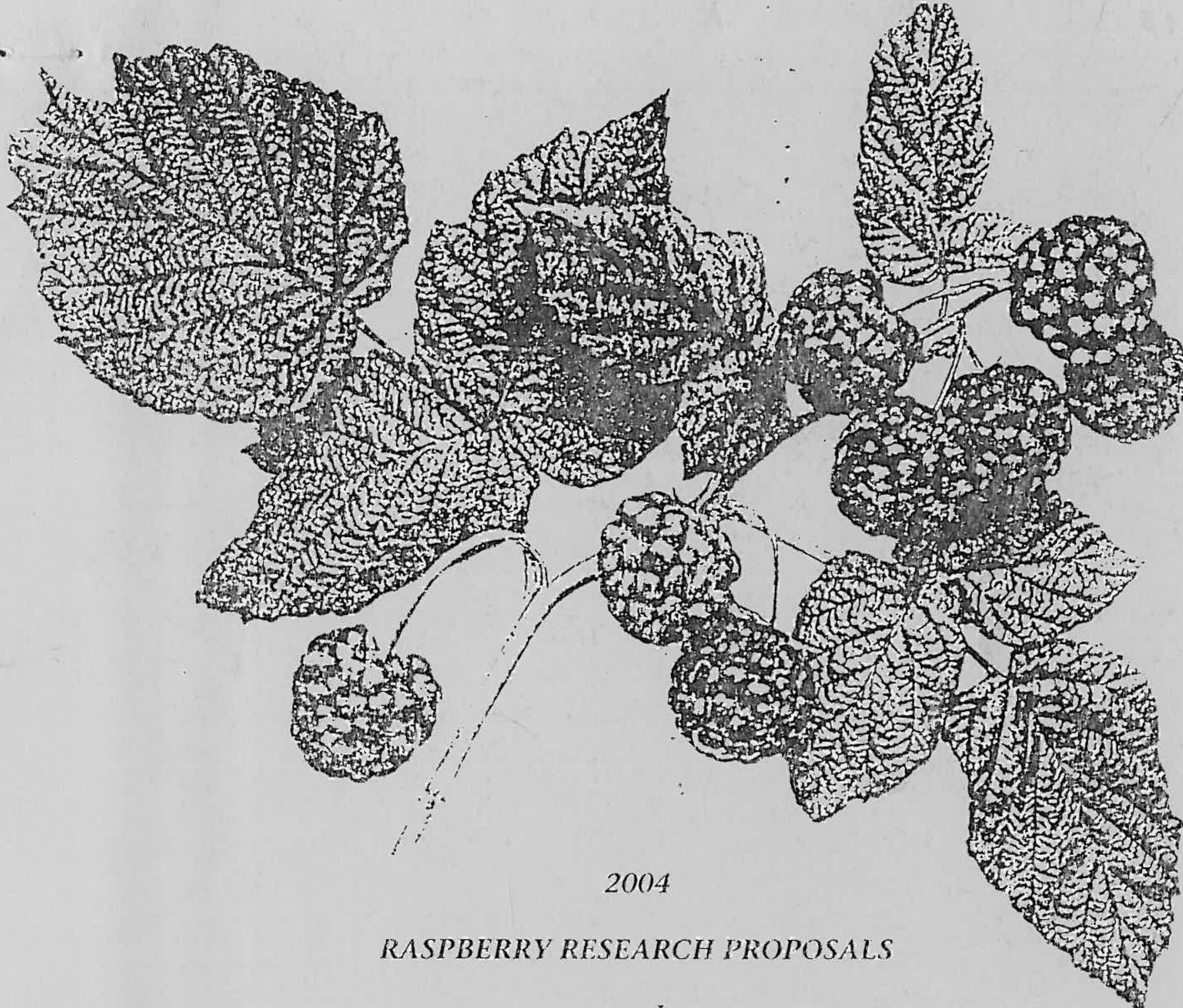

2004

RASPBERRY RESEARCH PROPOSALS

and

2003 PROGRESS REPORTS

to the

WASHINGTON STATE RASPBERRY COMMISSION

WASHINGTON RED RASPBERRY COMMISSION
BOARD OF DIRECTORS
2004-2005

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LAST YEAR FUNDING REQUESTS (2003)

Ongoing Projects (2003)

Project No.	Short Title	Lead Scientist	Amount Requested
13C-3755-5641	Raspberry Breeding	Moore	$48,000
13C-3755-7641	Advanced Testing/Vancouver	Moore	$1,700
13C-3755-8641	Advanced Testing/Mt. Vernon	Moore	$500
	Raspberry Cultivar Development	Kempler	$7,000
13C-3761-4251	Gypsum/Phytophthora root rot	Bristow	$2,900
13C-3543-4370	Insect/Mite control	Tanigoshi	$9,460
11C-3555-3780	Acquisition/Mechanical harvester	Tanigoshi	$3,000

New Projects (2003)

Short Title	Lead Scientist	Amount Requested
Fungicides/Effect on mite	Bristow	$6,124
Monitoring/Fruitworm	Murray	$1,242
Weed control	Miller	$4,230
Organic/Root rot	Miles	$6,180

CURRENT YEAR FUNDING REQUESTS (2004)

Ongoing Projects (2004)

Project No.	Short Title	Lead Scientist	Amount Requested
13C-3755-5641	Raspberry Breeding	Moore	$49,200
13C-3755-7641	Advanced Testing/Vancouver	Moore	$1,500
	Raspberry Cultivar Development	Kempler	$4,000
14C-4166-2815	Monitoring Fruitworm	Murray	$1,242
10A-3093-2403	Acquisition/Mechanical Harvester	Miles	$3,000
13C-3543-4370	Insect/Mite control	Tanigoshi	$9,540
13C-3761-4251	Gypsum/Phytophthora root rot	Bristow	$6,257

New Projects (2004)

Short Title (Ant iox)	Lead Scientist	Amount Requested ($10000)
Weed control	Miller	$4,700
Fruit rot fungicides/cane blight	Bristow	$3,515
Contain separation	Peerbolt	2,500
Grower New	?	3,000
Grower 02	Honcoop	2,000
Grower 03	Sakuma Bros	2,000
RBDV	Martin	3,900
Res travel		3,000

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: 2003

Accomplishments: In 2003, 90 crosses were made with emphases on using RBDV resistant parents, root rot tolerant parents and using diverse genetic material. No seedlings were planted in 2002. Approximately 5,800 seedlings were planted from the crosses made in 2001 and 2002. These seedlings will be evaluated in 2005 and 2006. Eighty-two selections were made among the approximately 12,500 seedlings planted in 2000 and 2001. Thirty-seven of the selections have a RBDV resistant parent or possibly resistant parent. Nineteen of the selections have a root rot resistant parent. Many of the selections used parents that have not been tested for RBDV or root rot resistance. Nootka (RBDV resistant), Malahat, Killarney (RBDV resistant), Qualicum, Tulameen and WSU 1162 were most represented as parents of the selections.

The 1999 replicated planting was harvested for the second time in 2003 (Table 1). Eighty-eight of the 168 plots were harvested in 2002 and only 50 were harvested in 2003. The average yield was 7.8. WSU 1309 had the highest yield in 2002 with 11.8 t/a and the highest yield in 2003 with 10.6 t/a. WSU 1309, has not tested RBDV positive, and has a parent that might be RBDV resistant, but has not been exposed to the disease very long. WSU 1112 had the second highest in 2002, 10.5 t/a, but below average in 2003, 6.8 t/a. WSU 1068 had the second highest yield in 2003, 9.8 t/a. WSU 1068 started harvest 6 days before Willamette, had a midpoint of harvest 5 days before Willamette and a yield 30% more that Willamette in both 2002 and 2003.

The 2000 replicated planting was harvested for the first time in 2003 (Table 2). This planting is in an area with a high level of root rot. Many of the plots are weak or have died. Only 32 of the 138 plots were harvested representing 13 clones. No plots of 33 raspberries were harvested, primarily because of death from root rot. Only 9 raspberries had all 3 plots harvested, 8 WSU selections and Cascade Delight. Five of these WSU selections have the same parents. WSU 1162 had very high yields, 11.7 t/a. Other selections with the same parents as WSU 1162 had yields over 5 t/a (WSU 1182, WSU 1164, WSU 1183, and WSU 1163). WSU 1369 was vigorous, had small fruit which limited its production. It has a wild North American red raspberry as a grandparent. This could be a useful new source of root rot resistance. Only a single plot of Meeker, Chilliwack and Willamette survived and were harvested. Yields of these were much less than some of the WSU selections. The performance of the raspberries in both the 1999 and 2000 plantings were compared (Table 3). Cascade Delight had 8.7 t/a only 0.4 t/a less than in the 1999 planting (which did not show obvious root rot in the planting). The yield of WSU 1068 in the 2000 planting was 70% of the yield of the 1999 planting, the yield for Meeker was only 41% and Willamette only 17%.

Data has been collected to support the release of WSU 1068 as an early season local fresh market cultivar with some root rot tolerance. Fruit quality of WSU 1162 will be evaluated in 2004 and data to support its release will be collected in 2004. It is hoped that WSU 1162 will be a high yielding, Meeker season, machine harvestable raspberry that is very root rot tolerant. WSU 1162 and the other selections from this cross have been planted in grower machine harvesting trials. WSU 1309 was planted in the 2003 machine harvesting trial and may be evaluated for machine harvestability in 2004.

Publications/Presentations:

Moore, P.P. Cascade Delight Red Raspberry. Accepted for publication.

Perkins-Veazie, P, P.Moore, C Weber, and L. Howard. 2003. Environmental Influence on Antioxidants in raspberries. HortScience (Abst.)

January, 2003. Strawberry and Raspberry fruit display. Northwest Food Processors, Portland, OR.

March 2003. Vancouver Small Fruit Workshop, Vancouver, WA.

July 2003. Raspberry Field Day, Puyallup, WA.

July 2003. Small Fruit Open House, Mt. Vernon, WA

Table 1. 2002-2003 harvest of 1999 planted raspberries, Puyallup, WA.

	Yield (t/a)			Fruit weight (g)		Fruit firmness (g)		2003 Harvest season			
	2003	2002	total	2003	2002	2003	2002	5%	50%	95%	Length of season (days)
WSU 1309	10.55 a	11.77 a	22.32 a	3.78 bc	3.82 ab	179 ef	211 de	7/1 c	7/12 bc	7/27 b-d	26 a-e
WSU 1068 [2]	9.80	8.07	17.87	4.07	3.61	185	198	6/21	7/1	7/16	25
WSU 1098 [1]	9.63			3.17		125		6/27	7/8	7/23	26
WSU 1307	9.17 ab	10.08 a-c	19.25 ab	3.54 c-e	3.82 ab	195 c-e	211 de	6/23 f	7/7 d-f	7/24 c-f	31 ab
C. Delight [2]	9.14	8.98	18.12	4.73	4.23	206	218	7/2	7/12	7/26	24
WSU 1321	8.49 a-c	6.93 d-f	15.41 bc	4.17 b	4.46 a	241 b	237 c	7/2 bc	7/14 b	7/31 a-c	29 a-c
Meeker	8.48 a-c	8.68 b-e	17.16 bc	2.71 h	2.89 c	190 d-f	190 ef	7/6 a	7/18 a	7/31 a-c	24 c-f
Tulameen	7.91 bc	7.96 c-f	15.87 bc	4.15 b	4.08 a	191 d-f	208 de	7/3 bc	7/18 a	8/6 a	34 a
WSU 1275	7.72 bc	7.38 d-f	15.10 bc	3.06 f-h	2.91 c	145 g	157 g	6/26 de	7/4 f	7/17 g	20 ef
Willamette	7.44 b-d	6.12 f	13.56 c	3.16 e-g	3.02 c	185 d-f	169 fg	6/27 de	7/6 ef	7/20 d-g	23 d-f
WSU 1274	7.23 b-d	6.50 ef	13.73 c	3.78 bc	3.83 ab	235 b	252 bc	7/5 ab	7/17 a	8/1 ab	28 a-d
WSU 1290	6.89 b-d	9.19 b-d	16.08 bc	3.28 d-f	2.90 c	212 c	230 cd	7/2 bc	7/10 cd	7/22 d-g	20 ef
WSU 1112	6.81 b-d	10.50 ab	17.31 bc	4.87 a	4.49 a	275 a	286 a	7/1 c	7/9 c-e	7/26 c-e	25 b-f
WSU 1293	6.54 b-d	8.04 c-f	14.58 bc	2.75 gh	2.68 c	173 f	186 f	6/27 de	7/8 de	7/22 d-g	24 c-f
WSU 1288	6.10 cd			3.32 d-f		149 g		6/19 g	6/26 g	7/8 h	18 f
WSU 1323	5.98 cd	7.00 d-f	12.98 c	3.98 bc	3.29 bc	271 a	266 ab	6/30 cd	7/8 de	7/19 e-g	19 f
Chemainus	4.92 d			3.63 cd		205 cd		6/27 de	7/6 ef	7/18 fg	21 ef
Average	7.81	8.37	16.38	3.66	3.57	198	216	6/29	7/9	7/23	25

Values are means of three replications, except those indicated by [1] or [2] which had only 1 or 2 plots harvested.

Table 2. 2003 harvest of 2000 planted raspberries, Puyallup, WA.

	Yield (t/a)	Fruit weight (g)	Fruit firmness (g)	Harvest season 5%	Harvest season 50%	Harvest season 95%	Length of season (days)
WSU 1162	11.73 a	3.28 b	163 c	6/29 a-c	7/10 B	7/25 a	25 a
C. Delight	8.69 b	4.47 a	197 b	6/30 ab	7/11 B	7/25 a	24 a
WSU 1182	8.48 bc	2.87 cd	105 d	7/3 a	7/13 A	7/25 a	23 a
WSU 1164	7.33 b-d	3.27 b	113 d	6/24 de	7/5 D	7/17 bc	23 a
WSU 1068	6.91 cd	2.79 d	174 c	6/18 f	6/27 F	7/10 e	22 a
WSU 1183	6.82 d	3.00 b-d	122 d	6/21 ef	6/28 F	7/9 e	18 a
WSU 1163	5.79 de	3.00 b-d	106 d	6/24 de	7/3 E	7/14 d	20 a
WSU 1369	4.82 ef	2.10 e	150 c	6/25 c-e	7/6 Cd	7/16 c	21 a
WSU 1112	3.93 f	3.20 bc	227 a	6/27 b-d	7/7 C	7/18 b	22 a
Meeker [1]	3.49	3.24	174	7/1	7/11	7/19	18
Chilliwack [1]	3.18	2.34	161	6/25	7/3	7/14	19
BC 89-34-41 [2]	2.41	2.06	143	6/26	7/8	7/17	22
Willamette [1]	1.23	1.94	124	6/24	7/4	7/12	18
Average	5.75	2.89	151	6/26	7/6	7/17	21

Raspberries indicated by [1] or [2] had only 1 or 2 plots harvested, with others severely damaged by root rot.
All other raspberries in table had 3 plots harvested.

The following raspberries were planted but not harvested because of root rot damage or crumbly fruit.

Cowichan	WSU 1161	WSU 1238	WSU 1270	WSU 1299	WSU 1326	WSU 1354	WSU 1372
Malahat	WSU 1197	WSU 1254	WSU 1282	WSU 1305	WSU 1335	WSU 1357	WSU 1377
Qualicum	WSU 1232	WSU 1262	WSU 1285	WSU 1308	WSU 1350	WSU 1358	WSU 1378
Tulameen	WSU 1233	WSU 1266	WSU 1298	WSU 1310	WSU 1352	WSU 1364	WSU 1379
							WSU 1380

Table 3. Comparison of 2003 harvest of 1999 planted raspberries (minimal root rot) and 2000 planted raspberries (severe root rot).

	Yield (t/a)			Fruit Wt. (g)			Harvest Season 5%			50%			95%			length of season (days)		
	1999	2000	%	1999	2000	%	1999	2000	diff	1999	2000	diff	1999	2000	diff	1999	2000	diff
C. Delight	9.1	8.7	95%	4.73	4.47	95%	7/3	6/30	3	7/13	7/11	2	7/27	7/25	2	24	24	0
WSU 1068	9.8	6.9	70%	4.07	2.79	69%	6/22	6/18	3	7/2	6/27	4	7/17	7/10	7	25	22	3
WSU 1112	6.8	3.9	58%	4.87	3.20	66%	7/2	6/27	5	7/10	7/7	3	7/27	7/18	8	25	22	3
Meeker	8.5	3.5	41%	2.71	3.24	120%	7/7	7/1	7	7/19	7/11	8	8/1	7/19	13	24	18	6
Willamette	7.4	1.2	17%	3.16	1.94	61%	6/28	6/24	4	7/7	7/4	3	7/21	7/12	9	23	18	5
Average	8.3	4.8	58%	3.91	3.13	80%	6/30	6/26	4	7/10	7/6	4	7/24	7/17	8	24	21	3

Project: 13C-3755-5641
Title: Red Raspberry Breeding, Genetics and Clone Evaluation
Year Initiated:2000
Current Year:2004
Terminating Year:2004
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 its supports. The PNW breeding programs have been an important part of this research, developing cultivars that are the basis for the entire 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.

There has been a history of cooperation between the breeding programs in Oregon, British Columbia, and Washington. Crossing plans for each of the programs are exchanged and compared. Seed, seedlings and selections are exchanged among the programs. 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 RBDV resistance, root rot tolerance, and yield. Other traits are ease of fruit removal, fruit firmness, fruit size, fruit color, harvest season, fruit rot resistance, and growth form.

3. Seed from the 89 crosses made in 2003 will be sowed in 2004. The goal will be to plant 108 plants for each cross, but will depend on the number of seeds and germination rate.

4. Selections will be made among the seedlings planted in 2002 (no seedlings were planted in 2002). Seedlings will be subjectively evaluated for yield, flavor, appearance, color, 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 2003 will be propagated for testing. Shoots of all selections will be collected and placed into tissue culture. Selections that are not 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. Ten plants of each of the selections in #5 above will be planted in a grower planting for machine harvesting evaluation. It is estimated that about 40 WSU selections will be planted in the field in 2004. Three plants of each selection will also be planted at WSU Puyallup for observation, use as a parent or future propagation.

7. The replicated plantings established in 2000 and 2001 at WSU Puyallup will be harvested for yield, fruit weight, fruit rot and fruit firmness.

8. Plants will be multiplied in tissue culture and propagated for testing at other locations and grower trials. WSU 1068, WSU 1112, WSU 1161, WSU 1162 and WSU 1226 are currently being propagated by commercial propagators and may be available for grower trial in 2004.

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

Anticipated Benefits and Information Transfer:
This program will develop new raspberry cultivars that are more productive or more pest resistant. Such cultivars may result from crosses made this year or may already be under evaluation.

Proposed Budget: For 2004-2005 I will keep my request to the WRRC at the 2002 and 2003 levels except for an increase in benefits and an increase for travel to the machine harvesting trials in Lynden and Burlington.

Support is requested for a portion of the project operations budget at WSU Puyallup. Salaries for one WSU faculty member, 1.05 FTE support staff, and some operating funds are provided by WSU for breeding work on BOTH strawberries and raspberries. This request provides for 0.70 FTE of staff support with 0.85 FTE from other sources for a total of 2.6 FTE for all small fruit breeding program support. The remaining funds requested will be used for timeslip labor, field supplies, greenhouse supplies and travel to research plots and to grower meetings to present results of research. This proposal does not include grower expenses for machine harvesting trials.

Budget:		**2003-2004**	**2004-2005**
00 Salaries			
Plant Tech II	0.15 FTE	$5,250	$5,250
Agr. Res. Tech. I	0.30 FTE	10,024	10,024
Agr. Res. Tech. II	0.15 FTE	5,653	5,653
Lab Tech.	0.10 FTE	3,040	3040
01 Timeslip Labor		10,000	10,000
03 Service and Supplies		3,464	3,466
04 Travel		400	1,400
07 Benefits			
Plant Tech II		1,449	1,470
Agr. Res. Tech. I		4,090	4,210
Agr. Res. Tech II		2,109	2,148
Lab Tech I		921	938
Timeslip		1,600	1,600
Total		**$48,000**	**$49,200**

Current & Pending 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	$25,000	2002-2004	Propagation of WSU Strawberry and Raspberry Selections for Testing
Moore, P.P.	Oregon Raspberry and Blackberry Commission	$7,000	2003-2004	Development of New Raspberry Cultivars for the Pacific Northwest

Project: 13C-3755-7641

Title: Advanced Testing of Washington State University Raspberry Selections at Vancouver Research and Extension Unit

Personnel: Patrick P. Moore, Scientist, WSU Puyallup
Martin Nicholson, Operations Manager, WSU Vancouver.

Reporting Period: 2003

Accomplishments:

A raspberry planting designed for machine harvesting evaluations was established at WSU Vancouver in 2001. The clones that were harvested in 2003 were Cowichan (BC 87-14-20), WSU 1068, Cascade Delight (WSU 1090), and WSU 1162. Meeker was added to the planting this spring.

In general, yields were low (Table 1). Cowichan and WSU 1162 had the highest yields and did not differ statistically. Cascade Delight and WSU 1068 had the lowest yields. Many laterals of Cascade Delight were damaged during machine harvesting. Fruit of WSU 1068 did not release well. Fruit of all plots was rated subjectively for fruit quality on July 1 and July 5 (Table 1). Fruit quality of all plots was better on July 7. WSU 1162 and Cowichan had the highest rated fruit quality.

Publications:

March 2003. Vancouver Small Fruit Workshop, Vancouver, WA.

Table 1. 2003 machine harvest data from 2001 planted raspberries, Vancouver, WA.

	Yield (t/a)	Fruit weight (g)	Harvest Season 5%	50%	95%	Length of season (days)	Evaluation of fruit quality[z]
Cowichan	1.8 a	3.3 b	6/25 bc	7/7 b	7/17 a	22 a	1.25 ab
WSU 1162	1.3 ab	3.0 bc	6/26 b	7/7 b	7/17 a	20 ab	1.00 a
Cascade Delight	1.1 bc	4.6 a	7/1 a	7/10 a	7/18 a	18 c	2.00 c
WSU 1068	0.7 c	2.6 c	6/22 c	7/1 c	7/11 b	19 bc	1.63 bc
Average	1.2	3.4	6/26	7/6	7/15	20	1.47

[z] Fruit from all plots subjectively evaluated on 1 and 5 July with 1=good fruit quality and 5=poor.

Project No.: 13C-3755-7641
Title: Advanced Testing of Washington State University Raspberry Selections at Vancouver Research and Extension Unit
Personnel: Patrick P. Moore, Scientist, WSU Puyallup;
Martin Nicholson, Operations Manager, WSU Vancouver.
Year Initiated: 1996 **Current Year:** 2003 **Terminating Year:** 2004

Justification: Developing a new raspberry cultivar is a long-term process. Promising selections are tested against standard cultivars in a replicated trial. If the selection performs well in this test, it then needs to be tested against standard cultivars in several locations throughout the region in which it will be grown. Accurate records of yield, fruit quality, susceptibility to pests at these locations is necessary in deciding to release or discard a promising selection. Many characters under genetic control are affected strongly by environment. Estimates of the effect of location on these characters will provide useful information that can improve the efficiency of a breeding program.

One of the most important characteristics to determine is the machine harvestability of a selection. There is no machine harvester at WSU Puyallup where most of the evaluation is conducted. WSU Vancouver has a current Littau harvester that can be used for evaluation of machine harvestability. A replicated planting was established in 2001 that was designed to evaluate machine harvestability.

Objectives:
1. To establish and maintain a replicated raspberry planting at WSU Vancouver Research and Extension Unit.

2. To measure yield, fruit quality, and susceptibility to pests in these selections as part of the ongoing cultivar development process with particular emphasis on evaluating machine harvestability.

Procedures: This is an ongoing project that depends on continuity of effort. Each year promising selections are propagated for possible grower trial. When several promising selections are identified, new test plantings are established.

1. A new replicated planting of raspberry clones for machine harvesting evaluation was established in 2001. Selections included were
WSU 1068, Cascade Delight (WSU 1090), WSU 1161, WSU 1162, and Cowichan (BC 87-14-20) along with Meeker for comparison. Four replications of twenty plant plots for each clone were planted at WSU Vancouver.

2. The station now has a current Littau harvester and can evaluate the machine harvestability of selections. The planting established in 2001 will be harvested in 2004 and yield and fruit weight measured. WSU 1068, WSU 1162, Cascade Delight, Cowichan and Meeker will be harvested in 2004.

Anticipated Benefits and Information Transfer:
New raspberry cultivars, which are more productive or more pest resistant, will be developed by this program. Such cultivars may result from crosses made this year or may already be under evaluation. The objective of this project is to make final evaluations of the most promising selections and to evaluate material from other programs. The most important evaluation will be evaluation of machine harvestability. WSU Vancouver now has a current Littau harvester that can

be used for evaluation of machine harvestability. Research results will be communicated at grower meetings, commission meetings, and field days.

Proposed Budget: Support is requested for harvest and maintenance of raspberry plots at WSU Vancouver.

Budget:	**2003-2004**	**2004-2005**
01 Timeslip Labor	$1,380	$1,250
03 Service and Supplies	100	50
07 Benefits	220	200
Total	**Requested $1,700**	**$1,500**
	Funded $1,000	

Title: Raspberry Machine Harvesting Trials

Personnel: Patrick P. Moore, Scientist
WSU Puyallup Research and Extension Center
Chaim Kempler, Agriculture and AgriFood Canada
Randy Honcoop, Grower, Lynden, WA
Tom Walters, Sakuma Bros, Burlington, WA

Reporting Period: 2003

A non-replicated planting of 70 clones was established in 2002 at Randy Honcoop's Farm in Lynden for evaluation of machine harvestability. Fifty WSU selections, 16 BC selections and 6 cultivars (Cowichan, Meeker, Tulameen and Willamette) were planted in 10 plant plots. Cascade Delight and Cascade Nectar were planted as numbered selections and were released as cultivars after the planting was established. Because the initial plants were small greenhouse grown tissue culture plants, many plants, although very healthy and growing vigorously, were not be large enough to machine harvest in 2003. This planting will be harvested in 2004 for the first time.

A non-replicated planting of 91 raspberry clones was established in 2003 at Sakuma Bros. Farms in Burlington, WA for evaluation of machine harvestability. Fifty-three WSU selections, 24 BC selections and 3 Cornell selections were planted in along with 11 cultivars (Cascade Nectar, Chilliwack, Coho, Cowichan, Esta, Malahat, Meeker, Prelude, Qualicum, Tulameen, and Willamette) in 10 plant plots. In 2003, the plants had been hardened off in a screenhouse than in 2002 and the growth of the plants in the field was better than in 2002. This planting may be harvested in 2004 for the first time.

Additional raspberry selections are being propagated for a new grower planting in 2004.

Progress Report

Title: Red Raspberry Cultivar Development for the Pacific Northwest

Personnel: Chaim Kempler, Fruit Breeder, KemplerC@agr.gc.ca
Brian Harding, Research Technician, HardingB@agr.gc.ca
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Website: http://res2.agr.ca/parc-crapac/agassiz/progs/crop_science/kempler_e.htm

Reporting period: 2003

Funding in 2003 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: In 2003 the PARC breeding program released two new cultivars; Esquimalt (tested as BC89-2-89)is a late yielding large fruited variety that is adapted for the fresh market and Chemainus (tested as BC89-33-84) which is suitable for both the fresh and processing markets and will machine harvest. 62 new selections were made from seedling fields planted in 1998, 1999, and 2000. These are now being propagated for planting at Abbotsford and at next year's WRRC testing site in Washington State. 376 plots were sampled and tested for RBDV. 79 selections tested positive for RBDV for the first time and as a result most of them have been eliminated. Three selections were identified to be resistant to root rot in the Puyallup field testing seven were identified as susceptible. The resistance for two of the selections comes from two new sources of *R. strigosus*, collected from Lake George, Minnesota and from Dalhosie Lake, Quebec. These two sources are not present in any known cultivar. For the third selection the source for resistance to root rot comes from the Latham cultivar. During the 2003 harvest season the 1996, 1997, 1998, 1999, 2000 and 2001 plantings were evaluated. Data on yield, fruit traits and harvest season is presented in tables 1 to 4.

Notes on cultivars and potential new cultivars:

Qualicum (Glen Moy x Chilliwack)
Very productive with large firm fruit that is well adapted for fresh market. It has a good postharvest quality for long distance shipping. Experience has shown that under proper growing conditions Qualicum can be adaptable to mechanical harvesting and its fruit is acceptable for the IQF market. However, under vigorous growing conditions Qualicum produces excessive growth, making this variety unsuitable for mechanical harvesting and very susceptible to pre-harvest fruit rot. It ripens with a similar season to Meeker. The very high yield in the middle of the harvest season makes it difficult to hand harvest for the fresh market. Qualicum is susceptible to crown gall, spur blight and cane botrytis. However, under regular growing conditions fruit rot sprays will also control cane and leaf diseases. Qualicum shows an excellent level of winter hardiness, somewhat similar to Haida.

Malahat (Meeker x BC/SCRI 7853/116)
Produces high yields of large, firm fruit that ripens up to a week earlier than any other recommended variety and is well suited to the fresh market. It should be particularly useful for the early fresh market where early production and good quality are important. Malahat is suitable for machine harvesting producing a high quality IQF and processing crop. Malahat is very suited for switching between hand and machine harvesting depending on the season and labour availability. Because Malahat ripens earlier than Meeker, it has allowed the producer a longer harvest season and a better utilisation of harvesting equipment. Plants of Malahat are susceptible to root rot; therefore it should be planted on well-drained soils that are free of root rot or on raised beds that provide a better-drained root zone. Canes have small spines over most of the cane surface. Laterals are short. Fruit is very easy to harvest. It is susceptible to

RBDV but the rate of infection appears to be slow. Malahat is resistant to the aphid vector of the raspberry mosaic virus complex.

Cowichan Tested as BC87-14-20 (Newburgh x Qualicum)
A recently named PARC cultivar, Cowichan, appears to be a very promising option to escape the infection of RBDV. 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 resistance 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 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 higher than Meeker (Tables 1 and 3). In growers' field trials, although exposed to high pressure of RBDV for the last 5 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 resistance to RBDV. In large-scale growers' trials it has shown itself very suitable for mechanical harvesting. It produces an acceptable yield of large fruit that ripens a few days earlier then Meeker and appears to be suitable for IQF. Cowichan fruit is soft and appears to be unsuited for long distance shipping and the fresh market. However, this harvest season, the fruit was firm and appeared to have excellent fresh market quality. It was also identified as having very good flavour and aroma comparable to Tulameen and Chilliwack. Plant growth is very vigorous with an upright habit and good 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*).

Esquimalt Tested as BC89-2-89 (Comox x Glen Ample)
Produces high yields of large fruit 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 PNW recommended variety. Fruit is larger than Tulameen, light in colour with large drupelets. The plant is very vigorous, with strong spineless canes and long, strong upright laterals. It is not recommended for machine harvest. The fruit is very meaty, having large drupelets that tend to break upon harvest. It is not resistant to RBDV but appears to have slow rates of infection. It is susceptible to cane botrytis (*B. cinerea*) and its reaction to root rot is unknown.

Chemainus Tested BC89-33-84 (BC82-5-84 x Tulameen)
A mid season processing and fresh market type that produces attractive dark berries with some resistance to fruit rot. The fruit is easy to harvest and in growers' trials has machine harvested well. 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 but appears to have a slow rate of infection. 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 and more than 100,000 plants have already been planted for large scale field tests.

BC89-34-41 (Algonquin x Chilliwack) x (Nootka x Glen Prosen)
Selected from a cross between two PARC selections. This is an early fresh market or processing selection producing high yields with a fruit size that is slightly larger than Meeker. It is very productive producing some of the highest yields in our trials. The medium glossy, firm excellent quality fruit have fine drupelets and a very pleasant flavour that is comparable to Tulameen. The canes are spineless with laterals that are short and bend easily without breaking and so are able to carry the high yield. This year in a grower's trial the fruit appeared to release well from the receptacle and did harvest well mechanically. This will require further observations as in the 2001 harvest year the comments were made that it did not harvest well. This selection although exposed to high pressure of RBDV for many years has been slow to show even low levels of RBDV infection.

BC90-6-2 (BC86-41-15 x BC83-15-15)
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. It produces numerous primocanes, but has been rated as being hard to harvest. BC90-6-2 is most suitable for the fresh market due to its long harvest duration, late producing period and large fruit. It is slow and hard to establish and the nurseries are having some difficulties propagating stock for field testing.

New selections for growers' trials:

BC87-11-33 (Latham x Qualicum)
This selection was identified for its high field resistance to root rot. It produces fruit that is comparable to. Meeker and yields that are higher than Meeker. It is easy to harvest and might be suited for mechanical harvesting. Fruit is glossy, dark, a bit soft and has fine drupelets. Plants are vigorous

BC90-8-11 (BC86-41-15 x Qualicum)
This is a 3rd backcross from *R. strigosus*. It produces a large mid to late season crop that is most suited for the fresh market but might be also be acceptable for processing. The fruit is large, firm and is well spaced and presented on the laterals. The plant has an upright habit.

BC90-8-20 (BC86-41-15 x Qualicum)
A productive mid-season selection with light fruit that is most suitable for the fresh market but also acceptable for IQF and processing. The large low-gloss fruit strongly resembles Qualicum. Plant vigour is not excessive with leaves that are large and light green. 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. It has good sized fruit that is firm and attractive with very fine drupelets. It is easy to harvest and appears suitable for processing and fresh markets.

BC91-17-10 (87-14-35 x Tulameen)
This is a productive selection that although exposed to high pressure of RBDV stayed free of infection producing high quality processing-type fruit. The fruit is large, firm, and glossy with large drupelets.

BC92-6-41 (Chilliwack x BC86-41-15)
This selection was identified for its high field resistant to root rot. It is 2nd 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 with a no-gloss medium red that might be too light for processing. It keeps good size and productivity and has a long harvesting season.

A limited number of plants from this list will be available for trials from Sakuma Bros. in Burlington, WA., Tel.: (360) 757-6611, and Ken M. Spooner Farms, Tel.: (253) 845-5717. You are encouraged to plant and test some of these experimental trial selections. During the growing season visit the experimental plantings at the Abbotsford Sub-Station, 510 Clearbrook Rd., Abbotsford. Tel.: (604) 853-1551.

Table 1. Yield, fruit weight, harvest season and harvest ease of raspberry cultivars harvested in 2003, Abbotsford, BC

Clone	No. Plots	Total Yield (kg/hill)	Total Yield (tons/ac)	Early[z] Yield (%)	Late[y] Yield (%)	Fruit Weight (g)	First Harvest (date)	50% Harvest (date)	95% Harvest (date)	Harvest Duration (Days)	Harvest Ease[x]
1996 planting											
87-11-33	1	5.13	8.22	28.3	8.9	3.9	27-Jun	16-Jul	11-Aug	46.4	2.6
87-14-35	1	5.60	8.98	0.0	38.7	2.9	16-Jul	30-Jul	18-Aug	34.4	1.8
87-3-37	1	3.21	5.14	2.4	10.9	3.6	4-Jul	20-Jul	7-Aug	35.1	2.8
90-8-11	1	3.92	6.28	1.0	8.7	4.0	9-Jul	20-Jul	7-Aug	30.1	1.8
1997 planting											
87-18-7	1	3.59	5.76	2.1	21.8	3.5	9-Jul	20-Jul	11-Aug	34.2	3.0
89-34-41	3	5.75	9.21	0.0	20.3	2.6	16-Jul	20-Jul	14-Aug	30.0	2.2
89-6-12	1	3.25	5.20	8.8	5.2	3.8	4-Jul	16-Jul	7-Aug	35.1	2.5
90-8-20	1	4.18	6.69	3.2	10.3	5.8	4-Jul	20-Jul	11-Aug	39.2	2.6
91-15-40	2	5.23	8.38	12.3	8.7	4.9	4-Jul	16-Jul	9-Aug	37.2	2.5
92-5-1	1	5.07	8.12	0.0	20.2	3.6	16-Jul	20-Jul	11-Aug	27.8	3.2
92-5-52	1	4.35	6.97	2.7	21.5	3.0	4-Jul	20-Jul	11-Aug	39.2	3.3
WSU 1090	1	4.95	7.93	0.0	27.6	3.0	16-Jul	30-Jul	18-Aug	34.4	2.8
Chemainus	2	4.54	7.28	5.4	12.8	3.4	4-Jul	18-Jul	11-Aug	39.2	2.8
Esquimalt	2	4.56	7.30	0.4	26.3	4.7	16-Jul	30-Jul	11-Aug	27.8	2.8
Malahat	2	3.24	5.19	12.7	8.6	4.0	4-Jul	16-Jul	9-Aug	37.2	2.8
Meeker	3	3.62	5.80	0.0	15.9	2.9	16-Jul	20-Jul	11-Aug	27.8	2.3
Qualicum	2	4.37	7.00	4.3	9.5	4.8	7-Jul	18-Jul	9-Aug	34.7	2.4
Tulameen	1	4.11	6.58	0.0	26.8	4.9	16-Jul	20-Jul	18-Aug	34.4	2.7
1998 planting											
92-6-41	3	4.70	7.52	7.0	11.0	3.4	9-Jul	19-Jul	10-Aug	32.8	2.2
Meeker	2	3.01	4.82	3.5	16.8	2.6	12-Jul	20-Jul	11-Aug	31.0	2.9
1999 planting											
87-14-35	1	5.78	9.25	0.0	41.3	2.9	16-Jul	30-Jul	18-Aug	34.4	3.2
87-5-1	2	3.12	5.00	0.5	9.8	3.7	12-Jul	20-Jul	11-Aug	31.0	3.7
89-34-41	3	5.68	9.09	3.0	25.8	2.6	9-Jul	20-Jul	16-Aug	38.6	2.8
89-6-12	1	3.60	5.76	16.4	13.5	4.1	9-Jul	16-Jul	11-Aug	34.2	2.6
90-4-23	1	4.90	7.85	26.1	2.6	3.7	4-Jul	16-Jul	7-Aug	35.1	3.3
90-8-20	2	4.06	6.50	4.7	10.8	5.2	9-Jul	18-Jul	9-Aug	32.2	3.6
Chemainus	3	4.27	6.85	44.0	3.5	3.9	4-Jul	9-Jul	5-Aug	32.4	3.1
Cowichan	3	4.14	6.64	8.4	12.6	3.8	9-Jul	20-Jul	11-Aug	34.2	2.5
Malahat	1	3.90	6.25	16.4	6.8	3.5	9-Jul	16-Jul	7-Aug	30.1	3.0
Meeker	3	4.26	6.82	2.7	17.3	2.6	11-Jul	20-Jul	10-Aug	30.7	3.2
Qualicum	2	5.50	8.80	5.8	11.0	4.1	9-Jul	20-Jul	11-Aug	34.2	2.2
2000 planting											
89-2-46	1	2.48	3.97	2.1	10.7	3.4	9-Jul	20-Jul	11-Aug	34.2	3.3
89-34-41	4	5.85	9.36	6.0	17.8	2.8	11-Jul	23-Jul	11-Aug	32.6	3.5
90-19-08	1	4.17	6.68	29.0	2.6	3.7	4-Jul	16-Jul	7-Aug	35.1	3.2
90-6-2	2	5.05	8.09	2.7	31.6	2.4	9-Jul	30-Jul	15-Aug	37.5	3.0
90-8-11	1	4.13	6.61	22.7	4.0	3.6	4-Jul	16-Jul	7-Aug	35.1	3.2

90-8-20	3	3.78	6.05	24.7	5.5	4.4	6-Jul	16-Jul	7-Aug	33.4	2.5
92-9-12	1	3.10	4.97	26.2	26.0	4.9	4-Jul	20-Jul	11-Aug	39.2	1.6
92-9-15	1	4.77	7.64	76.3	0.7	3.6	27-Jun	4-Jul	16-Jul	19.6	1.8
93-15-32	1	4.02	6.44	62.7	0.0	4.6	4-Jul	9-Jul	20-Jul	16.9	2.3
93-15-38	1	6.98	11.18	0.0	11.4	4.4	16-Jul	20-Jul	11-Aug	27.8	2.6
93-15-40	3	4.12	6.59	4.6	10.1	3.8	7-Jul	19-Jul	9-Aug	33.1	3.1
93-18-20	2	4.66	7.47	4.6	9.1	3.5	9-Jul	20-Jul	9-Aug	32.2	2.7
93-20-11	3	3.99	6.40	4.6	25.1	3.6	11-Jul	27-Jul	16-Aug	36.5	2.5
93-21-26	2	4.24	6.79	1.3	27.9	4.3	12-Jul	29-Jul	11-Aug	31.0	3.3
93-22-11	2	3.57	5.72	11.1	7.7	4.2	7-Jul	18-Jul	7-Aug	32.6	2.5
93-22-41	2	4.44	7.11	2.7	19.7	3.7	10-Jul	25-Jul	11-Aug	33.5	2.9
93-23-2	2	4.40	7.05	6.6	11.6	3.5	9-Jul	20-Jul	11-Aug	34.2	2.7
93-26-16	3	3.41	5.46	8.1	8.7	3.5	9-Jul	19-Jul	9-Aug	31.5	3.4
93-26-25	3	4.87	7.80	3.5	20.3	4.0	11-Jul	23-Jul	11-Aug	32.1	2.9
93-26-9	3	3.01	4.82	18.9	13.0	5.0	4-Jul	17-Jul	10-Aug	37.8	3.2
93-27-26	3	5.06	8.10	9.0	17.1	3.2	7-Jul	20-Jul	11-Aug	35.9	2.4
93-5-41	1	4.60	7.38	6.4	12.2	3.9	9-Jul	20-Jul	11-Aug	34.2	3.7
97-18-48	1	4.49	7.19	10.3	23.4	2.5	9-Jul	20-Jul	11-Aug	34.2	3.0
ORUS 674-17	1	2.72	4.36	8.7	0.0	3.5	9-Jul	16-Jul	20-Jul	11.9	2.7
WSU 1162	1	4.08	6.53	21.6	9.9	2.7	4-Jul	16-Jul	11-Aug	39.2	2.8
Chemainus	2	4.07	6.52	11.3	15.3	3.5	7-Jul	20-Jul	11-Aug	36.7	2.5
Cowichan	3	3.45	5.52	19.6	8.5	4.7	7-Jul	17-Jul	10-Aug	34.5	2.7
Esquimalt	3	5.62	9.01	2.2	27.9	4.3	14-Jul	27-Jul	11-Aug	29.9	3.1
Malahat	2	4.17	6.68	11.5	10.9	4.3	7-Jul	18-Jul	11-Aug	36.7	2.8
Meeker	2	4.03	6.45	6.2	22.6	2.7	7-Jul	25-Jul	11-Aug	36.7	3.2
Qualicum	2	3.17	5.07	36.3	2.4	4.1	4-Jul	12-Jul	7-Aug	35.1	2.2
Tulameen	3	4.11	6.58	7.6	13.5	4.2	9-Jul	17-Jul	11-Aug	34.2	2.4
2001 planting											
89-34-41	2	5.30	8.48	2.7	23.7	2.5	12-Jul	25-Jul	15-Aug	34.3	2.8
90-6-2	2	6.34	10.15	3.4	38.4	4.9	9-Jul	30-Jul	26-Aug	48.8	3.3
90-11-44	3	3.68	5.90	9.4	8.3	3.4	7-Jul	20-Jul	9-Aug	33.1	3.1
90-17-45	1	8.17	13.09	2.4	46.1	2.2	16-Jul	7-Aug	18-Aug	34.4	2.8
91-28-4	1	3.19	5.12	6.9	11.1	3.3	9-Jul	20-Jul	11-Aug	34.2	2.4
92-4-11	2	5.96	9.54	15.0	17.3	3.8	4-Jul	20-Jul	11-Aug	39.2	2.5
92-4-29	3	4.70	7.53	33.6	6.9	3.2	4-Jul	13-Jul	7-Aug	35.1	3.0
92-5-1	2	5.16	8.26	8.8	15.4	3.4	7-Jul	20-Jul	11-Aug	36.7	2.8
92-5-47	2	4.32	6.92	18.6	14.8	3.6	4-Jul	18-Jul	11-Aug	39.2	3.1
93-2-7	2	5.41	8.67	7.3	27.2	3.2	7-Jul	25-Jul	15-Aug	40.0	3.0
93-9-40	3	4.61	7.38	25.9	4.9	4.0	6-Jul	15-Jul	7-Aug	33.4	2.8
93-9-48	3	4.40	7.05	11.9	8.5	3.5	6-Jul	19-Jul	9-Aug	34.8	3.1
94-4-17	3	5.99	9.59	10.8	12.6	5.2	4-Jul	20-Jul	11-Aug	39.2	3.1
94-4-18	1	4.43	7.09	16.2	5.7	4.3	4-Jul	16-Jul	7-Aug	35.1	2.4
94-13-2	3	3.38	5.41	20.4	5.8	4.1	4-Jul	13-Jul	27-Jul	24.3	3.4
96-13R-67	3	3.83	6.13	19.3	8.4	3.1	2-Jul	19-Jul	10-Aug	40.2	3.2
96-17R-21	2	3.39	5.42	14.0	12.2	3.6	7-Jul	23-Jul	9-Aug	34.7	2.4
96-17R-45	2	3.09	4.95	25.2	1.6	3.2	4-Jul	16-Jul	3-Aug	31.0	2.4
96-19-4	3	3.38	5.41	5.4	9.5	3.4	11-Jul	20-Jul	10-Aug	30.7	2.3

96-19R-19	2	6.00	9.62	0.9	43.2	4.0	18-Jul	3-Aug	26-Aug	40.2	2.9
96-21R-58(56)	2	3.61	5.79	3.3	10.2	3.7	12-Jul	20-Jul	9-Aug	29.0	3.0
96-22R-55	2	5.86	9.39	0.2	16.9	4.3	16-Jul	25-Jul	11-Aug	27.8	2.6
96-26R-10	1	3.88	6.21	2.5	24.6	4.4	9-Jul	30-Jul	18-Aug	40.8	4.0
96-37-1	2	6.98	11.17	0.0	54.1	2.2	18-Jul	7-Aug	22-Aug	36.2	3.0
97-1-7	1	6.86	10.98	0.5	57.5	2.4	16-Jul	7-Aug	26-Aug	42.4	3.0
Cowichan	3	5.17	8.28	13.4	7.3	4.2	4-Jul	17-Jul	9-Aug	36.5	2.7
Malahat	1	3.29	5.27	25.6	11.1	3.4	4-Jul	16-Jul	11-Aug	39.2	3.2
Meeker	3	3.23	5.17	9.9	14.8	2.4	6-Jul	20-Jul	11-Aug	37.5	3.2
Qualicum	2	5.54	8.87	19.7	7.5	3.9	4-Jul	18-Jul	7-Aug	35.1	1.7
LSD[w]		1.61	2.57	10.6	11.6	0.5	4	7	6	5.7	1.1

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.

[z]Early yield harvested befor July 10, 2003. [y]Late yield harvested after July 30, 2003.

[x]Harvest ease was rated on each harvest, 1=easy, 5=hard.

wData from replicated plots was subjected to analysis of variance, with least significant difference (LSD) of 5% used to separate means.

Table 2. Fruit traits of Raspberry cultivars harvested in 2003, Abbotsford, BC.

Clone	Firmness (g/cm^2)	Soluble Solids Concentration (%)	Postharvest Fruit Rot After 48 hrs (%)
87-5-1	194	8.5	10.0
89-34-41	343	9.7	24.4
89-6-12	.	.	35.0
90-11-44	436	10.7	15.0
90-8-20	341	11.0	19.4
91-28-4	342	11.3	41.7
92-4-11	321	9.1	33.8
92-4-29	191	10.1	.
92-5-1	255	8.6	11.1
92-5-47	185	11.3	31.7
93-15-38	491	8.7	.
93-15-40	340	9.6	11.7
93-21-26	323	9.9	31.7
93-22-11	359	10.3	.
93-23-2	360	9.5	32.5
93-26-16	320	10.5	30.0
93-26-25	361	9.7	29.2
93-27-26	206	10.0	10.0
93-9-40	281	10.1	30.0
93-9-48	439	9.2	50.0
94-4-17	415	9.4	73.3
94-4-18	171	9.4	43.3
WSU 1090	.	.	3.3
WSU 1162	265	10.3	20.0
Chemainus	376	9.7	15.0
Cowichan	291	10.3	23.8
Esquimalt	418	9.3	19.4
Malahat	242	9.7	11.1
Meeker	216	10.7	12.1
Qualicum	348	10.7	19.4
Tulameen	334	10.0	26.7
LSD	**191**	**1.6**	**13.4**

Firmness, the force required to close the opening of the fruit.

Firmness and SSC was obtained for 10 fruits from 1-4 harvest dates.

Data was subjected to analysis of variance, with least significant difference (LSD) of 5% used to separate means.

Table 3. 1999-2003 harvest data for 1996, 1997 and 1998 planted raspberries, Abbotsford, BC.

CLONE	Total Yield (tons/acre)					Mean Yield (t/ha)
	2003	2002	2001	2000	1999	
1996 planting						
87-11-33	8.22		7.10	6.39		7.24
87-14-35	8.98			8.06	8.55	8.53
87-3-37	5.14		4.75	6.17	10.20	6.57
89-34-41			8.06	9.13	8.68	8.62
90-8-11	6.28		8.23	7.53	8.22	7.56
Chemainus			6.07	7.21	7.14	6.81
Chilcotin			5.30	4.60	8.75	6.21
Cowichan			6.44	6.84	6.28	6.52
Meeker			4.93	5.91	6.63	5.82
Nootka			3.90	3.91	4.07	3.96
Qualicum			7.39	7.11	7.06	7.19
1997 planting						
89-34-41	5.76	7.77	10.95	8.97	13.81	9.45
89-6-12	5.20	4.62	6.87	5.35	10.16	6.44
90-8-20	6.69		8.03	5.85	12.75	8.33
91-15-40	8.38	6.31	7.20	8.36	12.24	8.50
92-5-1	8.12	7.44	9.64	8.71	10.78	8.94
92-5-52	6.97	4.22	9.99	8.76	11.45	8.28
Chemainus	7.28	5.61	7.51	7.58	7.19	7.03
Chilliwack		3.84	6.09	5.49	9.82	6.31
Coho			6.54	5.40	8.33	6.76
Esquimalt	7.30	6.11	10.00	9.87	18.36	10.33
Malahat	5.19	5.74	6.98	7.13	8.43	6.69
Meeker	5.80	5.61	7.50	6.76	8.95	6.93
Qualicum	7.00	6.77	8.48	5.96	12.80	8.20
Tulameen	6.58	6.02	9.30	7.78	12.45	8.43
1998 planting						
92-6-41	7.52	6.05	7.01	7.70		7.07
Meeker	4.82	5.65	5.67	6.68		5.70
LSD	**2.57**	**2.95**	**2.87**	**2.69**	**3.66**	**2.77**

Table 3b. 1999-2003 harvest data for 1999 and 2000 planted raspberries, Abbotsford, BC.

CLONE	Total Yield (tons/acre) 2003	2002	2001	Mean Yield (t/ha)
1999 planting				
84-12-22			7.74	7.74
87-14-35	9.25	6.70	6.17	7.37
87-5-1	5.00	4.33	5.17	4.84
89-34-41	9.09	5.33	10.97	8.46
89-6-12	5.76	4.44	5.56	5.25
90-4-23	7.85	5.94	6.63	6.81
90-6-2		8.39	7.77	8.08
90-8-20	6.50	5.87	7.06	6.48
Chemainus	6.85	5.96	9.14	7.32
Cowichan	6.64	5.37	5.92	5.98
Esquimalt		5.37	6.53	5.95
Malahat	6.25	4.64	8.01	6.30
Meeker	6.82	5.06	6.82	6.23
Qualicum	8.80	6.70	11.64	9.05
Tulameen		7.06	10.69	8.88
LSD	**2.57**	**2.95**	**2.87**	**2.80**

CLONE	Total Yield (tons/acre) 2003	2002	Mean Yield (t/ha)
2000 planting			
89-2-46	3.97	3.82	3.89
89-34-41	9.36	9.37	9.37
90-8-20	6.05	8.05	7.05
91-15-40		10.18	10.18
93-15-32	6.44	8.07	7.26
93-15-38	11.18	11.11	11.14
93-15-40	6.59	5.86	6.23
93-18-20	7.47	5.21	6.34
93-20-11	6.40	5.53	5.96
93-21-26	6.79	6.82	6.81
93-22-11	5.72	5.30	5.51
93-22-41	7.11	5.79	6.45
93-23-2	7.05	9.85	8.45
93-26-16	5.46	4.32	4.89
93-26-25	7.80	6.89	7.35
93-26-9	4.82	6.61	5.72
93-27-26	8.10	7.45	7.78
93-5-41	7.38	4.89	6.13
Chemainus	6.52	5.18	5.85
Cowichan	5.52	5.52	5.52
Esquimalt	9.01	9.65	9.33
Malahat	6.68	6.25	6.47
Meeker	6.45	4.26	5.35
Qualicum	5.07	7.20	6.14
Tulameen	6.58	6.24	6.41
LSD	**2.57**	**2.96**	**2.77**

Project No:

Year Initiated: 2001 **Current Year:** 2004-2005 **Terminating Year:** 2007

Title: **Red Raspberry Cultivar Development**

Personnel:

Chaim Kempler (Research Scientist), Brian Harding (Technician) and Hugh Daubeny (Retired).
Pacific Agri-Food Research Centre, Agriculture and Agri-Food Canada,
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Project Description:

Develop red raspberry cultivars stressing suitability for machine harvesting, dark fruit, winter hardiness, and resistance to RBDV, root rot, and aphids. Of particular importance is to speedup the release of cultivars that are disease and pest resistant to replace Meeker.

Justification:

The Agriculture and Agri-Food Canada (AAFC) breeding program supports the berry industry throughout the Pacific Northwest (PNW) and produces varieties that enhance production. Of particular importance are 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 and can be simply controlled by resistance to the 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 common strain of the RBDV virus has been controlled by breeding for resistant. Of cultivars released in the past, Haida and Nootka, and Chilcotin are resistant to RBDV. The recently released Cowichan (BC87-14-20) has given some hope to the industry that there is a cultivar that is suitable for mechanical harvesting and that escapes RBDV. Close to 150,000 Cowichan test plants were already planted in the last few years across the PNW. The plantings are evaluated by the growers for their production and suitability for their operation. The advance testing shows that Cowichan stands up to expectations; escapes RBDV, machine harvests very well, is high yielding, stands 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 is lacking root rot resistance needed in infected soils and heavy and poorly drained soils. Another selection, BC89-33-84, that was named in the summer as Chemainus has 105,000 test plants planted across the PNW. This cultivar produces large glossy dark firm fruit that is suited for processing and fresh market and machine harvests very well.

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. BC90-19-34 is a hybrid between Tulameen and *R. strigosus*. It has shown resistance to root rot under field conditions in Puyallup and also appears to be suited for mechanical harvesting and processing. It has been already planted in growers' trials and if it will be named it will be the first cultivar release from this source of *R. strigosus* collected from Lake George, Minnesota.

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 using parents that were derived from various species. Germplasm from other breeding programs around the world is used. This germplasm is tested and used to incorporate desirable traits. Also, a wide range of wild species is used. Three cultivars released from the program (Tulameen, Qualicum and Malahat) have the black raspberry, *Rubus occidentalis* L., in their derivation. In addition, Malahat has *R. phoenicolasius* Maxim. Some of the potential cultivars that are now in growers' trials have *R. occidentalis* in their derivation. Kitsilano has *R. crataegifolius* in its derivation, BC90-6-2, BC90-8-11, BC90-8-20, 92-5-1 and BC92-6-41 have the 'Dalhousie Lake' selection of *R. strigosus* Maxim. in its derivation. 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:

Develop red raspberry selections stressing suitability for machine harvesting, dark fruit, winter hardiness, resistance to root rot, resistance to divergent aphid biotypes, and RBDV.

- Fast release of potential cultivars to the propagators for multiplication for testing on growers' fields.
- Resistance to pollen infection from the raspberry bushy dwarf virus (RBDV).
- Resistance or tolerance to root rot (*Phytophthora fragariae)*, and lesion nematodes.
- Manageable plant habit that is suitable for machine harvesting and produces high yields.
- Superior fruit quality, which includes flavour, size, firmness, ease of harvest, and rot resistance.
- Winter hardy plants that withstand low temperatures and desiccating winds throughout winter months, and/or late breaking dormancy.
- Aphid resistance, which controls the Raspberry Mosaic Virus Complex (RMVC).
- Processing fruit needs to be dark and have high acidity and soluble solids content.
- Resistance or tolerance to cane diseases (such as spur blight, cane *botrytis* and cane spot), spider mites, bacterial blight, crown gall and to leaf diseases such as rust and powdery mildew.
- Adequate replacement cane production.

Procedures:

Experimental Details: This will involve harvesting of sound and rotte fruit, assessing for 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:

- 2004 crossing blocks – cross selections that stand up to root rot under field conditions with cultivars and potential cultivars and with RBDV resistance parents.
- Evaluation of the seedling population that was planted in 2001 and 2002.
- Propagation of advance selections for the WRRC machine harvesting evaluation.
- Establish replicated trials at the Abbotsford substation to assess advanced selections suitable for processing and machine harvest.
- Evaluation of advanced selections in growers' fields throughout the PNW to assess productivity, machine harvesting, and resistance to root rot and RBDV.
- Release two potentially root rot resistant selections to the propagators (BC90-19-34 and BC92-6-41).
- Supervise distribution of advanced selections to North American propagators and growers and subsequently monitor their performance.
- Evaluate Cowichan, Esquimalt, Chemainus and other selections on large growers' trials.
- Collaborate research with Robert R. Martin, USDA-ARS, Corvallis, 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 for resistance into a simple screening process that can be done before the seedlings are planted in the field.

Anticipated Benefits and Information Transfer:

Four out of the six research priorities determined by the Red Raspberry Commission are addressed within this research proposal and are of major importance in the objectives of the breeding program. 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 developing and releasing RBDV resistance cultivars (Cowichan) and cultivars that will withstand *Phytophthora* root rot pressure (Cowichan, Chemainus, BC90-19-34 and 92-6-41). All PARC releases are resistant to aphids, which is one of the insects that are the cause of 'insect harvest contaminants'. The results of the evaluations will be directly available to the red raspberry industry in the PNW. In the coming years the evaluations will help determine if the latest releases and other selections are commercially suitable. It will also allow the PARC breeding program to continue with the breeding activities identifying new potential cultivars to be release for propagation and testing.

**Budget: Amount requested from the WRRC for FY 2003/2004: <u>$US 4,000.</u>** ($CD 5,100)

Other industry partners and level of funding requested:

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	5,865	2,000	-
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 02/03 planting			2,200
WRRC trials 03/04 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**	**$ 24,100**	**$ 20,718**

Budget Summary

Contribution			
RIDC		15,000	
WRRC (US$4,000)		5,100	
LMHIA		4,000	
Industry in-kind	20,718		
Total industry (Cash + in-kind)			**44,818**
AAFC-MII		44,818	
Total for project			**90,636**
Administration cost (AAFC-PARC)	12,093		
Total funds available to the program			**57,825**

Project No.: 14C-4166-2815

Title: Threshold Development and Monitoring of the Western Raspberry Fruitworm, *Byturus unicolor*.

Year Initiated: 2003 **Current Year:** 2004 **Terminating Year:** 2005

Personnel:

Todd A. Murray, Extension Coordinator, IPM Project
Craig B. MacConnell, Horticulturalist,
Washington State University Whatcom County

Collaborators:

Lynell K. Tanigoshi, Associate Entomologist
Washington State University REU Vancouver
Stuart Gordon, Berry Crop Specialist
Scottish Crop Research Institute, Scotland, UK

Justification:

The western raspberry fruitworm (WRFW) is an insect contaminant of machine-harvested raspberries. Tolerances for this contaminant range from zero tolerance to moderate depending on the berry grade that is harvested. In areas where this insect pest occurs, growers apply an insecticide at 5% bloom, just prior to setting bees out. The insecticide application is one of the remaining few calendar-based treatments in the developing IPM program for raspberries. This insecticide application is preventative in nature and little information about pest occurrence, abundance or distribution is available for growers to aid in the decision-making process of IPM.

Growers currently use diazinon as the standard insecticide for fruitworm prevention. The United States Environmental Protection Agency, under the Food Quality Protection Act of 1996, has sought to reduce risks associated with organophosphates, such as diazinon, through higher restrictions and cancellations. The red raspberry industry, along with many others, is looking towards a reduced-reliance on diazinon in preparation of its cancellation and or reduction in red raspberry. The following proposed project seeks to enhance the IPM program for red raspberries while eliminating calendar-based pest management for WRFW.

Through collaborations with Stuart Gordon, Scottish Crop Research Institute, and Dr. Lynell Tanigoshi, the Whatcom County IPM project tested experimental trap designs and attractive lures. In doing so, an effective device for monitoring flight activity and abundance of WRFW was identified. Overcoming this milestone of finding effective monitoring tools allows for many opportunities to develop an IPM program for WRFW.

Current Status of Objectives:

1. Evaluate different traps and refine monitoring flight activity of WRFW using different visual attraction traps in multiple cooperating grower fields.

   See Dr. Lynell Tanigoshi's small fruit research project, Insect and Mite Control in Red Raspberries (13C-3543-4370) for specific results.

2. Establish thresholds for various product grades by correlating adult fruitworm flight and abundance with percent fruit infestation by WRFW larvae in multiple cooperating grower fields.

   Rebell Bianco traps were placed in eleven grower fields in mid-April totaling over 150 sites that were monitored. Each grower represented one of the following management strategies: organic management, conventional management without the use of diazinon and conventional management with the use of diazinon. Beetle numbers counted and recorded weekly. In mid-August, fruit laterals were harvested at each of the 150+ sites to determine the percent fruit infestation. We are currently analyzing the usefulness of the data. Estimated fruit infestation, trap data and management practices will be related in order to develop decision-making guidelines for managing raspberry beetles in different production settings.

3. Identify and correlate abiotic environmental factors with significant biological and season events of WRFW.

   Two Onset Hobo data loggers were placed at two separate farms that are currently recording air and soil temperature. Significant biological events will be related to temperature once the life cycle is completed. Understanding the phenology as it relates to temperature will provide predictive temperature models to be used in precise timing of management tactics.

Anticipated Benefits and Information Transfer:
In close collaboration with Dr. Tanigoshi, this specific effort compliments existing red raspberry research to identify new, alternative strategies for managing WRFW. Anticipated benefits of this research will lead raspberry growers to a reduced reliance on diazinon and remove calendar-based pesticide applications from their pest management program. Firstly, this research will be able to recommend a trap design that is readily available for purchase by growers. Secondly, by looking at infestation rates relative to adult flight we can develop a functional threshold based on trap counts for management decisions. Finally, using environmental data and observing significant biological events of the WRFW, we can look to build a predictive model of fruitworm activity.

Dissemination of knowledge and recommendations gained through this research will be through versions of published materials such as *Integrated Pest Management for Raspberries Manual* and EB1419, *Pest Management Guide for Commercial Small Fruits*. Growers will be educated about IPM programs developed by this effort through mentoring and forums such as monthly grower meetings, WSU Whatcom County web pages and educational workshops.

Budget:		**2003**
04	Travel	$1,242
Total		**$1,242**

Other Support of Project:
To achieve these goals, this program needs support from Washington Red Raspberry growers through on-farm cooperation and funding. Specifically we are looking for financial support for travel to the field during the intensive three months of data collection. Whatcom County as identified this research as a priority and is giving support to this research project. Additional equipment, supplies, travel, wages and salaries are currently funded through the IPM program at Whatcom County. As well, this support is shared by Dr. Lynell Tanigoshi's small fruit research project, Insect and Mite Control in Red Raspberries. We have submitted this component to leverage additional support from the American Farmland Trust/EPA Region 10.

Project No: Project # 10A-3093-2403

Title: Acquisition of a Mechanical Red Raspberry Harvester for Pest Management Studies at the WSU-VREU

Year Initiated 2000 Current Year 2003-2004 Terminating Year 2009

Personnel: Dr Carol Miles, Dr Patrick Moore, Dr Pete Bristow, and Martin Nicholson

Justification: The WSU Vancouver Research and Extension Unit (WSU-VREU) has been a center for raspberry research for four decades. Current research is focused on managing raspberry pest problems. These projects involve disciplines and departments from horticulture, entomology, plant pathology, genetics, weed science and sustainable agriculture. Projects address numerous IPM strategies that fall under the old and new WSCPR mandates. Targeted pests include root rot, the root weevil complex, spider mites, weeds, orange tortrix and other leaf rollers, and raspberry primocane management. About 99% of raspberries grown in the Pacific Northwest are machine harvested. To obtain accurate yield data for these studies, and produce the cultural environment that is associated with machine harvesting, WSU-VREU purchased a machine harvester. Continued funding by the WSCPR will allow WSUV to make payments on the machine purchased in 2000.

Objectives: In 2000 WSU-VREU acquired partial funding from WSU, the Washington Red Raspberry Commission and the WSCPR to purchase a Littau (Littau Harvester, Stayton, OR) 2000 "over the row" model harvester. The Washington State Finance Office purchased the machine from Littau, for $103, 296. After the down payment was made ($41000 from WSU, $5000 from WSCPR, and $3000 from WRRC) the remaining balance was financed by Washington State with payments of $6928 over 9 years. In order to have enough in the payment account we are asking for the additional year of funding as part of the funding request. $7750 is needed to make all of the payments; the WRRC has committed $3000 yearly, leaving $4750, which is being requested from the WSCPR. We are also requesting funding of $4750 from WSCPR to continue to make payments on the harvester.

Procedures:

Root rot: Dr Peter Bristow and Dr Carol Miles are both working on root rot IPM.
<u>Gypsum for Root Rot control on Red Raspberry, (WRRC 13C 3761 4251)</u>. Dr Peter Bristow. This trial was planted in 2002 and is designed as a machine harvested research plot. The trial will evaluate different rates of gypsum and different gypsum sources.
<u>Annual addition of organic materials to soil: impact on root rot of red raspberry</u>, Dr Peter Bristow, this project looks at sources and rates of organic materials for root rot control. The project was planted in 2002 and will be machine harvested.
<u>Soil Solarization as a component of an integrated program for controlling root rot in red raspberry</u>. Dr Peter Bristow, 11D-3761-6640, this project planted in 2001 was machine harvested for yield data in 2003.
<u>Organic Management of Root Rot in Raspberries, NWCSF</u>. Dr Carol Miles is testing the efficacy organic pesticides manure and soil amendments for disease suppression. Dr Miles has received funding from NWCSF to continue research on the root rot management system using organic and sustainable control methods. The project is a large plot design and was machine harvested for yield in 2002 2003 and the final year will be 2004

Plant Breeding: Advanced testing of WSU Raspberry Selections at WSU-VREU, WRRC 13C-3755-7641, Dr Patrick Moore. In 2001 a breeding trial was planted to evaluate the yield and machine harvestability of six new cultivars. The plots are 50ft long and replicated to cover half an acre. The first harvest year was 2003. Harvest will continue in 2004.

Anticipated Benefits and Information Transfer:

We have found that it is much more efficient and cheaper to harvest plots with the machine versus paying hand pickers. Also the machine has enabled plot sizes to be larger and sampling to occur on a larger scale, which reduces variability and gives more significant results. The ability to purchase and maintain ownership of the berry harvester is a key to the current and future success of the station and the ability of the researchers to develop new technologies and strategies for raspberry pest management for Washington growers.

Budget:

Amount allocated by Commission for FY 2003-2004: $3000

Request for FY 2004-2005

Equipment	$3000

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
Martin Nicholson	Current: WSCPR	$4750	2003, Have had continue support but is granted yearly.		Acquisition of a mechanical red raspberry harvester for pest management studies at WSU-VREU

Project No.: **13C-3543-4370**

Title: Insect and Mite Control in Red Raspberry

Year Initiated: 2001 **Current Year:** 2003 **Terminating Year:** 2004

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, IPM Coordinator, Whatcom County Extension

Reporting period: 2003

Accomplishments:

Several promising biorational or reduced risk insecticides and those EPA call OP alternatives were tested in the laboratory at recommended field rates on adult black vine and rough strawberry root weevils. Over the past four years, the rough strawberry root weevil has increasingly become problematic in small fruit compared with the steady decline of black vine and strawberry root weevils as harvest contaminants. Treatments on red raspberry foliage were applied with our standard Petri dish bioassay applied an aqueous suspension with a Precision Spray Tower. This year's bioassays further reinforced our understanding that the root weevil complex in Washington's red raspberry responds differently to several promising experimental insecticides.

Four insecticides were compared with our diazinon standard for efficacy and labeling/registration to control the western raspberry fruitworm, *Byturus unicolor*. Field collected adults were place on air-dried fruit buds that we uniformly treated with field rates applied with a Precision Spray Tower.

Five experimental insecticides were compared with our malathion standard for efficacy and potential labeling/registration for raspberry aphid, *Amphorophora agathonica*, management. Wingless female aphids were placed on red raspberry leaves treated with recommended field rates of each compound with a Precision Spray Tower.

Fifteen registered and experimental insecticide/acaricides were bioassayed for their toxicity or safety against field populations of the phytoseiid predator, *Neoseiulus fallacis*, field collected from the Vancouver REU, Burlington and Lynden.

Two white sticky traps were used to monitor western raspberry fruitworm, *Byturus unicolor*, flight at two farms. At each farm, side-by-side comparisons of the Rebell® Bianco trap and the Pherocon AM white trap were compared and replicated four times. Traps were place one post length (approx. 30 feet) apart. The two different traps changed locations with one another each week to avoid any directional bias. Traps were checked weekly and counted for new beetles. Traps were replaced every third week. Traps were placed in the field on 15 May and removed on 14 August, after raspberry fruitworm flight.

Several different pheromone blends were tested to monitor the raspberry crown borer, *Pennisetia marginata*, in fields known to be infested with their overwintering larvae. The blends tested shared the component E3Z13-18OH or a closely related compound.

Results:

Ten insecticides were bioassayed with our standard Potter Tower Sprayer method for their laboratory efficacy against field collected black vine weevil, *Otiorhynchus sulcatus* and the problematic rough strawberry root weevil, *O. rugosostriatus* (Tables 1-2. Our standard preharvest Capture/Brigade (bifenthrin) to control harvest contaminating insects provided 100% mortality after 24 hours exposure on red raspberry foliage for both root weevil species. This compound continues to give excellent field control if timed to root weevil foraging activity during a 4-5 day field residue window. The 3 neonicotinoid compounds provided variable results for both root weevils. Mortality for Actara (thiamethoxam) was 70% through 7 days posttreatment for black vine weevil and 100% after 4 days. Assail (acetamiprid) and Provado (imidacloprid) performed poorly against the black vine weevil and intermediate for the rough strawberry root weevil. Mustang (zeta cypermethrin) showed good activity for the rough strawberry root weevil while Warrior (lambda cyhalothrin) showed promise after 3 days to the black vine weevil. DeltaGard (deltamethrin) performed intermediate to Mustang and Warrior against both root weevil species. Guthion (azinphos- methyl) still remains a good alternative weevilcide to Capture while Imidan (phosmet) was active to the black vine weevil 3-4 days posttreatment. Auvant (indoxacarb) did not show the tremendous efficacy reported by UMass researchers against cranberry weevil. Nonetheless, this new insecticide with low toxicity to human and known to be a broadspectrum moth/worm insect control agent showed significant 80% and 70% mortality to the black vine weevil and rough strawberry root weevil at 7 days posttreatment compared with the untreated check.

Western raspberry fruitworm adults were collected from an organic red raspberry field in northern Whatcom County on 21 May 2003. Three adults were placed on air-dried, red raspberry fruit bud terminal that were individually treated with one of five insecticides and replicated 10 times. The insecticides were applied in aqueous suspensions using a Precision Spray Tower and held in individual Petri dishes. One day after treatment, 100% mortality was observed for Diazinon and the 0.03 lb(AI)/acre rate of Actara (Table 3). At 48 hours posttreatment, 100% mortality was obtained from the remaining insecticides (i.e., Imidan, Capture, Success (spinosad) and Actara). Success is registered on red raspberry as a leafroller/worm pesticide during the prebloom period and its efficacy on western raspberry fruit worm is a nice benefit.

Late September, a population of the raspberry aphid, *Amphorophora agathonica* were collected at two different dates from red raspberry in Lynden, WA. Insecticides known to have activity for sucking insects were applied at recommended field rates to red raspberry terminal leaflets with a Precision Spray Tower. Ten wingless adults were then placed on these air-dried, treated leaflets and replicated 10 times for each treatment. Compared with the untreated checks, all treatments at both dates were significantly different at the 5% level through 4 days posttreatment (Table 4). At 2 days after treatment, the standard Malathion along with the three related neonicotinoids (i.e., Provado (registered on strawberry, Actara, Assail) provided excellent aphid knockdown. By the 3rd to 4th day, all compounds provided economic raspberry aphid control. The highly selective, systemic aphicide Fulfill (pymetrozine) affects aphids by paralyzing their sucking mechanism within a few hours. This unique mode of action results in their eventual death by starvation. This novel, reduced risk product is difficult to evaluate because the aphid may appear normal on red raspberry foliage but in reality has stopped feeding and is noneconomic. As with spider mites, there are several excellent new aphicide chemistries that are registered for major crops and are pending registration through the EPA/IR-4 program.

Our toxicity rating used the one defined by Dr. James for assessing affects of selected pesticides on natural enemies from hops and vineyards. Each pesticide was applied to individual one inch diameter red raspberry foliage discs for concentrations equivalent to twice, full, half and quarter of the recommended field rate when applied in 100 gallons of water per acre. The data shown (Table 5) is for the recommended field rate with 10 individual females per concentration after 48 hours posttreatment on air-dried residues. Pesticides were applied with our standard Precision Spray Tower on discs place on water saturated cotton wool in six inch diameter Petri dishes. The miticides Agrimek (abamectin) and Pyramite (pyridaben) were toxic to all three field populations as were the insecticides Sevin (carbaryl) and Malathion. However, the miticides Acramite (bifenazate), Vendex (fenbutatin oxide) and Savey (hexythiazox) and insecticides Actara, Avaunt and Success were safe to moderately toxic. Interestingly, the organophosphates Guthion and Diazinon and pyrethroids Brigade/Capture and Mustang were safe to moderately toxic to *N. fallacis* populations bioassayed from the two intensively managed farms in northern Washington compared with the Vancouver REU. Of significance was the moderate level of toxicity observed for Provado. Additional lab bioassays next season will further clarify which insecticides and miticides used or to be registered in red raspberry are toxic to native biological control agents (i.e., predatory mites, *Stethorus*) of spider mites

Raspberry fruitworm flight was monitored at two organically managed raspberry fields using the Rebell® Bianco trap. These fields do not receive insecticides for managing raspberry fruitworms. Because of this, endemic populations have developed allowing us to monitor raspberry fruitworm activity uninterrupted. Traps were placed along the perimeter, one post length in the fields. Traps were counted for new beetles every week, and traps were replaced every three weeks. A total of 20 traps were maintained throughout beetle flight, from mid-April to mid-August. Figure 1 shows the total average number of raspberry fruitworm adults trapped at each farm. In all cases, the Rebell® trap caught more beetles than the Pherocon AM trap.

Peak flight for both farms corresponded to late May and early June (Fig. 2). Most conventional growers treat for western raspberry fruitworm at 5% bloom, which occurred the last week of May in most Whatcom County fields. This timing would occur earlier than this season's peak flight. Earlier application(s) of Diazinon may miss peak population densities of foraging beetles.

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Table 1. Black Vine Weevil Chemical Bioassay, 2003

		Mean Mortality				
Treatment	lb(AI)/acre	1DAT	2DAT	3DAT	4DAT	7DAT
Actara 25WG	0.06	0.3bc	0.4abc	0.7abc	0.7ab	0.7abc
Assail 70WP	0.15	0.1bc	0.1bc	0.1c	0.2bc	0.3bcd
Provado 1.6F	0.04	0.0c	0.1bc	0.2bc	0.2bc	0.2cd
Capture 2EC	0.1	1.0a				
DeltaGard 5SC	0.5	0.5abc	0.6abc	0.7abc	0.7ab	0.7abc
Mustang Max	0.025	0.3bc	0.4abc	0.5abc	0.6abc	0.6abcd
Warrior T	0.03	0.3bc	0.3bc	0.9a	0.9a	0.9a
Guthion 50WP	0.5	0.6ab	0.7ab	0.8ab	1.0a	
Imidan 70W	0.91	0.0c	0.2bc	0.6abc	0.8a	1.0a
Avaunt 30WG	0.11	0.3bc	0.5abc	0.5abc	0.6abc	0.8ab
Untreated check		0.0c	0.0c	0.1c	0.1c	0.1d

Mean within columns followed by the same letter are not significantly different (Tukey HSD test, *P*<0.05).
10 weevil/rep--10 reps/treatment.

Table 2. Rough Strawberry Root Weevil Chemical Bioassay, 2003

		Mean Mortality				
Treatment	lb(AI)/acre	1DAT	2DAT	3DAT	4DAT	7DAT
Actara 25WG	0.06	0.6ab	0.8ab	0.9ab	1.0a	
Assail 70WP	0.15	0.3bc	0.3bcd	0.4abcd	0.4bcd	0.4bc
Provado 1.6F	0.04	0.4bc	0.4bcd	0.6abcd	0.7abc	0.8ab
Capture 2EC	0.1	1.0a				
DeltaGard 5SC	0.5	0.3bc	0.5abcd	0.5abcd	0.6abc	0.8ab
Mustang Max	0.025	0.5abc	0.6abc	0.7abc	0.9ab	1.0a
Warrior T	0.03	0.0c	0.2cd	0.5abcd	0.5abcd	0.7ab
Guthion 50WP	0.5	0.4bc	0.6abc	0.7abc	0.9ab	1.0a
Imidan 70W	0.91	0.0c	0.1cd	0.3bcd	0.6abc	0.7ab
Avaunt 30WG	0.11	0.0c	0.0d	0.2cd	0.3cd	0.7ab
Untreated check		0.0c	0.0d	0.0d	0.0d	0.0d

Mean within columns followed by the same letter are not significantly different (Tukey HSD test, *P*<0.05).
10 weevil/rep--10 reps/treatment.

Table 3. Aphid Study 2003 Lynden Washington

Sprayed: Sept. 16, 2003

Treatment	lb (AI)/acre	Mean Mortality 1DAT	2DAT	3DAT	4DAT
Actara 25WG	0.05	0.4ab	0.06a	0.7b	0.8ab
Assail 70WP	0.04	0.5ab	0.5a	0.9a	1.0a
Provado 1.6F	0.1	0.7a	0.8a	0.9a	1.0a
Malathion 8F	2pt/A	0.5ab	0.6a	0.8ab	0.8ab
Imidan 70 W	0.94	0.4ab	0.6a	0.7ab	0.9ab
Fulfill 50WG	0.07	0.4b	0.6a	0.7b	0.8b
Untreated Check		0.02c	0.03b	0.07c	0.1c

Mean within columns followed by the same letter are not significantly different (Tukey HSD test, $P<0.05$).
10 aphids/rep--10 reps/treatment

Table 4. 2003 Western Raspberry Fruitworm

Potter Tower Spray Trial

Treatment	lb(AI)/acre	Mean Mortality 1DAT	2DAT
Actara 25G	0.03	1.0a	
Actara 25G	0.06	0.97a	1.0a
Capture 2EC	0.10	0.93a	1.0a
Diazinon 50W	1.00	1.0a	
Imidan 70W	0.94	0.87a	1.0a
Success 2SC	0.05	0.97a	1.0a
Success 2SC	0.09	0.97a	1.0a
Untreated Check		0.0b	0.1b

Mean within columns followed by the same letter are not significantly different (Tukey HSD test, $P<0.05$).
Sampled size: 3 beetles/10 treatments.

Table 5. Safety rating of selected pesticides against *Neoseiulus fallacis* mites occurring on farms in Washington State

Pesticide	WSU R&E Unit	Mayberry Farm	Sakuma Farm
Agrimek	H	H	H
Guthion	H	M	S
Acramite	S	S	S
Capture	H	M	M
Brigade	H	M	S
Sevin	M	H	H
Diazinon	H	M	S
Vendex	M	S	S
Savey	S	S	S
Provado	M	M	M
Avaunt	M	S	S
Malathion	H	H	M
Pyramite	M	H	H
Success	M	S	M
Actara	M	S	S
Mustang	H	M	M

S= Safe, less than 33% mortality expected when field rate used.
M= Moderately harmful, 33-66% mortality.
H= Harmful, 66-100% mortality.
Five predators per disk, replicated four times.

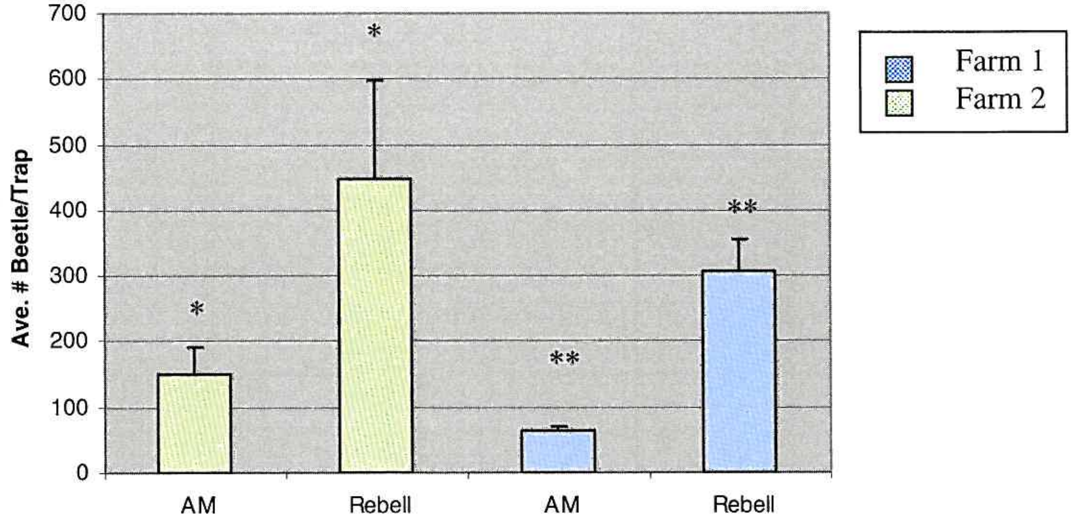


Fig. 1. Average total raspberry fruitworms caught for each trap at both farms.
* denotes statistically significant (P=0.02); ** denotes statistically significant (P=0.002).

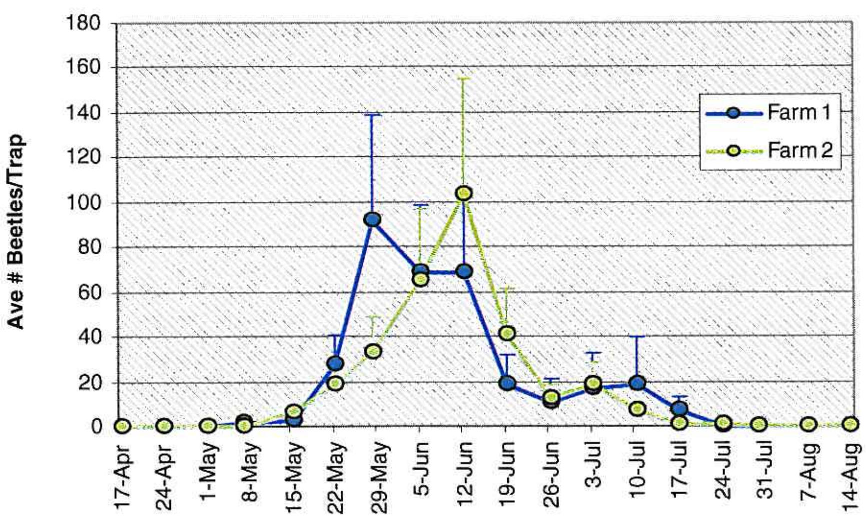


Fig. 2. Weekly average number of raspberry fruitworm trap counted at two sites in Whatcom County, 2003. Bars indicated the standard deviation from the sample mean to illustrate variation of the sample.

Project No.: 13C-3543-4370

Title: Insect and Mite Control in Red Raspberry

Year Initiated: 2001 **Current Year:** 2003 **Terminating Year:** 2004

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, IPM Coordinator, Whatcom County Extension

Justification: A review of insecticides and miticides in the *Pacific Northwest 2003 Insect Management Handbook* lists 12 pesticides recommended for effective insect and mite control in red raspberry. Six of them are "older", broadspectrum, synthetic organic insecticides. Specifically the organophosphates (malathion, diazinon, Guthion), the carbamate Sevin and pyrethroids (Asana, Brigade/Capture). The loss of these compounds would leave our red raspberry arsenal without the recently registered Brigade/Capture and a few specific compounds that have been classified by the EPA as reduced-risk, OP replacement and biopesticides. These are microbial insecticides (bacteria, fungi), an IGR for caterpillar control (Confirm), an IGR for spider mites (Savey), lime sulfur (eriophyid mites), cryolite bait (root weevils), organic tin Vendex (spider mites), insecticidal soap (spider mites) and natural fermentation metabolites from a bacterium (Success). The reduced risk characteristics for the aforementioned pesticides are important. Most of them are not cheap and their minimal residual activity and selectivity may not make them especially cost and pest effective for current red raspberry production. EPA's FQPA guidelines and criteria for chemical registrations have created a strong reason to intensify our efforts to evaluate new chemistries, particularly the reduced risk and OP alternative insecticides for which EPA has expedited registration guidelines.

Objective:

1. Continue evaluations of experimental insecticides, acaricides and biorational products such as insect growth regulators, neonicotinoids, novel compounds such as pymetrozine, microbially derived compounds and nematodes for the control of root weevils, leafrollers, raspberry aphid, western raspberry fruitworm and spider mites in the lab and field.

2. Continue bioassaying and rating the toxicity/safety of select insecticides and acaricides to the phytoseiid predator of spider mites, *Neoseiulus fallacis*, and the spider mite destroyer, *Stethorus punctum picipes*.

Procedures:

Pending their seasonal abundance, the multiple pest species listed for laboratory bioassays will involve modifications of our standard Petri dish bioassay and foliage treatment applied in an aqueous suspension with a Precision Spray Tower. Mortality through contact and stomach modes of entry will be assessed from 24 hours to seven days posttreatment. Field trials will be applied with a tractor mounted, six tank plot sprayer equipped with an over-row boom from which nozzle configurations can be altered and modified (e.g., drench, basal placements). Posttreatment evaluation for root weevils will consist of plant shaken samples taken in late evening with our standard drop cloth placed on either side of the plot row. The standard beat tray, white side up, will be used to assess relative abundance of raspberry aphids. Population levels of orange tortrix adults will be monitored with pheromone traps while larval response to insecticides will be evaluated by collecting and opening up their leaf nests which are easily observed on developing primocanes. Multiple insecticides will be field trialed in a variety block of red raspberry at the Puyallup REC known to be highly infested with western raspberry fruitworm. Relative efficacy to these insecticides will be obtained by monitoring adult flight activity with the Rebell® Bianco trap.

Phytoseiid predators will be field collected from several different red raspberry-growing areas in Washington. One-inch diameter raspberry leaf discs will be placed on saturated cotton wool in standard Petri dishes. For each pesticide, disc replicates will be treated with concentrations equivalent to full, half and one quarter of the recommended field rates. After the deposits are air-dried, *Amblyseius fallacis* adult females will be placed on the leaf discs. The pesticides will be applied in aqueous suspension using a Precision Spray Tower. Discs will be provisioned with spider mites as food for the predatory mites. Pending their field abundance, *Stethorus* larvae and adults will be bioassayed on arenas similar to those used for predatory mites

Anticipated Benefits and Information Transfer:

Registration of additional insecticides with different modes of action and their application in a pesticide rotation program will prolong the development of spider mite resistance or potential for their posttreatment flare-up. Pending registrations of additional insecticides and miticides with different modes of action (e.g., neonicotinoids, carbazate, pyridine compounds), a weevil and spider mite control program that integrates biological control for spider mite control in red raspberry may be realized. Similar pesticide usage as recently reported for hops and grapes will soon provided effective control of target pests while preserving predators and parasitoids. In turn, this will lead to increased biological control and reduced pesticide usage in the crop. Research must refine monitoring tools and identify compatible/selective chemical controls for secondary pests such as the western raspberry fruitworm, aphids and raspberry crown borer. In cooperation with WSU 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 Vancouver REU's website will update industry on new developments as appropriate.

Budget:

	2004
01 Wages	$6,500
03 Goods and services	500
04 Travel	1,500
07 Employee benefits (16% of 01)	1,040
Total	**$9,540**

We will submit this grant proposal through the Washington Red Raspberry Commission to the Washington State Commission on Pesticide Registration for an equivalent match in early January, 2004.

Project No.: 13C-3761-6251

Title: Gray mold fruit rot (*Botrytis cinerea*): field evaluation of new fungicides and the effect of fungicides on mite populations in red raspberry.

Year initiated: 2003 (Terminal Report)

Personnel: Peter Bristow, Associate Plant Pathologist
Gwen Windom, Agricultural Research Technologist III
Todd Murray, WSU-Whatcom County Cooperative Extension

Accomplishments: The incidence fruit rot was extremely low this year, due mainly to warm dry conditions during bloom and berry development. Despite the low disease pressure, both objectives were accomplished. Useful data on the control of fruit rots were obtained from the two different post harvest rot tests.

Results:

A) Fungicide trial. Nine fungicide treatments were compared to a water check treatment for control of fruit rots (especially gray mold fruit rot) in a replicated field trial conducted in a commercial field of 'Meeker' red raspberries located west of Lynden, WA. Except for two fungicide-timing treatments, all products were applied on 6 dates between early bloom (Jun 2) and early harvest (Jul 8). Very few berries turned moldy before harvest. Yield (berries harvested by machine) differences between treatments were mostly non-significant (Table 1). Only the occasional moldy berry was found on laterals collected after the final harvest. The laterals were also free of cane botrytis and spur blight lesions. Similarly, the incidence of these two cane diseases on primocanes was extremely low regardless of treatment.

Useful information was obtained from the two post harvest tests performed with berries picked by hand on three dates during the harvest period. For one test, fully ripe berries (processing stage) were incubated individually in a moist chamber and assessed for fruit rot after 3 and 5 days (data for day 3 are in Table 2). Plants treated with Abound or BAS 516 had the lowest incidence of fruit rot. For the second test, slightly under ripe berries (fresh market stage), picked directly into plastic clamshell packs, were incubated for 6 days under conditions thought to simulate those in marketing channels. The most effective treatments were Elevate, Captevate and BAS 516 (Tables 3 and 4). Captevate contains fenhexamid (the active ingredient in Elevate) plus Captan.

B) Phytotoxicity: Two treatments (Captan and Captevate) were phytotoxic to leaves on fruiting canes. Symptoms were first observed in June. Affected leaves were initially a darker green color than leaves from plants of the other treatments. Affected leaves slowly developed chlorotic flecks followed by a general yellowing. This damage was most likely caused by Captan as no damage was observed in plots treated with water, Elevate and other fungicides. The active ingredient in Elevate is fenhexamid. Captevate is a packaged mixture of Captan and fenhexamid. Differences in leaf color were documented with a SPAD chlorophyll meter (Table 5) for leaves collected in early August.

C) Mites: Damage to primocane leaves by mites was minimal in 2003. Leaves from fruiting canes were collected on three dates (Jul 15 & 28 and Aug 4) for mite counts. Counts of parasitic mites (two-spotted spider mite, yellow mite and European red mite) and a predatory mite were made. Immature and mature mites and mite eggs were counted separately. None of the fungicide treatments in the 2003 trial impacted mite populations.

D) New registrations. Since 2000, several new products have been approved for use on red raspberries to control fungal fruit rots. The most recent (July 2003) is BAS 516 (Pristine), which has two active ingredients (pyraclostrobin and boscalid). Other materials include: 1) Switch (active ingredients = cyprodinil and fludioxonil) and 2) Elevate (fenhexamid). In addition, Abound (azoxystrobin) and Cabrio (pyraclostrobin) are also registered but their labels state that the active ingredients only suppress *Botrytis cinerea*. A registration for a packaged mixture of captan and fenhexamid (to be called Captevate) is pending on caneberries and it might be cleared for use in time for the 2004 crop season. The mode of action of each of the new active ingredients is unique which means all will be useful in managing fungicide resistance. Caneberry growers are in the enviable position of having several new active ingredients for use in 1) controlling fruit and cane diseases and 2) combating the build-up of tolerant strains of *B. cinerea* (and other fungal pathogens or red raspberry).

Appendix

Table 1. Impact of treatment on yield.

Product and rate per acre (application dates*)	Yield, kg per plot**
Switch 62.5 WG 0.875 lb (A,C,D,F) **alternated with** Elevate 50 WDG 1.5 lb (B, E) [full season]	24.082 a***
Elevate 50WDG 1.5 lb (A-F)	23.778 a
Abound 2.08 SC 12.28 fl oz (A-F)	23.088 a
Switch 62.5 WG 0.875 lb (A-F)	22.990 a
BAS 516 1.45 lb	22.489 a
Switch 62.5 WG 0.875 lb (A, C) **alternated with** Elevate 50 WDG 1.5 lb (B) [early season]	22.401 a
Water check (A-F)	22.241 ab
Switch 62.5 WG 0.875 lb (D, F) **alternated with** Elevate 50 WDG 1.5 lb (E) [late season]	21.716 ab
Captan 50 WP 4.0 lb (A, F)****	21.292 ab
Captevate 68 WG 3.5 lb (A, F)****	19.712 b

* A=2 Jun, B=9 Jun, C=16 Jun, D=24 Jun, E=1 Jul, and F 8 Jul.

** A Littau harvester was used to harvest berries in 9 dates between early July and mid August.
The center 20 ft of each plot was harvested (each plot was 30 ft of row).

*** Mean separation by DMRT, $P < 0.05$

**** Phytotoxicity (yellowing and bronzing of fruiting cane leaves in plots treated with Captan or Captevate).

Table 2. Fruit rot developing after harvest (**processing ripe berries**).

	% rot (all fungi)*			
Treatment	7 Jul**	17 Jul	28 Jul	Overall
Water check	36.4 bc	83.9 a	72.4 ab	64.2 a
Switch **alternated with** Elevate [full season]	51.0 a	69.8 b	84.4 a	68.4 a
Switch **alternated with** Elevate [early season]	49.5 a	82.3 a	67.6 ab	66.4 a
Elevate	43.2 ab	78.1 ab	71.4 ab	64.2 a
Switch	39.1 bc	74.5 ab	70.3 ab	61.3 a
Switch **alternated with** Elevate [late season]	33.3 c	75.0 ab	69.3 ab	59.2 a
Captevate	24.0 d	30.2 d	66.1 b	40.1 b
Captan	19.8 d	46.9 c	48.5 c	38.4 b
Abound	17.7 d	35.4 d	32.8 d	28.6 c
BAS 516	4.2 e	14.1 e	12.5 e	10.2 d

* berries incubated individually at 50-60 F and 100% relative humidity for 3 days.

** berries harvested by hand on three dates.

Table 3. Effect of treatment on rot from all causes developing after harvest (**fresh market ripe berries**).

Treatment	% rot (all fungi)*			
	7 Jul**	17 Jul	28 Jul	Overall
Water check	5.8 a	47.7 a	17.3a	23.6 a
Switch **alternated with** Elevate [late season]	6.8 a	29.0 b	7.5 bc	14.5 b
Switch	2.8 a	26.4 bc	14.4 ab	14.4 b
Captan***	2.0 a	27.2 bc	9.2 bc	12.5 b
Switch **alternated with** Elevate [early season]	2.4 a	25.6 bc	9.2 bc	12.1 b
Switch **alternated with** Elevate [full season]	4.1 a	22.1 bcd	10.2 abc	12.0 b
Abound	0.0 a	22.1 bcd	10.8 abc	11.0 bc
Elevate	3.7 a	19.3 bcd	6.5 bc	9.7 bcd
Captevate***	0.9 a	12.3 cd	4.0 c	5.6 cd
BAS 516	0.5 a	7.2 d	6.7 bc	4.8 d

* incubation in clamshell packs for 6 days (day 1=33 °F, day 2=38° F and days 3-6=58-60 °F).

** berries harvested by hand on three dates.

Table 4. Effect of treatment on Botrytis fruit rot developing after harvest (**fresh market ripe berries**).

Treatment	% rot (Botrytis)*	
	17 Jul	28 Jul
Water check	27.5 a	8.5 a
Captan	14.7 b	1.3 c
Switch **alternated with** Elevate [early season]	11.7 bc	2.4 bc
Switch **alternated with** Elevate [late season]	8.9 bc	4.7 abc
Abound	7.9 bc	3.3 abc
Switch	7.8 bc	7.9 ab
Elevate	5.3 bc	3.1 abc
Switch **alternated with** Elevate [full season]	3.8 c	5.2 abc
Captevate	3.7 c	0.4 c
BAS 516	3.4 bc	0.8 c

* incubation in clamshell packs for 6 days (day 1=33 °F, day 2=38° F and days 3-6=58-60 °F).

** berries harvested by hand on three dates.

Table 5. Phytotoxicity as measured with a SPAD chlorophyll meter.

Treatment	SPAD reading, % greenness*
Water check	35.5 a
Switch **alternated with** Elevate [full season]	38.2 a
Switch	38.0 a
Abound	37.5 a
Switch **alternated with** Elevate [early season]	36.7
BAS 516	36.0a
Elevate	35.5 a
Switch **alternated with** Elevate [late season]	35.2 a
Captevate	27.3 b
Captan	25.8 b

* readings from fruiting cane leaves collected Aug. 4, 2003.

Project No.: 13C-3761-4251

Title: Investigating rates and sources of gypsum to reduce damage from Phytophthora root rot in an integrated control program.

Year initiated: 2002 **Reporting year:** 2003 **Terminating year:** 2005

Personnel: Peter Bristow, Associate Plant Pathologist
Gwen Windom, Agricultural Research Technologist III
Washington State University
Puyallup Research and Extension Center

Accomplishments: Primocane growth was monitored in 2003 with root rot symptoms appearing in some plots for the first time. Plant vigor was correlated to rate of agricultural gypsum for the highly susceptible cultivar Malahat, but not for the more root rot tolerant cultivar Meeker. Canes will be trained to the trellis during the winter and the plots will be harvested for the first time in 2004.

Results: The field trial was established in spring 2002 at the WSU-Vancouver Research and Extension Unit in soil naturally infested with the root rot fungus *Phytophthora fragariae* var. *rubi.* Each treatment is replicated four times in a randomized complete block experimental design. Individual plots consist of 5 plants. The plants established well in 2002, but did not have enough cane growth to warrant tying canes to the trellis for harvest in 2003. Growth in 2002 was measured by cutting the plants off at ground level in fall after growth ceased and recording the fresh weight of primocanes (Table 1 in Appendix). Plant survival and disease severity data (collectively reported at plant vigor) were collected in 2003. Primocanes produced in 2003 will be trained to the trellis and the plots will be harvested with a Littau harvester in 2004.

While no significant differences between treatments were found in 2002, there was a trend toward more and larger primocanes in Malahat plots receiving the higher rates of agricultural gypsum. No such trend was noted for the Meeker plots. Significant differences in primocane vigor for Malahat were recorded in 2003. The dosage-response curve (Figure 1 in Appendix) suggests that Malahat was still responding to the 8 tons per acre rate, the highest rate tested. In contrast, the dosage-response curve for Meeker (Figure 2 in Appendix) was essentially flat indicating that gypsum may be less important in cultivars that have some tolerance to the disease.

Appendix

Table 1. Effect of gypsum incorporated into the soil immediately before planting (May 2002) on growth of Malahat and Meeker plants in 2002 and 2003.

		*Top growth, grams/plant** (2002)*		*Plant vigor rating*** (2003)	
Treatment	Rate, *ton/A*	Malahat	Meeker	Malahat	Meeker
Untreated check	0	93.1	120.3	0.6 e	2.4
Ag. gypsum	.375	86.1	119.3	1.3 cde	1.9
(dihydrate)(pelletized)	.75	94.9	100.7	1.6 bcd	2.4
	1.5	89.8	121.9	1.3 cde	2.8
	3	99.8	132.8	2.0 abcd	2.6
	4.5	97.3	157.2	2.2 abc	2.8
	6	110.5	137.9	2.4 ab	2.8
	8	102.9	119.5	2.6 a	2.5
Gypsum (anhydrite)	2	104.7	110.2	1.6 bcd	2.1
	3.5	111.0	134.8	1.8 abcd	2.6
	5	108.2	129.4	1.8 abcd	2.0
Gypsum from recycled	3	100.4	115.5	1.1 de	1.9
wallboard	4.5	95.8	105.4	1.9 abcd	2.4
	6	101.6	131.7	1.3 cde	2.4
Fungicide standard	0	125.2	135.1	2.3 ab	2.8
Fungicide std + Ag. gypsum	6	118.3	141.2	2.0 abcd	2.8
Pr>F		0.1039	0.2531	0.0004	0.5546

* Fresh weight of top growth collected in November 2002.
** 0-4 plant vigor rating scale (0=all plants dead, 1=least primocane growth and 4=most primocane growth.

Figure 1.

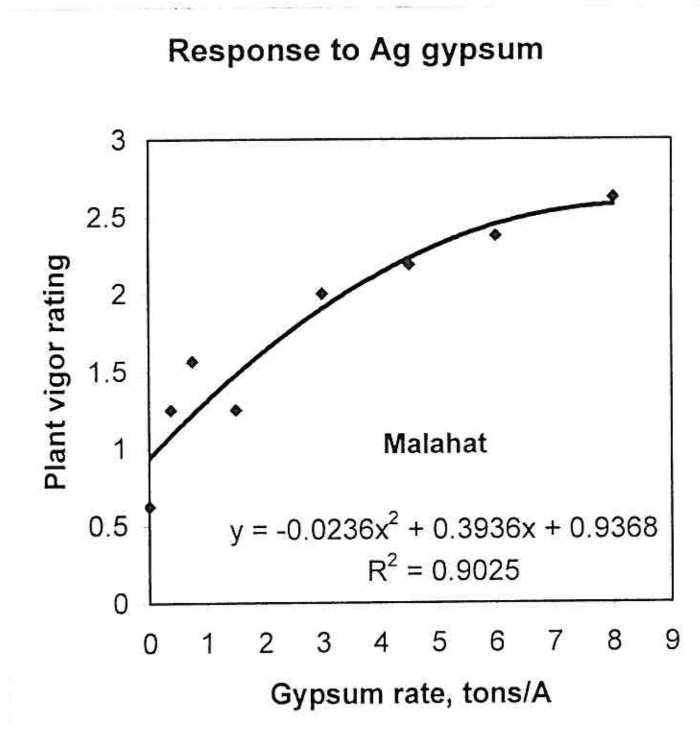
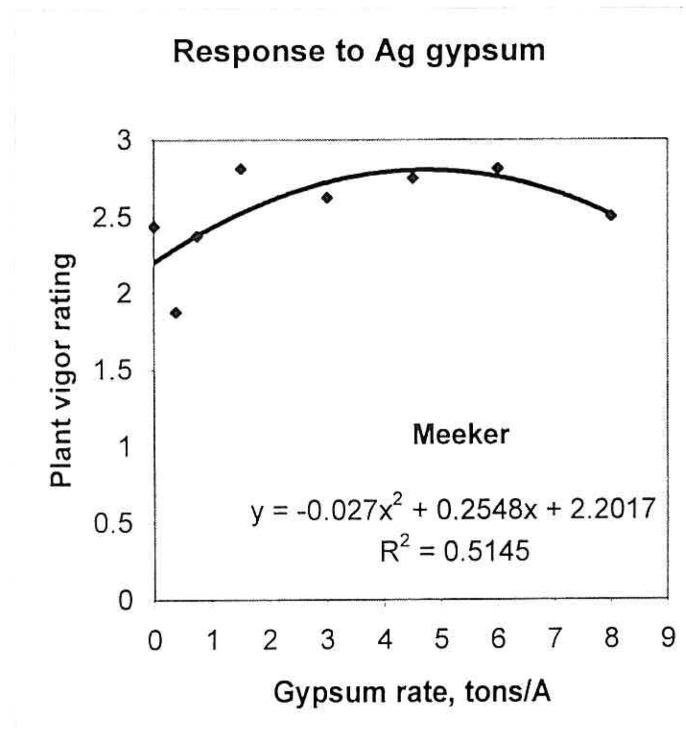


Figure 2.



Project No.: 13C-3761-4251

Title: Investigating rates and sources of gypsum to reduce damage from Phytophthora root rot in an integrated control program.

Year Initiated: 2002 **Current year:** 2003 **Terminating year:** 2005

Personnel: Peter Bristow, Associate Plant Pathologist
Gwen Windom, Agricultural Research Technologist III
Washington State University
Puyallup Research and Extension Center

Justification: Root rot, caused by the soil-borne fungus *Phytophthora fragariae* var. *rubi*, is the most serious root disease of red raspberry in the Pacific Northwest. In attempting to develop control measures for this disease, it has become evident that no single control measure or method will provide the level of control required for this high value crop. Earlier work demonstrated that incorporating high rates of agricultural gypsum into infested soil before planting helps to control the disease and that control is enhanced when gypsum is used in combination with raised beds and the application of the fungicide mefenoxam (Ridomil Gold). Ridomil Gold (and Ridomil before that) successfully controlled this disease in many sites. However, in an increasing number of locations Ridomil Gold is no longer effective. In test plots at the WSU-Vancouver Research and Extension Unit we experienced our first failure in the mid 1990's after nearly 20 years of working with the fungicide. Fosetyl-Al (Aliette) also has activity against this pathogen but it has not been as effective as Ridomil. Efforts continue to develop an integrated program for disease control and breeding for disease resistance is another important one component. Several recent selections in the WSU red raspberry breeding program appear to have combined a high level of disease resistance with acceptable horticultural traits. These selections were planted in a field trial in infested soil at the WSU-VREU in 2003 for further evaluation.

Objectives:

1. In a field planting with naturally infested soil, test different rates of agricultural gypsum for suppression of this root disease. The planting will be on raised beds.
2. Evaluate different sources of gypsum including the anhydrite form of gypsum and recycled wallboard (where the paper backing has been removed before recycling).
3. Develop green house methods for evaluating the effectiveness of gypsum in controlling the disease.

Procedures: Replicated plots at the WSU-VREU will be harvested for the first time in 2004 using a Littau harvester. Data will continue to be taken on root rot severity and primocane growth. Soil with different treatments will be sampled for pH and calcium. Primocanes grown in 2004 will be trained to the trellis for harvest in 2005.

Anticipated Benefits and Information Transfer: Testing different rates of agricultural gypsum will help to determine if the current recommended rate of 6 tons per acre is too high and if so, what rates are needed to realize a benefit from amending soil with gypsum prior to planting. Identifying non-chemical control measures should help to maintain the usefulness of traditional fungicides that are registered to control this root disease. Soil types suitable for growing red raspberries are limited. Developing an integrated program to control Phytophthora root rot will permit infested sites to be re-planted to this high value crop.

The results of this field study and additional studies investigating other aspects of root rot control will be presented at grower meetings, workshop, and field days. The information will also be available through local and regional publications including the PNW Plant Disease Management Handbook and the Pest Management Guide for Commercial Small Fruits. Demonstration plots may also be established on farms of cooperating growers.

Budget:
Amount allocated by the Commission for 2003-04: $2,900

Request for 2004-05

Labor	
Salary*	$2,100
Timeslip labor	1,500
Operations (good and services)	800
Travel	900
Project needs	
Meetings	150
Employee benefits for	
Salaried labor	567
Timeslip labor	240
Total	**$6,257**

* WSU no longer funds 100% of the salary and benefits for technician. The addition of a salary component to this request reflects this change in funding.

Other Support of Project: The incorporation of gypsum in soil is also part of a related project looking at the influence of organic amendments on the severity of this root rot. An IFAFS Grant from USDA is funding that work.

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:					
Bristow, P. R. Windom, G.E.	WRRC	$2,900	Mar 03-Mar 04	4	Investigating rates and sources of gypsum to reduce damage from Phytophthora root rot in an integrated control program.
Bristow, P. R Pinkerton, J.N.	NCSRF (USDA)	$4,900	Oct 03-Oct 04	4	Soil solarization as a component of an integrated program to control Phytophthora root rot of red raspberry.
Cogger, C.G., Ostrom, M., Bristow, P.R.	IFAFS (USDA)	$112,614	May 01-Sep 05	8	Small scale agriculture organic waste stream use.
Pending:					
Bristow, P.R. Pinkerton, J.N. Schriner, P.R.	NCSFR	$8,376	Oct 04-Oct 05		

A:instructions01/cp2/cm
9/01

NEW PROJECTS

Project No: New

Title: Weed Control in Red Raspberries

Year Initiated: 2004-05 **Current Year:** 2004-05 **Terminating Year:** 2006-07

Personnel:

Tim Miller, Extension Weed Scientist, WSU Mount Vernon
Carl Libbey, AP Technician, WSU Mount Vernon

Justification:

Perennial weed species generally become more important the longer raspberry blocks are left in production. Horsetail (*Equisetum* spp.), quackgrass *(Elytrigia repens*), broadleaf dock (*Rumex obtusifolius*), Canada thistle (*Cirsium arvense*), dandelion (*Taraxacum officinale*), and hedge bindweed (*Calystegia sepium*) have long been weedy in western Washington. These weeds frequently become established the first few seasons on a new raspberry block, when raspberry plants are small and not as competitive. If not controlled when young, perennial weeds become increasingly difficult to kill, ballooning herbicide and labor costs and becoming a major factor in reducing the longevity of raspberry plantings. Conversely, controlling seedling perennials the first few seasons likely will result in sizeable weed control savings over the life of the raspberry block since raspberry plants that become more quickly established are more capable of slowing weed seed germination in the row (through canopy shading) while at the same time resisting encroachment from outside the row (through shading and vigorous cane growth).

Weed control in newly-transplanted (baby) raspberries therefore merits further examination. Broadleaf herbicides currently registered for this use include simazine, Devrinol (napropamide), Surflan (oryzalin), Basagran T/O (bentazon), and Gallery (isoxaben) and of these, only Basagran has postemergence (POST) activity. In 2002 and 2003 research at WSU Mount Vernon, eight additional herbicides were tested in baby/first year raspberries, applied after planting (preemergence (PRE), May) and again in over-the-top in mid-summer (POST, July). Most of these products caused little injury to raspberry, although three products [Milestone (azafenidin), Cobra (lactofen), and Valor (flumioxazin)] displayed appreciable postemergence activity on weeds and raspberries alike (18 to 37%). Milestone herbicide has since been dropped by DuPont from further registration trials. This trial was continued in 2003 on one-year old canes, but combination treatments with various herbicides applied PRE and POST, directed need further evaluation to determine their safety to newly planted raspberries.

A recently introduced perennial species with tremendous weedy potential is yellow nutsedge (*Cyperus esculentus*). In previous trials near Burlington, WA, nutsedge has been shown to be sensitive to Casoron (dichlobenil, dormant season), Dual Magnum (s-metolachlor, preemergence), Outlook (dimethenamid-p, preemergence), and Manage (halosulfuron, postemergence). These products have not reduced raspberry yield or berry size, but due to spotty nutsedge infestation, the reliability of the weed control data was rather poor (LSDs near 50%). Control has also been relatively poor, indicating that multiple or sequential applications will be necessary to successfully control this species. Clearly, more data is required, and to that end, sites with substantial yellow nutsedge infestation in southeastern Washington have been identified.

Objectives: To (1) test several combination herbicide treatments for weed control in baby raspberries, and (2) test several products in combination for control of yellow nutsedge in established raspberries.

Procedures:

1. *Baby raspberries*: Plots will be established in 2004 at WSU Mount Vernon will be maintained for two seasons, during which various products will be tested. Three cultivars were included in the previous trial ('Meeker', 'Tulameen', and 'Willamette') and will be tested again. Initial herbicide applications will be made shortly after transplanting, and again at midseason. Canes will be cut at the soil surface in fall, 2004. Herbicide applications will then be made during late dormancy (2005) and directed sprays used at mid-season. A total of ten treatment combinations will be tested and their effect on weed control and primocane growth (number, height, and diameter) will be monitored during 2004 and 2005.

2. *Yellow nutsedge*: Plots will be established in 2004 in severely-infested raspberry field, probably near Woodland, WA. Herbicide applications will be made during dormancy (2003-04) and POST directed sprays used in spring, 2004. Yellow nutsedge control will be evaluated, as will herbicide effects on raspberry yield and berry size.

Anticipated Benefits and Information Transfer:

These studies will improve weed control practices in baby raspberries by adding to the knowledge of growers when they make decisions regarding herbicide selection and application. Data from this experiment will be used to support new herbicide registrations in baby raspberries and to fine-tune existing labels. 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 2003-2004: $ 0

	Requested 2004-05
Salaries	
AP technician (Carl Libbey)	$ 2,000
Time-slip	1,000
Operations (goods & services)	500
Travel	
Projected needs[a]	500
Meetings	0
Other	0
Equipment	0
Employee Benefits	
AP technician (27%)	540
Time slip (16%)	160
Total Request	4,700

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

Other Support of Project:

Herbicides are typically provided by herbicide manufacturers.

Current & Pending Support

Timothy W. Miller

Extension Weed Scientist, WSU Mount Vernon

Name (List PI #1 first)	Supporting Agency and Project #	Total $ Amount	Effective and Expiration Dates	% of Time Committed	Title of Project
	Current:				
	WA Com. Pest. Reg.				
du Toit & Miller	10A 3093 2611	$ 5,265	1/1/03 to 12/31/03	5	Biofumigation in spinach seed
Miller	10A 3093 2614	4,500	1/1/03 to 12/31/03	5	Weed control in cucurbits
Miller	10A 3093 2530	1,500	1/1/03 to 12/31/03	5	Postemergence herbicides in Apiaceae seed crops
Boydston, Miller, and Yenish	10A 3093 2547	4,000	1/1/03 to 12/31/03	5	Flumioxazin and sulfentrazone in peas, lentils, and chickpeas
	WA Bulb Com.				
Miller	13C 3419 4228	9,000	2/1/04 to 1/31/05	5	Weed control in ornamental bulbs
	WA Blueberry Com.				
Miller	13C 3419 5229	4,230	7/1/03 to 6/30/04	5	Weed control in blueberries
	WA Strawberry Com.				
Miller	13C 3419 8228	10,120	7/1/03 to 6/30/04	10	Weed control in strawberries
	NARF				
Miller	13K 3419 5228	5,903	7/1/03 to 6/30/04	10	Weed control in green peas
Miller	13K 3419 6228	12,530	7/1/03 to 6/30/04	10	Weed control in cucumbers
Miller	13K 3419 7228	5,500	7/1/03 to 6/30/04	10	Weed control in vegetable seed
	Pending:				
Miller, Inglis, & duToit	Special USDA Research Grant	$ 18,670	1/1/04 to 12/31/04	20	Organic transition rotations for PNW
du Toit & Miller	WA Com. Pest. Reg.	20,530	1/1/04 to 12/31/04	5	Biofumigation in spinach seed
Miller	WA Com. Pest. Reg.	2,500	1/1/04 to 12/31/04	5	Herbicides and flame for weed control in spinach seed
Miller	WA Com. Pest. Reg.	3,500	1/1/04 to 12/31/04	5	Perennial weed control in blueberry
Miller	WA Com. Pest. Reg.	1,500	1/1/04 to 12/31/04	5	Postemergence herbicides in Apiaceae seed crops

Project No.: New

Title: Effectiveness of new fruit rot fungicides in controlling cane blight (*Leptosphaeria coniothyrium*).

Personnel: Peter Bristow, Associate Plant Pathologist
Gwen Windom, Agricultural Research Technologist III
Washington State University
Puyallup Research and Extension center

Justification: Since 2000, several new fungicides have been cleared for use on caneberries (including red raspberry). These new products target control of gray mold fruit rot caused by the fungus *Botrytis cinerea*, but most also provide protection against the cane diseases cane botrytis and spur blight (*Didymella* applanata). If is not known if any of these materials will control the potentially serious cane blight disease caused by the fungus *Leptosphaeria coniothyrium*. To date only the benzimidazole fungicides Benlate (benomyl) and Topsin M (thiophanate methyl) have controlled cane blight. An effort is being made to add caneberries and this disease to the Topsin M label, but it is uncertain when that might occur.

In the late summer or fall when primocanes are trained to the trellis, infected canes look normal. However, the following spring, buds fail to grow on canes where the fungus has girdled the vascular tissue. Some weak laterals often grow on infected canes that are only partially girdled. In short, the benefits of protecting primocanes are not realized until the next crop season

L. coniothyrium only gains entry into primocanes through fresh wounds. The catcher plates on the mechanical harvester wound primocanes near the base. Because repeated passes are made during a harvest season, new wounds are made and older ones fail to heal. Spores of the cane blight fungus are produced on old cane stubs and the base of fruiting canes that were infected during the primocane year. The cane blight fungus forms two types of spores: ascospores that are dispersed by wind and conidia which are moved about by splashing water (rain and overhead irrigation). In wet weather the catcher plates, contaminated with conidia of *L.* coniothyrium, may inoculated wounds as they are made. Applications of Benlate directed at the base of the canes during and after harvest protect wounds made by the harvester.

The use pattern of the newer fungicides is ideal for the control of cane blight if the any have activity against this fungus. They have a short pre-harvest interval (PHI), so they can be used during harvest when the canes are being wounded.

The incidence of cane blight in 2002 and 2003 was higher that expected. Based on the dry warm summers in 2001 and 2002 coupled with growers switching from overhead to drip irrigation systems, one would expect disease incidence to be low in 2002 and 2003. With cane blight it is important to remember that infection takes place during the primocane year and the damage is usually not evident until the fruiting cane year. One explanation for higher disease incidence might be a reduction in the use of Benlate for fruit rot control.

Objectives:

1. Using laboratory tests, determine the sensitivity of cane blight fungus spores to several new fruit rot fungicides.
2. Develop a method for inoculating primocanes of potted plants to test the effectiveness of fungicides in controlling cane blight.

Procedures:

1. A poisoned agar method will be used for determining the sensitivity of conidia to increasing concentrations of different fungicides.
2. Primocanes on potted red raspberry plants will be wounded and inoculated with spores of the pathogen. Fungicides will be applied to primocanes at different times before and after inoculation.
3. The benzimidazole fungicides Benlate and Topsin M will be included as standards for Objectives 1 and 2.

Anticipated Benefits and Information Transfer:

This project will determine if any of the active ingredients in new fungicides (recently registered for fruit rot control on caneberries) have activity against the cane blight fungus. The potted plant portion of the study will determine fungicides with activity can control the cane blight disease. Research results will be communicated at grower meetings, workshops and field days. Recommendations will also appear in the annually revised "Pest Management Guide for Small Fruits" and "PNW Plant Disease Management Handbook".

Budget:

Request for 2004-05

Labor	
Salary*	$1,500
Timeslip labor	1,000
Operations (good and services)	400
Project needs	
Meetings	50
Employee benefits for	
Salaried labor	405
Timeslip labor	160
Total	**$3,515**

* WSU no longer funds 100% of the salary and benefits for technician. The addition of a salary component to this request reflects this change in funding.