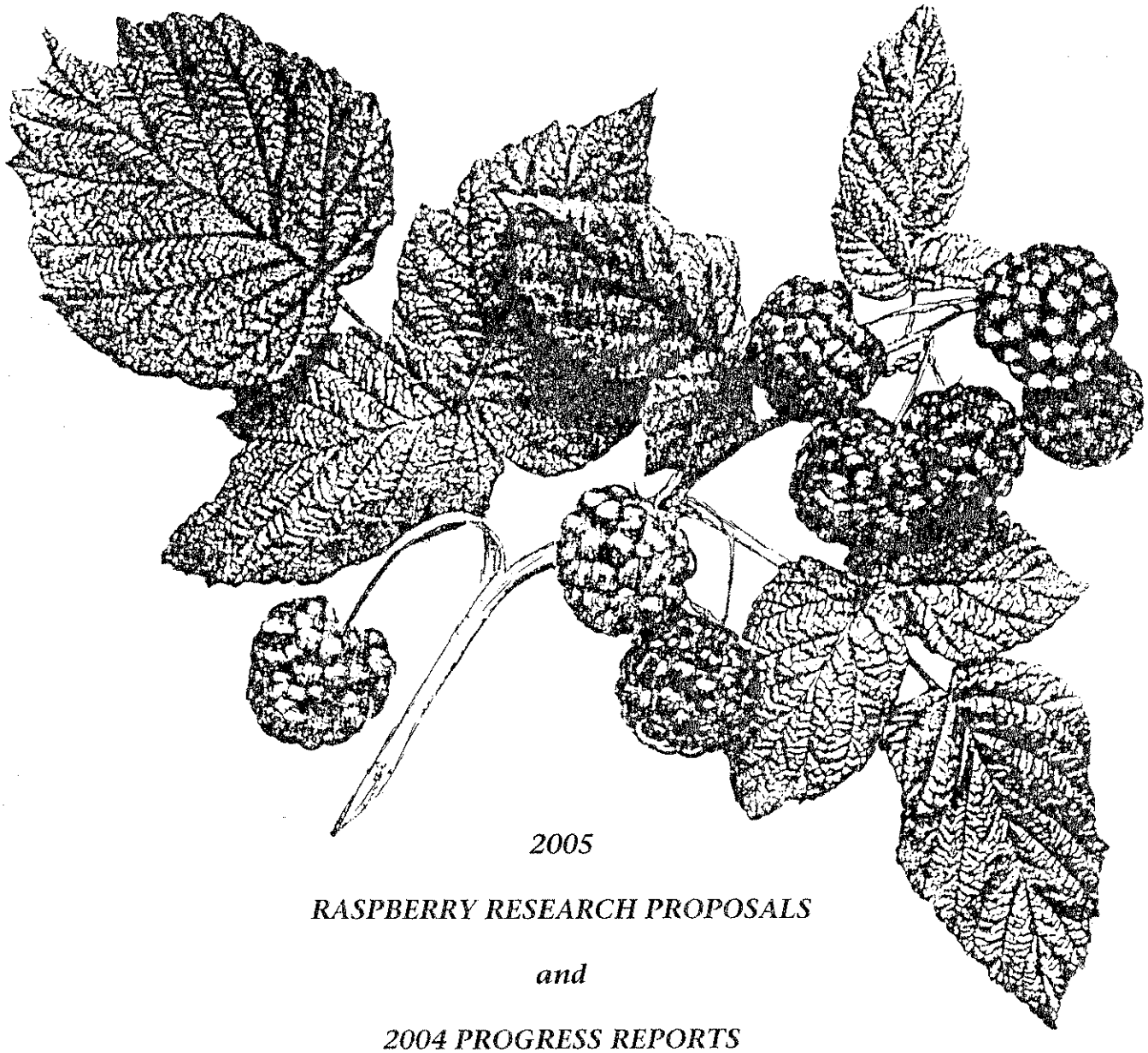

2005

RASPBERRY RESEARCH PROPOSALS

and

2004 PROGRESS REPORTS

to the

WASHINGTON STATE RASPBERRY COMMISSION

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

WASHINGTON RED RASPBERRY COMMISSION
2004 BOARD OF DIRECTORS

District #1 – Whatcom County

Rob Dhaliwal, President 722 Vine Street Lynden, WA 98264 rob@samsonestates.com 360-966-7787 FAX 318-8501 *Position # 2* *Expires – 2004*	Darryl Ehlers 2366 Halverstick Rd. Lynden, WA 98264 lingonberry1@aol.com 360-988-5184 FAX 988-5184 *Position # 4* *Expires - 2005*
Ralph Minaker 6862 Nooksack Rd. Everson, WA 98247 minakerr@hotmail.com 360-966-5645 FAX 966-5645 *Position # 3* *Expires - 2005*	Tena Ondeck 2096 Halverstick Rd. Lynden, WA 98264 ondeck@earthlink.net 360-988-6324 FAX 988-4304 *Position # 8* *Expires - 2004*

District #2 – Clallam, Grays Harbor, Island, Jefferson, King, Kitsap, Mason, Pierce, & Thurston Counties

Vacant *Position # 1* *Expires - 2004*	Vacant *Position # 7* *Expires - 2003*

District #3 – Clark, Cowlitz, Lewis, Pacific, Skamania, & Wahkiakum Counties

Erin Thoeny, Vice-President P.O. Box 194 Woodland, WA 98674 thoenyf@pacifier.com 360-225-7133 FAX 225-2154 *Position # 5* *Expires - 2005*	Jon Cotton 17709 NE 102nd Ave. Battle Ground, WA 98604 silverstarfarms1@aol.com 360-600-4949 FAX 256-0195 *Position # 9* *Expires - 2006*

District #4 – San Juan, Skagit, & Snohomish Counties

Glenn Sakuma, Treasurer 17400 Cook Rd. Burlington, WA 98233 glenns@sakumabros.com 360-661-4168 FAX 757-6611 *Position # 6* *Expires - 2006*	Mike Youngquist 16402 Jungquist Rd. Mt. Vernon, WA 98273 MJBerry@Fidalgo.net 360-424-7220 FAX 424-7225 *Position # 10* *Expires - 2004*

WSDA Representative

Bill Dallas
WSDA
P.O. Box 42560
Olympia, WA 98504
bdallas@agr.wa.gov
360-902-1925
FAX 902-2092

Key Personnel Contacts:

Henry Bierlink, Executive Director
1796 Front Street
Lynden, WA 98264
(360) 354-8767
FAX 354-0948
waredberry@verizon.net

Tom Peerbolt, Research Coordinator
Peerbolt Crop Management
5261 North Princeton St.
Portland, OR 97203
(503) 289-7287
FAX 289-7229
Tom@Peerbolt.com

2004 Officers and Committee Chairs

Rob Dhaliwal, President
Erin Thoeny, Vice President
Glenn Sakuma, Treasurer

Darryl Ehlers, Research Chair
Rob Dhaliwal, Chemical Chair
Glenn Sakuma, Communications Chair
Tena Ondeck, Promotions Chair

TABLE OF CONTENTS

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

ONGOING PROJECTS

PAGE

Moore, Patrick
Red Raspberry Breeding, Genetics and Clone Evaluation *1-7*
Executive Summary 1
Progress Report 2-4
Proposal 5-6
Current & Pending Support 7

Kempler, Chaim, Brian Harding, and Hugh Daubeny
Red Raspberry Cultivar Development *8-31*
Progress Report 8-27
Proposal 28-31

Murray, Todd, and Craig MacConnell
Threshold Development and Monitoring of the Western Raspberry Fruitworm, Byturus unicolor *32*
Progress Report 32

Moore, Patrick, Peter Bristow, and Martin Nicholson
Acquisition of a Mechanical Red Raspberry Harvester for Pest Management Studies at WSU Vancouver REU *33-35*
Progress Report 33
Proposal 34-35

Tanigoshi, Lynell, Jeanette Bergen, and Todd Murray
Insect and Mite Control in Red Raspberry *36-37*
Progress Report 36-37

Miller, Tim, and Carl Libbey
Weed Control in Red Raspberries *38-41*
Progress Report 38
Proposal 39-40
Current & Pending Support 41

NEW PROJECTS

Tanigoshi, Lynell, Jeanette Bergen, and Todd Murray
***Integrating Insect and Mite Management in Red Raspberry*.....43**
Executive Summary.....43
Progress Report.....44-46

Bristow, Peter, and Patrick Moore
***Effect of Kaolin Clay Particle Mulch on Phytophthora Root Rot and Soil Moisture Content in Red Raspberry*.....47**
Proposal.....47-48

Murray, Todd, Craig MacConnell, and Peter Bristow
***Voluntary Grower Survey for Phytophthora Fragariae Var. Rubi in Pre-Plant Stocks and Planted Root Samples of Red Raspberry in Washington State*.....49**
Summary.....49
Proposal.....50-52

Summary
Budget Requests

LAST 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	Lead Scientist	Amount Requested
Weed control	Miller	$4,700
Fruit rot fungicides/cane blight	Bristow	$3,515

CURRENT YEAR FUNDING REQUESTS (2004)

Ongoing Projects (2005)

Project No.	Short Title	Lead Scientist	Requested
13C-3755-5641	Raspberry Breeding	Moore	$21,000
	Raspberry Cultivar Development	Kempler	$4,000
14C-4166-2815	Monitoring Fruitworm	Murray	$1,242
10A-3093-2403	Acquisition/Mechanical Harvester	Bristow	$3,000
13C-3419-3297	Weed Control in Red Raspberry	Miller	$7,060

New Projects (2005)

Short Title	Lead Scientist	Amount Requested
Insect/Mite Management	Tanigoshi	$17,319
Effect of Kaolin Clay Particle Mulch	Bristow	$3,700
Voluntary Grower Survey for Phytophthora fragariae	Murray	$40,000

EXECUTIVE SUMMARY SHEET

PROJECT TITLE: **Red Raspberry Breeding, Genetics and Clone Evaluation**

INVESTIGATOR: Patrick P. Moore

PROJECT NUMBER: 13C-3755-5641

PROJECT DURATION: continuing

CALENDAR YEAR: 2005

PROPOSED BUDGET: $21,000

OTHER SUPPORT: Northwest Center for Small Fruit Research $90,000
October 1, 2004- May 31, 2006 (for both strawberries and raspberries)

Oregon Raspberry and Blackberry Commission $7,000 for 2004-2005

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

BENEFITS: New cultivars would give growers more options for their growing/market conditions. New cultivars may be more productive than previous cultivars.

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

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

Project: 13C-3755-5641

Title: Red Raspberry Breeding, Genetics and Clone Evaluation

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

Reporting Period: 2004

Accomplishments:
Seed was obtained from 140 raspberry crosses. 127 of these crosses have an RBDV resistant or possibly resistant parent, 107 have a root rot tolerant parent and 96 of the crosses combine RBDV and root rot resistance. Approximately, 3,300 seedlings were planted from the crosses made in 2003. 33 selections were made for cultivar development among the seedlings that were planted in 2001. Six selections have possible RBDV resistant parents, 19 are possibly root rot tolerant and 8 could have both RBDV and root rot resistance. **WSU 1020**, **WSU 1068, WSU 1098, WSU 1162,** and **WSU 1182** were the parents most represented among the selections. A planting of late season fresh market selections was planted at Puyallup and will be harvested in 2006.

The 2000 replicated planting was harvested for the second time in 2004 (Table R1). This planting is in an area with a high level of root rot. Many of the plots are weak or have died. **WSU 1162** had very high yields, 15.5 t/a in 2004 and 26.9 t/a total over two years. **Cascade Delight** had the second highest yield with 8.7 t/a. Other selections with the same parents as **WSU 1162** had yields over 5 t/a (**WSU 1182**, **WSU 1183**, and **WSU 1163**) in both 2003 and 2004. **WSU 1068** had a yield of 6.9 t/a in 2004. Only a single plot of **Meeker** and **Chilliwack** survived and were harvested.

The 2001 replicated planting was harvested for the first time in 2004 (Table R2). This planting is in an area with a high level of root rot. Only 23 of the 66 raspberries in the 2001 planting were harvested. 43 of the raspberries were not harvested because of root rot. **WSU 1399** was the highest yielding, but the fruit is not of cultivar quality and will only be used for breeding. It is a derivative of a raspberry species obtained from Russia. A cross between the raspberry species and **WSU 930** was made in 1988, a selection made from those seedlings was then crossed with **Chilliwack** in 1992, a selection made from those seedlings was then crossed with **Schonemann** in 1996. **WSU 1399** was selected from this cross. It appears to be highly root rot tolerant, may be RBDV resistant, is very productive and very late season. Although not cultivar quality it was used as a parent in 11 crosses in 2004. There were 3 other selections that had good yields and may be RBDV resistant (based on parents), **WSU 1462**, **WSU 1349** and **WSU 1342**.

A new machine harvesting trial was planted at Sakuma Brothers, Burlington, WA. 78 raspberries were included in the new planting, with 52 WSU selections, 21 BC selections and 5 cultivars. The plantings established in 2002 and 2003 were machine harvested for the first time in 2004. Observations were made on 5 harvests at each location. 10 selections (**WSU 1253, WSU 1384, WSU 1387, WSU 1468, WSU 1469, WSU 1472, WSU 1499, WSU 1502, WSU 1507**, and **WSU 1539**) appeared to harvest well and may be suitable for IQF. 9 of these selections may have some root rot tolerance and 5 may have RBDV resistance. They will be propagated and planted in 2005 to evaluate their suitability for IQF.

Data has been collected to support the release of **WSU 1068** and **WSU 1162**. **WSU 1068** is an early season local fresh market selection with some root rot tolerance and possible RBDV resistance. **WSU 1162** is extremely productive and very root rot tolerant. The fruit does machine harvest, but may not have the quality for IQF.

Publications/Presentations:
Moore, P.P. 2004. 'Cascade Delight' Red Raspberry. HortScience .39:185-187.
Moore, P.P. 'Cascade Nectar' Red Raspberry. HortScience. (Accepted).
January 2004. Strawberry and Raspberry fruit display. Northwest Food Processors, Portland, OR.
March 2004. Vancouver Small Fruit Workshop, Vancouver, WA.
July 2004 Machine Harvesting Open House, Burlington, WA
July 2004. Raspberry Field Day, Puyallup, WA.
July 2004. Machine Harvesting Open House, Lynden, WA.
July 2004. Small Fruit Open House, Mt. Vernon, WA

Table R1. 2003-2004 harvests of 2000 planted raspberries, Puyallup, WA.

	Yield (t/a)			Fruit weight (g)		Fruit firmness (g)		2003 Midpoint of harvest	Harvest season			Length of season (days)
	2003	2004	Total	2003	2004	2003	2004		5%	50%	95%	
WSU 1162	11.7 a	15.2 a	26.9 a	3.3 b	3.5 b	163 b	144 bc	7/11/03 b	6/21/04 bc	7/4/04 ab	7/19/04 a	28 a
C. Delight	8.7 b	8.7 b	17.4 b	4.5 a	4.2 a	197 a	223 a	7/12/03 b	6/23/04 ab	7/2/04 ab	7/16/04 a	22 a
WSU 1182	8.5 bc	8.2 bc	16.7 bc	2.9 bc	2.8 c	105 c	117 cd	7/14/03 a	6/26/04 a	7/7/04 a	7/19/04 a	23 a
WSU 1183	6.8 cd	9.4 b	16.2 b-d	3.0 bc	3.6 b	122 c	116 cd	6/29/03 e	6/10/04 e	6/19/04 c	7/5/04 b	26 a
WSU 1163	5.8 de	8.0 bc	13.8 c-e	3.0 bc	3.3 b	106 c	110 d	7/4/03 d	6/19/04 cd	6/30/04 b	7/13/04 ab	24 a
WSU 1068	6.9 cd	6.2 c	13.2 de	2.8 c	2.9 c	174 ab	171 b	6/28/03 e	6/11/04 e	6/20/04 c	7/5/04 b	23 a
WSU 1369	4.8 e	6.5 c	11.3 e	2.1 d	2.1 d	150 b	138 cd	7/7/03 c	6/17/04 d	6/30/04 b	7/18/04 a	30 a
Meeker*	3.5	6.9	10.4	3.2	2.7	174	173	7/12/03	6/22/04	7/6/04	7/18/04	26
Chilliwack*	3.2	2.1	5.2	2.3	2.2	161	167	7/4/03	6/18/04	6/24/04	7/8/04	20
Average	6.7	7.9	14.6	3.0	3.0	150	151	7/7	6/18	6/29	7/13	25

* Harvest data for Meeker and Chilliwack is for only one plot, the other two plots died from root rot.
Means within a column followed by the same letter are not significantly different at $P<0.05$, by Duncan's Multiple Range Test.
Clones indicated by * had one 1 plot harvested and were not included in the statistical analysis.

Table R2. 2004 harvest of 2001 planted raspberries, Puyallup, WA.

	Yield (t/a)	Fruit weight (g)	Fruit Firmness (g)	Harvest season 5%	50%	95%	Length of season
WSU 1399**	**11.6**	**2.7**	**144**	**7/7**	**7/18**	**8/6**	**30**
WSU 1462	**10.1 a**	**3.0 f-h**	**179 de**	**6/29 a**	**7/11 a**	**7/26 a**	**27 c-h**
WSU 1459	9.9 ab	3.5 d-f	235 a	6/19 d-f	7/5 de	7/20 b-d	31 ab
WSU 1444	8.7 a-c	3.7 c-e	161 d-f	6/19 d-f	7/4 d-f	7/19 b-e	30 a-d
* WSU 1464	8.5 a-d	3.6 c-e	230 a	6/25 a-c	7/4 d-f	7/18 c-g	22 hi
WSU 1349	**8.3 a-d**	**2.6 h-j**	**118 hi**	**6/16 e-g**	**6/27 ij**	**7/10 ij**	**24 f-i**
WSU 1394	7.9 a-d	3.0 f-h	143 f-i	6/20 c-e	7/6 cd	7/18 b-f	28 b-g
WSU 1342	**7.8 a-e**	**4.8 a**	**223 a**	**6/17 ef**	**6/29 hi**	**7/13 g-i**	**26 d-h**
C. Delight	7.4 a-f	4.5 ab	185 cd	6/24 a-d	7/5 de	7/19 b-f	24 f-i
WSU 1244	6.6 b-g	2.5 h-j	190 b-d	6/27 ab	7/10 ab	7/23 ab	25 e-i
WSU 1451	6.4 c-g	3.1 e-h	141 f-i	6/23 b-d	7/7 b-d	7/22 a-c	29 b-f
WSU 1450	6.3 c-g	2.6 h-j	116 hi	6/19 d-f	6/30 g-i	7/13 g-i	24 g-i
WSU 1390	5.9 c-g	3.5 d-f	144 f-h	6/16 e-g	7/2 e-h	7/17 d-h	31 a-c
WSU 1376	**5.7 c-g**	**2.8 g-i**	**113 i**	**6/16 e-g**	**7/1 f-i**	**7/14 f-i**	**29 b-f**
Meeker	5.2 d-g	2.5 h-j	152 e-g	6/20 de	7/4 d-g	7/15 e-h	25 e-i
WSU 1382	5.2 d-g	3.9 cd	217 ab	6/14 fg	6/24 k	7/6 jk	23 hi
WSU 1467	4.5 e-h	4.1 bc	214 a-c	6/27 ab	7/9 a-c	7/22 a-c	26 d-h
WSU 1470	**4.5 e-h**	**3.4 d-g**	**186 cd**	**6/26 ab**	**7/7 a-d**	**7/20 b-d**	**24 f-i**
WSU 1461	**4.5 e-h**	**2.3 i-k**	**188 cd**	**6/14 e-g**	**7/2 e-h**	**7/18 c-g**	**33 a**
Willamette	4.4 e-h	2.6 h-j	141 f-i	6/11 gh	6/22 k	7/4 k	23 hi
WSU 1370	**4.2 f-h**	**1.7 k**	**126 g-i**	**6/8 h**	**6/24 jk**	**7/7 jk**	**29 a-e**
WSU 1389	**3.6 gh**	**2.0 jk**	**75 j**	**6/7 h**	**6/17 l**	**6/28 l**	**21 i**
Tulameen	1.5 h	2.4 h-j	176 de	6/19 d-f	6/30 g-i	7/13 hi	23 hi
Average	6.5	3.1	165	6/20	7/2	7/16	26

** only two plots of WSU 1399 were harvested and were not included in the statistical analysis.

Means within a column followed by the same letter are not significantly different at P<0.05, by Duncan's Multiple Range Test.

Clones indicated by * or ** only had 1 or 2 plots harvested respectively and

Selections listed in **bold**, may be RBDV resistant (based on parents)

The following clones were planted, but not harvested because of root rot:
Chemainus, Esquimalt, WSU 1190, WSU 1198, WSU 1205, WSU 1229, WSU 1245, WSU 1251, WSU 1264, WSU 1265, WSU 1268, WSU 1269, WSU 1334, WSU 1338, WSU 1339, WSU 1346, WSU 1347, WSU 1348, WSU 1359, WSU 1367, WSU 1368, WSU 1371, WSU 1374, WSU 1383, WSU 1385, WSU 1391, WSU 1392, WSU 1393, WSU 1395, WSU 1397, WSU 1402, WSU 1403, WSU 1429, WSU 1430, WSU 1435, WSU 1440, WSU 1443, WSU 1445, WSU 1446, WSU 1457, WSU 1460, WSU 1463, and WSU 1465

Project: 13C-3755-5641
Title: Red Raspberry Breeding, Genetics and Clone Evaluation
Year Initiated:2004
Current Year:2005
Terminating Year: continuing
Personnel: Patrick P. Moore, Scientist,
WSU Puyallup Research and Extension Center, Puyallup, WA

Justification: The Pacific Northwest (PNW) raspberry industry is dependent upon the research programs that it supports. The PNW breeding programs have been an important part of this research, developing cultivars that are the basis for the 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. With 95% of the Washington production used for processing, new cultivars need to be machine harvestable.

There has been a history of cooperation between the breeding programs in Oregon, British Columbia, and Washington. 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 machine harvestability, RBDV resistance, root rot tolerance, and yield. Other traits are fruit firmness, fruit size, fruit color, harvest season, fruit rot resistance, and growth form. Selections identified in the machine harvesting trials as being machine harvestable will be used extensively as parents.

3. Seed from the 140 crosses made in 2004 will be sown in 2004-2005. 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 2003 (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 2004 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. The replicated plantings established in 2001 at WSU Puyallup will be harvested for yield, fruit weight, fruit rot and fruit firmness.

7. Plants will be multiplied in tissue culture and propagated for testing at other locations and grower trials.

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

Machine Harvesting Evaluation

1. Ten plants of each of the selections in #5 above will be planted in a grower planting for machine harvesting evaluation. It is estimated that about 40-50 WSU selections will be planted in the field in 2005. Three plants of each selection will also be planted at WSU Puyallup for observation, use as a parent or future propagation.

2. The machine harvesting trials established in 2002 and 2003 will be evaluated again in 2005. Evaluations made in 2005 will be compared with those made in 2004.

3. Samples of fruit from selections that appear: productive and dark fruited will be collected and analyzed for soluble sugars, pH, titratable acidity and anthocyanin content. Productive selections with high sugars and anthocyanin content may be desirable for puree/juice/bulk. A trial of promising selections for these uses may be planted with cooperating growers in 2006.

4. 10 selections evaluated in machine harvesting trials in 2004 appeared to harvest well and may be suitable for IQF. **(WSU 1253, WSU 1384, WSU 1387, WSU 1468, WSU 1469, WSU 1472, WSU 1499, WSU 1502, WSU 1507**, and **WSU 1539)** These advanced MH selections will be evaluated further.

A. They will be propagated and planted in larger plots with cooperating growers. The purpose of these plantings is to produce enough fruit to evaluate IQF quality.

B. They will be planted in replicated plots at WSU Puyallup to collect harvest data in 2007 and 2008.

C. They will be planted on a severe root rot site, to evaluate there tolerance to root rot.

D. Selections will be grown in pots and will have RBDV infected plants placed next to them to determine if they are resistant to RBDV.

Anticipated Benefits and Information Transfer: This program will develop new raspberry cultivars that are more productive or more pest resistant. Modifications to the evaluation process will place increased emphasis on developing machine harvestable cultivars. Such cultivars may result from crosses made this year or may already be under evaluation.

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

The funds requested will be used for timeslip labor, field supplies, greenhouse supplies and travel to research plots and to grower meetings to present results of research. This includes funds for tissue culture propagation of selections previously funded by the Northwest Center for Small Fruit Research. This proposal does not include grower expenses for machine harvesting trials.

Budget:		**2004-2005**	**2005-2006**
00 Salaries			
Plant Tech II	0.15 FTE	$5,250	$0
Agr. Res. Tech. I	0.30 FTE	10,024	0
Agr. Res. Tech. II	0.15 FTE	5,653	0
Lab Tech.	0.10 FTE	3,040	0
01 Timeslip Labor		10,000	12,500
03 Service and Supplies		3,466	5,100
04 Travel		1,400	1,400
07 Benefits			
Plant Tech II		1,470	0
Agr. Res. Tech. I		4,210	0
Agr. Res. Tech II		2,148	0
Lab Tech I		938	0
Timeslip		1,600	2,000
Total		**$49,200**	**$21,000**
2003-2004 funding		**$49,000**	

Current Support

Name (List PI #1 first)	Supporting Agency and Project #	Total $ Amount	Effective and Expiration Dates	Title of Project
Moore, P.P.	Northwest Center for Small Fruit Research	$90,000	2004-2006	Small Fruit Breeding in the Pacific Northwest
Moore, P.P.	Oregon Raspberry and Blackberry Commission	$7,000	2004-2005	Development of New Raspberry Cultivars for the Pacific Northwest

Project No:

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
Hugh Daubeny, Emeritus, hdaubney@telus.net

Agriculture and Agri-Food Canada, Pacific Agri-Food Research Centre (PARC)
PO Box 1000, 6947 #7 Hwy. Agassiz, BC, Canada V0M 1A0
Tel: (604) 796-2221 ext. 224. Fax: (604) 796-0359
Website: http://res2.agr.ca/parc-crapac/agassiz/progs/crop_science/kempler_e.htm

Reporting period: 2004
Funding 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 2004 the PNW nurseries sold more than one million raspberry plants of varieties released by PARC. This represents more than 20% of cultivars planted in the PNW this year. This is an almost three fold increase over the PARC plants sold in 2003. The latest releases from the PARC breeding program performed very well in growers' trials. Cowichan established very well with good vigorous growth although on some locations it showed that it is not as root rot tolerant as expected. Chemainus (tested as BC89-33-84) performed very well producing high quality fruit that is suited for both the fresh and processing markets. This cultivar machine harvest very well producing fruit that is IQF quality. Sixty-eight PARC selections were planted in replicated and unreplicated plots in the 2004 yield and observation trial. Ten of these were advance selections and fifty-eight were new selections being planted in the field for the first time. Nineteen other clones were planted. These included control varieties as well as new releases and advanced selections from other breeding programs. Sixty eight new selections were made from the seedling field planted in 2001 mostly based on their suitability for harvesting by machine. These are now being propagated for planting at Abbotsford and at next year's WRRC machine testing site in Washington State. The seedling field planted in 2002 was evaluated for the first time and some selections were made however these will be re-evaluated next year.

This year was the first evaluation for the WRRC machine harvest trials that were planted in 2002 and 2003, the results are summarized in tables 4 and 5. During the 2004 harvest season the 2000, 2001 and 2002 plantings were evaluated and data on yield, fruit traits and harvest season will be presented in tables 1 to 3. Three hundred and eighty plots were sampled and tested for RBDV. Sixteen selections tested positive for RBDV for the first time and as a result most of them will be eliminated. Approximately 3600 new seedlings were planted this year. The seed came mainly from PARC crosses made in 2001 and 2003 and some recent WSU crosses. Thirty-five new crosses were made all with one or two parents that are resistant to root rot and RBDV. The resulting seedlings are now being raised and tested for aphid resistance and will be planted in the field next spring.
There are several advance selections that are released for advance growers trial and they are F1 or 1st to 4th back cross from *Rubus strigosus* selection that were collected from different sites in North America. They show excellent resistant to root rot. This source of resistant was not used for any other known cultivar development. We are hoping that this source will contribute to the resistance of the modern day raspberries cultivars. The following are the three clones that were used in the PARC breeding program.
R. strigosus collected at Lake George, Minn.
R. strigosus collected at Dalhousie Lake 4 clone
R. strigosus collected from 8th Lake State Park Campground, Adirondack State Park, NY.

Machine harvest trials
Sixteen BC advance selections and two BC named cultivars that were planted in the 2002 Hancoop planting were evaluated in 2004 for the first time. The plants developed and established very well and were ready for the machine harvest evaluation. The results are summarized in table 4. Winter injuries were relatively severe this year at this

location mainly because of excessive vigor. Early in the spring plants were rated for winter injury. None of the PARC selections in this trial is expected to be resistance to RBDV because their parents are not resistance or they already tested positive at another location. The selections that are recommended to be released to the propagators for further testing for their suitability for machine harvesting are BC90-11-44, BC 92-5-47, BC96-21R-56, BC96-22R-55, and BC97-30-27. Selections BC87-14-35, BC90-8-20 BC91-28-4, BC93-36-10, BC96-21R-6 are recommended to be discarded from the machine harvesting trials.

The plants at the Sakuma 2003 planting had established reasonably well and were ready for a first year harvest evaluation. The results of this trial are summarized in table 5. This trial will be evaluated again next year when the selections have fully established and are representative enough to allow a proper evaluation. The recently named PARC cultivar, Chemainus, produced fruit that was very suited for IQF and processing. It harvested very well and was one of the best cultivars in the trial. Other PARC named cultivars in this trial were Malahat which harvest well with some over rip fruit. Qualicum produce fruit that did harvest except that the fruit was lighter than that of Meeker and to many green fruit came off the plant. Tulameen did harvest well but the fruit was a bit over rip and therefore soft and it color was to light. The selections that have the 97 prefix are all from a cross between Willamette and PARC selections and therefore have a potential of being resistant to RBDV. They all have dark fruit that is suited for processing but they will need to be further evaluated for their productivity. Most of them showed suitability for machine harvesting. The ones that show the most promise were BC90-19-8, BC96-22R-55, BC97-30-3, BC97-32-22, and BC97-34-19. Selections BC93-1-32, BC93-23-2, BC 96-21R-6 and BC97-27-8 will be discarded because of they are unsuited for mechanical harvesting.

Notes on cultivars and potential new cultivars:

Malahat (Meeker x BC/SCRI 7853/116)
Malahat is still the leading cultivar planted for the early fresh market. It ripens very early and has superior fruit quality. In the past few years some farmers have planted Malahat on marginally suitable land which resulted in poor plant stands and dead plants. Plants of Malahat are very susceptible to root rot; therefor 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. 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. Laterals are short. Fruit is very easy to harvest. Malahat is susceptible to RBDV.

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 root rot infected and poorly drained land Cowichan did not stand up against root rot and should be considered as moderately susceptible to root rot. In the research plots it was very vigorous, establishing quickly and producing yields that are higher than Meeker. Cowichan ripens about three days earlier than Meeker and its mid-point harvest was five days earlier than Meeker (Tables 1). In growers' field trials, although exposed to high pressure of RBDV for the last 7 years, it has tested negative to RBDV, while Meeker and other PNW varieties grown in the same field have shown very high infection rates. It can be assumed that Cowichan is resistant to RBDV. In large-scale growers' trials it has shown itself very suitable for mechanical harvesting. Cowichan fruit appears to be soft and unsuited for long distance shipping. However, for the last two harvest seasons, the fruit was firm and appeared to have excellent fresh market quality with very good flavour and aroma comparable to that of 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*).

Chemainus Tested BC89-33-84 (BC82-5-84 x Tulameen)
A mid-season processing and fresh market type that produces large size attractive dark berries with some resistance to fruit rot. The fruit is easy to harvest and in machine harvesting and growers' trials has machine harvested very well with excellent quality fruit that can be used for IQF. The fruit is glossy, large, and firm, perfect in shape with fine drupelets, and so is very suitable for IQF and fresh markets. The plant has excellent vigor producing plenty of replacement canes. Its primocanes are green with no spines and its laterals are short and strong with a good upright angle and well spaced fruit. It is not resistant to RBDV. The selection appears to have some field resistance to root rot showing good growth in comparison to Meeker and Malahat. Chemainus is gaining popularity in the PNW with more than 300,000 plants that have been already planted on large scale field tests.

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

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 (table 1). The excellent quality fruit are medium glossy and firm with 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. In grower's trial the fruit appeared to release well from the receptacle and did harvest well mechanically. This selection although exposed to high pressure of RBDV for many years has been slows to show RBDV infection. Because of its productivity and suitability for machine harvesting this selection has real potential to be named in the near future.

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. Fruit is round, firm and dark red in color which make it suited for processing. BC90-6-2 is most suitable for the fresh market due to its long harvest duration, late producing period and large fruit but in machine harvest trial we notice that it does harvest very well producing large round dark fruit that is very firm and suited for IQF. The dwarf growing habit of the plant might allow growing it with minimum support system. This will be tested in the coming years.

New selections for growers' trials:

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

BC90-8-11 (BC86-41-15 x Qualicum)
This is 2nd backcross from *R. strigosus* Dalhousie Lake 4 clone. 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)
Parentage is same as the selection above. A productive mid-season selection that have light fruit that is most suitable for the fresh market but also acceptable for IQF. It is not suited for mechanical harvesting. The large low-gloss fruit strongly resembles Qualicum. Plant vigour is not excessive with leaves that are large and light green color. It is resistant to aphids and might also be resistant to the resistance-breaking biotype of aphid.

BC90-11-44 (Algonquin x Qualicum)
This is a very productive selection that produces over an extended harvest season. The attractive fruit is large sized, glossy and firm with very fine drupelets. It is easy to harvest and suitable for mechanical harvesting and for processing and fresh markets. This selection is not resistant to root rot.

BC90-19-8 (Tulameen x *R. strigosus*)
This selection is from a cross between Tulameen and a *R. strigosus* selection collected at Lake George, Minn. This selection has shown resistance to root rot in greenhouse trials. In the machine harvesting trial it harvested well, producing fruit that was very firm and a bit lighter than Meeker but very acceptable for IQF.

BC91-17-10 [(Newburgh x Qualicum) 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 but of a medium red that might be too light for processing. It keeps good size and productivity and has a long harvesting season.

BC96-22R-55 [(Tulameen x *R. strigosus*) x (Cherokee x Qualicum)]
This selection is a 1st back cross from *R. strigosus* from 8th Lake State Park Campground, Adirondack State Park, NY. This parent was selected because of its resistance to root rot. In machine harvesting trials it harvested very well producing fruit that is very close in color to Meeker. The fruit is round shaped with coarse droplets and glossy red color. The plant growth habit is also well adapted for machine harvesting with short upright laterals. The harvest season of this selection starts about one week after Meeker's season.

BC96-37-1 [(Tulameen x *R. strigosus*) x Kitsilano]
This selection is a 1st back cross from *R. strigosus* from Lake George, Minn. It produces a high yield of dark fruit that is suited for processing and mechanical harvesting. Fruit is round in shape with fine drupelets. The fruit color is as dark as Meeker.

BC97-30-3 (Qualicum x Willamette)
In the machine harvesting trial this selection harvested very well. This selection has the potential of being resistant to RBDV because of its Willamette parent. The fruit color is darker than Meeker and the drupelets are fine.

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 1a. Yield, fruit weight, harvest season and harvest ease of raspberry cultivars harvested in 2004, Abbotsford, BC

Clone	No. Plots	Total Yield (kg/hill)	Marketable Yield (tons/ac)	Early Yield[1] (%)	Late Yield[2] (%)	Fruit Weight (g)	Fruit Rot (%)	Harvest Ease[3]
2000 Planting								
89-34-41	4	5.48	7.82	6.0	10.2	2.8	10.6	2.6
90-8-20	3	4.51	5.99	4.6	2.5	4.2	17.0	2.6
90-12-50	1	3.54	4.91	5.9	3.9	3.1	13.4	2.7
90-19-8	1	4.66	6.81	23.3	1.8	3.6	8.8	2.5
91-15-40	3	6.15	8.59	10.1	5.6	4.1	13.3	2.6
92-9-39	3	2.83	4.08	18.4	3.7	4.7	9.7	3.1
93-6-5	1	3.00	4.10	15.9	3.6	4.2	14.9	3.2
93-15-32	1	7.04	8.92	12.3	2.3	4.4	20.9	2.9
93-15-37	3	4.43	5.99	5.4	4.6	4.0	15.8	2.8
93-15-38	1	4.88	6.17	15.2	2.9	3.9	21.1	2.5
93-15-40	3	4.20	5.50	2.7	11.4	3.4	18.4	2.6
93-18-20	3	4.91	6.46	3.6	7.7	3.4	18.4	2.6
93-20-11	3	4.27	4.89	3.5	16.3	3.9	28.1	2.8
93-21-26	3	4.08	5.33	0.3	14.5	4.0	17.9	2.5
93-22-11	2	3.85	5.42	6.4	4.5	4.2	12.2	2.3
93-22-40	1	4.17	6.11	17.1	0.9	4.8	8.4	2.7
93-22-41	3	3.74	5.23	4.2	6.1	4.2	13.1	2.7
93-22-62	3	3.94	5.23	9.8	1.5	4.5	16.2	3.8
93-23-2	3	4.64	6.32	1.1	9.3	3.1	14.7	2.3
93-26-13	1	2.80	3.57	16.6	1.6	4.5	19.7	3.1
93-26-16	3	3.71	5.11	11.3	4.0	4.1	13.9	2.4
93-26-25	3	4.73	6.50	3.4	13.4	4.2	14.2	2.7
93-26-63	1	4.17	6.29	24.7	0.5	4.6	5.8	2.3
93-26-9	1	4.74	6.12	0.0	3.5	5.4	18.9	2.7
93-27-26	3	6.90	9.32	3.9	8.1	3.3	15.1	2.9
97-25-16	1	5.25	7.41	24.7	2.8	2.6	11.9	2.8
ORUS 1149-2	1	4.51	6.41	20.8	13.1	3.3	11.4	2.9
WSU 1112	1	3.35	4.15	0.0	12.5	4.6	22.5	2.5
WSU 1161	2	5.53	7.58	6.2	6.1	3.7	14.3	2.1

Table 1a. (continued)

Clone	No. Plots	Total Yield (kg/hill)	Marketable Yield (tons/ac)	Early Yield[1] (%)	Late Yield[2] (%)	Fruit Weight (g)	Fruit Rot (%)	Harvest Ease[3]
WSU 1162	1	4.36	5.80	9.3	9.5	2.2	16.9	2.6
Chemainus	2	4.17	5.45	11.6	8.2	3.4	17.7	2.7
Cowichan	4	4.89	6.88	9.2	5.3	4.2	12.7	2.7
Encore	1	3.47	4.53	17.1	0.8	3.9	18.4	2.9
Esquimault	3	4.96	6.71	4.8	12.3	4.5	15.1	2.7
Malahat	3	4.10	5.84	19.8	3.1	4.3	11.0	2.3
Meeker	2	3.92	5.86	3.2	1.1	2.5	6.7	2.5
Nootka	1	2.08	2.67	8.0	6.7	2.9	20.0	2.0
Qualicum	3	4.09	4.86	11.6	3.5	4.0	25.6	2.1
Tulameen	2	5.81	6.59	8.1	14.4	4.3	28.5	2.5
LSD[4]		**2.95**	**3.98**	**6.7**	**4.9**	**0.5**	**7.1**	**1.2**

see foot notes on table 1c

Table 1b. Yield, fruit weight, harvest season and harvest ease of raspberry cultivars harvested in 2004, Abbotsford, BC

Clone	No. Plots	Total Yield (kg/hill)	Marketable Yield (tons/ac)	Early Yield[1] (%)	Late Yield[2] (%)	Fruit Weight (g)	Fruit Rot (%)	Harvest Ease[3]
2001 Planting								
87-3-37	2	1.93	2.47	3.4	14.0	2.6	19.6	3.2
89-6-12	2	3.71	4.71	16.2	1.0	3.5	21.1	2.7
89-34-41	2	5.84	8.07	5.5	11.1	2.7	13.7	2.2
90-6-2	2	5.51	7.61	14.8	27.0	4.9	13.8	3.2
90-8-20	1	3.58	4.74	1.9	6.3	4.2	17.3	3.0
90-11-44	3	3.13	4.43	14.4	3.9	3.9	11.8	2.9
90-17-45	2	4.18	5.67	3.1	21.4	2.5	17.5	2.4
91-28-4	1	3.41	3.86	3.8	7.5	2.9	29.4	2.8
92-4-11	1	5.43	7.81	23.1	6.0	4.6	10.2	2.8
92-4-29	3	4.81	7.03	10.8	8.5	3.2	8.6	3.0
92-5-1	2	5.13	7.34	3.6	7.6	3.4	10.4	3.8
92-5-47	3	5.26	7.65	17.0	3.0	3.5	9.2	2.7
92-9-39	2	3.52	5.01	13.4	2.3	4.6	11.0	2.7
93-9-40	3	4.92	7.09	12.9	3.3	4.4	9.9	2.7
93-9-48	3	5.58	7.59	1.6	10.9	3.7	15.0	2.8
93-15-47	1	6.50	8.71	3.9	8.5	3.3	16.2	2.9
94-4-17	3	6.46	8.97	9.0	10.0	5.3	13.3	3.3
94-4-18	2	5.22	7.12	15.8	7.4	4.0	14.6	3.2
94-13-2	3	4.47	6.25	21.0	9.5	3.7	12.8	2.7
94-15-1	1	8.70	11.34	0.0	8.6	4.0	18.5	1.5
96-13R-122	2	2.85	3.83	17.9	0.8	3.0	15.6	2.1
96-17R-21	2	3.69	5.03	0.0	21.9	3.5	15.0	3.0
96-17R-30	2	3.77	5.19	4.3	10.9	2.5	13.9	2.5
96-17R-45	2	3.62	4.98	3.9	0.8	2.9	14.0	2.6
96-18R-16	3	2.32	3.00	0.0	5.1	3.6	18.8	2.3
96-19-4	3	3.04	4.37	1.6	8.8	3.1	9.7	2.4
96-19R-19	2	5.12	7.26	0.9	19.2	4.5	11.3	3.0
96-19R-20	2	4.24	5.90	2.6	12.3	3.5	13.1	2.1
96-21R-56	2	3.33	4.19	7.5	3.3	3.8	21.3	2.5

Table 1b. (continued)

Clone	No. Plots	Total Yield (kg/hill)	Marketable Yield (tons/ac)	Early Yield[1] (%)	Late Yield[2] (%)	Fruit Weight (g)	Fruit Rot (%)	Harvest Ease[3]
96-22-7	2	3.51	3.92	0.0	3.3	3.2	30.5	3.0
96-22R-55	2	3.22	3.53	0.3	8.8	4.5	31.4	2.7
96-26R-10	2	3.89	5.63	1.2	26.5	3.8	9.5	3.4
96-37-1	2	5.84	7.64	0.0	29.8	2.5	18.4	2.7
97-2-15	2	2.37	3.36	0.7	8.7	2.0	11.4	3.6
97-6-25	1	5.83	8.14	2.4	23.4	2.3	13.0	3.0
97-17-22	2	3.19	4.85	0.0	48.8	1.7	5.2	3.0
97-42-21	1	2.26	2.93	3.2	0.0	3.3	19.2	2.4
Chemainus	2	4.34	5.95	7.8	8.7	2.9	14.3	2.6
Cowichan	2	5.16	7.30	8.7	2.8	4.2	11.9	2.3
Esquimault	2	5.26	7.06	2.4	6.0	3.7	16.2	2.4
Malahat	2	5.49	7.75	24.4	1.5	3.8	11.9	2.2
Meeker	2	4.12	5.99	2.3	2.5	3.0	9.5	2.8
Qualicum	1	4.65	5.43	6.1	3.6	4.1	27.1	2.0
Tulameen	1	5.45	6.33	4.2	12.2	3.5	27.5	2.3
LSD[4]		**2.95**	**3.98**	**6.7**	**4.9**	**0.5**	**7.1**	**1.2**

see foot notes on table 1c

Table 1c. Yield, fruit weight, harvest season and harvest ease of raspberry cultivars harvested in 2004, Abbotsford, BC

Clone	No. Plots	Total Yield (kg/hill)	Marketable Yield (tons/ac)	Early Yield[1] (%)	Late Yield[2] (%)	Fruit Weight (g)	Fruit Rot (%)	Harvest Ease[3]
2002 Planting								
90-2-45	3	5.46	7.66	8.9	3.9	3.9	12.0	2.5
90-5-30	3	5.25	7.06	25.0	3.2	4.6	15.9	2.2
90-6-2	3	4.76	6.67	15.2	28.1	5.1	12.2	3.2
90-8-11	1	5.02	7.30	0.0	4.7	3.9	9.1	1.8
90-8-20	3	5.54	7.66	1.2	4.1	5.1	13.6	2.7
92-9-39	2	5.18	7.52	25.7	4.2	5.1	9.4	2.8
93-15-3	1	7.50	11.41	5.7	3.6	3.6	4.9	2.6
96-13R-17	1	3.31	5.09	3.5	3.5	1.9	4.0	2.5
97-19-63	1	2.89	3.75	3.5	21.1	2.5	19.2	3.6
97-20-34	1	2.06	3.15	14.8	2.2	2.2	4.4	3.0
97-22-116	1	2.11	2.88	22.8	8.3	2.5	14.7	3.4
97-22-121	1	1.03	1.57	10.1	16.0	2.0	4.7	4.0
97-22-99	1	3.76	5.34	32.3	7.7	3.1	11.4	2.1
97-25-28	1	4.15	6.11	51.4	1.4	2.9	8.0	2.3
97-25-4	1	6.60	9.92	1.2	7.1	2.7	6.1	3.0
97-25-58	1	5.00	7.08	7.3	2.9	3.7	11.4	1.7
97-25-66	1	5.06	7.15	27.7	3.0	3.6	11.6	2.1
97-27-17	1	4.23	6.20	30.0	1.9	3.3	8.6	2.8
97-27-31	1	4.85	7.02	36.5	0.7	3.6	9.7	2.4
97-27-6	1	2.90	4.49	26.0	0.0	3.7	3.1	2.3
97-27-76	1	3.86	5.50	19.0	3.1	3.0	11.0	2.1
97-27-8	1	3.84	4.98	61.9	0.6	2.9	18.9	3.2
97-28-81	1	5.05	7.86	8.2	5.5	3.7	2.8	3.3
97-29-23	1	1.81	2.53	3.9	10.1	3.4	12.4	3.0
97-29-29	1	4.40	6.72	3.4	6.1	3.6	4.7	4.3
97-29-35	1	5.71	8.57	18.9	4.9	3.8	6.2	2.6
97-29-43	1	5.44	7.84	16.8	0.0	3.6	9.8	2.4
97-29-71	1	6.08	8.79	10.2	8.5	3.4	9.7	3.6
97-30-3	1	5.01	7.38	27.6	3.0	3.2	8.0	2.1

Table 1c. (continued)

Clone	No. Plots	Total Yield (kg/hill)	Marketable Yield (tons/ac)	Early Yield[1] (%)	Late Yield[2] (%)	Fruit Weight (g)	Fruit Rot (%)	Harvest Ease[3]
97-30-4	1	3.10	4.42	21.3	0.0	3.4	11.0	2.5
97-30-49	1	3.78	5.26	44.0	4.2	4.1	13.0	2.3
97-33-15	1	2.72	4.13	19.0	2.9	2.9	5.0	2.0
97-33-25	1	2.86	4.28	32.7	0.0	3.0	6.3	2.2
97-33-33	1	4.32	6.46	3.3	4.9	3.4	6.4	2.8
97-33-55	1	4.03	5.73	36.3	0.0	3.2	11.1	2.7
97-34-19	1	3.30	4.80	12.5	11.8	2.8	9.0	2.0
97-42-24	1	6.18	7.87	7.8	4.1	5.1	20.5	2.0
Cascade Delight	1	5.55	8.31	2.0	4.5	4.2	6.5	2.0
Chilliwack	1	3.62	4.58	2.6	2.8	3.1	20.9	2.0
Cowichan	3	6.22	8.64	13.9	2.7	4.4	13.2	2.8
Malahat	3	5.82	8.24	28.4	2.1	4.1	11.6	1.8
Meeker	3	6.84	10.37	3.3	3.0	3.2	5.3	3.3
Qualicum	2	7.06	8.87	6.8	1.9	4.3	21.7	2.8
Tulameen	3	5.57	7.42	3.1	14.0	4.2	17.0	2.5
LSD[4]		2.95	3.98	6.7	4.9	0.5	7.1	1.2

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

[1]Early Yield harvested before July 5, 2004

[2]Late Yield harvested after July 26, 2004

[3]Harvest Ease was rated on each harvest, 1=easy, 5=hard

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

Table 2a. Harvest season of raspberry cultivars harvested in 2004, Abbotsford, BC

Clone	5% Harvest (Date)	50% Harvest (Date)	95% Harvest (Date)	Harvest Duration (Days)
2000 Planting				
89-34-41	23-Jun	3-Jul	24-Jul	32
90-8-20	23-Jun	4-Jul	16-Jul	24
90-12-50	23-Jun	5-Jul	15-Jul	23
90-19-8	14-Jun	27-Jun	16-Jul	33
91-15-40	21-Jun	4-Jul	18-Jul	29
92-9-39	17-Jun	30-Jun	17-Jul	31
93-6-5	18-Jun	1-Jul	17-Jul	30
93-15-32	19-Jun	28-Jun	17-Jul	29
93-15-37	23-Jun	4-Jul	19-Jul	27
93-15-38	17-Jun	3-Jul	15-Jul	29
93-15-40	25-Jun	8-Jul	25-Jul	32
93-18-20	24-Jun	6-Jul	21-Jul	28
93-20-11	24-Jun	6-Jul	26-Jul	33
93-21-26	28-Jun	12-Jul	24-Jul	27
93-22-11	22-Jun	3-Jul	19-Jul	29
93-22-40	18-Jun	28-Jun	14-Jul	27
93-22-41	24-Jun	6-Jul	20-Jul	27
93-22-62	20-Jun	3-Jul	15-Jul	27
93-23-2	27-Jun	6-Jul	21-Jul	26
93-26-13	18-Jun	1-Jul	12-Jul	25
93-26-16	21-Jun	2-Jul	14-Jul	25
93-26-25	23-Jun	5-Jul	25-Jul	33
93-26-63	17-Jun	28-Jun	11-Jul	25
93-26-9	27-Jun	4-Jul	19-Jul	23
93-27-26	24-Jun	6-Jul	21-Jul	28
97-25-16	16-Jun	27-Jun	17-Jul	32
ORUS 1149-2	16-Jun	1-Jul	25-Jul	40
WSU 1112	25-Jun	5-Jul	25-Jul	31
WSU 1161	23-Jun	1-Jul	21-Jul	30
WSU 1162	20-Jun	1-Jul	24-Jul	35
Chemainus	20-Jun	5-Jul	21-Jul	32
Cowichan	21-Jun	30-Jun	20-Jul	30
Encore	17-Jun	28-Jun	14-Jul	28
Esquimault	23-Jun	11-Jul	23-Jul	31

Clone	5% Harvest (Date)	50% Harvest (Date)	95% Harvest (Date)	Harvest Duration (Days)
2001 Planting				
87-3-37	27-Jun	10-Jul	29-Jul	33
89-6-12	21-Jun	5-Jul	18-Jul	28
89-34-41	28-Jun	12-Jul	31-Jul	34
90-6-2	25-Jun	14-Jul	9-Aug	46
90-8-20	30-Jun	10-Jul	27-Jul	28
90-11-44	23-Jun	4-Jul	24-Jul	31
90-17-45	2-Jul	16-Jul	4-Aug	34
91-28-4	23-Jun	2-Jul	22-Jul	30
92-4-11	22-Jun	7-Jul	27-Jul	36
92-4-29	24-Jun	8-Jul	26-Jul	34
92-5-1	30-Jun	13-Jul	28-Jul	29
92-5-47	24-Jun	6-Jul	20-Jul	28
92-9-39	23-Jun	5-Jul	19-Jul	28
93-9-40	23-Jun	5-Jul	22-Jul	29
93-9-48	30-Jun	12-Jul	28-Jul	29
93-15-47	24-Jun	6-Jul	22-Jul	29
94-4-17	25-Jun	8-Jul	30-Jul	36
94-4-18	24-Jun	10-Jul	29-Jul	36
94-13-2	22-Jun	7-Jul	28-Jul	37
94-15-1	25-Jun	4-Jul	22-Jul	28
96-13R-122	22-Jun	3-Jul	15-Jul	24
96-17R-21	7-Jul	19-Jul	4-Aug	29
96-17R-30	27-Jun	10-Jul	28-Jul	33
96-17R-45	27-Jun	7-Jul	18-Jul	23
96-18R-16	4-Jul	14-Jul	26-Jul	23
96-19-4	29-Jun	10-Jul	28-Jul	29
96-19R-19	6-Jul	17-Jul	5-Aug	32
96-19R-20	28-Jun	10-Jul	30-Jul	34
96-21R-56	25-Jun	5-Jul	19-Jul	25
96-22-7	6-Jul	15-Jul	24-Jul	19
96-22R-55	4-Jul	13-Jul	29-Jul	26
96-26R-10	1-Jul	15-Jul	4-Aug	35
96-37-1	3-Jul	17-Jul	4-Aug	34
97-2-15	3-Jul	15-Jul	29-Jul	27

Table 2a. (continued)

Clone	5% Harvest (Date)	50% Harvest (Date)	95% Harvest (Date)	Harvest Duration (Days)
Malahat	17-Jun	30-Jun	14-Jul	28
Meeker	24-Jun	4-Jul	17-Jul	25
Nootka	21-Jun	29-Jun	21-Jul	31
Qualicum	19-Jun	1-Jul	18-Jul	30
Tulameen	22-Jun	4-Jul	26-Jul	35
LSD[4]	8	8	5	4

Clone	5% Harvest (Date)	50% Harvest (Date)	95% Harvest (Date)	Harvest Duration (Days)
97-6-25	29-Jun	16-Jul	8-Aug	41
97-17-22	9-Jul	23-Jul	7-Aug	30
97-42-21	25-Jun	6-Jul	17-Jul	23
Chemainus	24-Jun	7-Jul	26-Jul	33
Cowichan	27-Jun	8-Jul	24-Jul	29
Esquimault	28-Jun	9-Jul	23-Jul	26
Malahat	21-Jun	5-Jul	19-Jul	29
Meeker	28-Jun	8-Jul	20-Jul	24
Qualicum	23-Jun	3-Jul	17-Jul	25
Tulameen	28-Jun	11-Jul	5-Aug	39
LSD[4]	8	8	5	4

see foot notes on table 1b

Table 2b. Harvest season of raspberry cultivars harvested in 2004, Abbotsford, BC

Clone	5% Harvest (Date)	50% Harvest (Date)	95% Harvest (Date)	Harvest Duration (Days)
2002 Planting				
90-2-45	20-Jun	2-Jul	18-Jul	29
90-5-30	16-Jun	27-Jun	16-Jul	30
90-6-2	18-Jun	4-Jul	3-Aug	47
90-8-11	27-Jun	4-Jul	19-Jul	23
90-8-20	25-Jun	4-Jul	18-Jul	24
92-9-39	17-Jun	29-Jun	18-Jul	33
93-15-3	23-Jun	4-Jul	18-Jul	26
96-13R-17	24-Jun	5-Jul	18-Jul	25
97-19-63	24-Jun	10-Jul	26-Jul	33
97-20-34	19-Jun	30-Jun	14-Jul	26
97-22-116	17-Jun	29-Jun	23-Jul	37
97-22-121	19-Jun	7-Jul	26-Jul	38
97-22-99	12-Jun	28-Jun	22-Jul	41
97-25-28	13-Jun	23-Jun	9-Jul	27
97-25-4	25-Jun	7-Jul	20-Jul	26
97-25-58	21-Jun	3-Jul	17-Jul	27
97-25-66	17-Jun	27-Jun	12-Jul	26
97-27-17	17-Jun	28-Jun	15-Jul	29
97-27-31	16-Jun	26-Jun	11-Jul	26
97-27-6	17-Jun	28-Jun	12-Jul	26
97-27-76	17-Jun	29-Jun	15-Jul	29
97-27-8	10-Jun	20-Jun	5-Jul	26
97-28-81	20-Jun	4-Jul	19-Jul	30
97-29-23	23-Jun	9-Jul	24-Jul	32
97-29-29	24-Jun	5-Jul	20-Jul	27
97-29-35	18-Jun	29-Jun	19-Jul	32
97-29-43	18-Jun	29-Jun	13-Jul	26
97-29-71	19-Jun	4-Jul	23-Jul	35
97-30-3	16-Jun	27-Jun	12-Jul	27
97-30-4	18-Jun	28-Jun	12-Jul	25
97-30-49	16-Jun	24-Jun	17-Jul	32
97-33-15	16-Jun	30-Jun	14-Jul	29
97-33-25	15-Jun	28-Jun	10-Jul	26
97-33-33	24-Jun	5-Jul	19-Jul	26
97-33-55	13-Jun	26-Jun	11-Jul	29
97-34-19	18-Jun	3-Jul	26-Jul	39
97-42-24	22-Jun	1-Jul	19-Jul	28
Cascade Delight	25-Jun	5-Jul	19-Jul	25

Table 2b. (continued)

Clone	5% Harvest (Date)	50% Harvest (Date)	95% Harvest (Date)	Harvest Duration (Days)
Chilliwack	24-Jun	2-Jul	17-Jul	24
Cowichan	19-Jun	30-Jun	16-Jul	28
Malahat	16-Jun	26-Jun	13-Jul	29
Meeker	24-Jun	5-Jul	18-Jul	25
Qualicum	22-Jun	2-Jul	17-Jul	26
Tulameen	24-Jun	5-Jul	27-Jul	35
LSD[4]	8	8	5	4

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.

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

Table 3. Fruit traits of raspberry cultivars and selections harvested in 2004, Abbotsford, BC.

Clone	Firmness (g/cm2)	Soluble Solids Concentration (%)	Postharvest Fruit Rot After 48 hours (%)
89-34-41	145	10.1	21.7
90-11-44	144	12.2	38.3
90-2-45	148	9.8	40.0
90-5-30	94	9.6	
90-6-2	159	9.0	32.5
90-8-11	152	8.2	
90-8-20	292	11.5	15.8
92-5-1	131	10.2	26.7
92-5-47	104	10.3	35.0
92-9-39	160	10.5	22.2
93-15-3	160	9.7	
93-15-37	144	10.3	10.8
93-15-38	173	10.1	15.0
93-15-40	200	9.9	9.2
93-18-20	137	9.8	13.3
93-21-26	113	9.6	43.3
93-22-11	144	10.9	12.5
93-22-40	150	11.4	36.7
93-23-2	194	10.8	11.7
93-26-16	150	11.0	24.2
93-26-25	156	10.4	13.3
93-26-9	132	10.0	37.5
93-27-26	208	9.6	21.7
93-9-40	117	10.6	23.3
93-9-48	128	10.9	18.3
94-4-17	147	10.5	31.7
94-4-18	129	10.1	45.0
96-13R-122	106	12.6	17.5
96-13R-17	78	8.4	
96-17R-21	158	9.6	21.7
96-19-4	95	10.6	27.5
96-19R-19	123	10.2	30.8
96-19R-20	111	12.0	11.7
96-22R-55	134	10.2	17.5
97-20-34	93	10.0	
97-22-99	147	8.3	
97-25-28	104	10.7	
97-25-4	112	8.9	27.5
97-25-58	157	9.3	
97-27-31	87	9.2	
97-27-6	135	9.6	19.2
97-28-81	159	8.8	

Table 3. (continued)

Clone	Firmness (g/cm2)	Soluble Solids Concentration (%)	Postharvest Fruit Rot After 48 hours (%)
97-29-29	93	9.4	
97-29-35	109	10.0	
97-29-43	169	11.1	25.0
97-29-65	75	10.3	
97-29-71	133	10.1	38.3
97-30-3	126	10.3	35.0
97-30-4	144	9.8	25.0
97-30-49	138	11.4	
97-33-15	125	9.0	24.2
97-33-25	129	8.2	
97-33-33	137	11.8	18.3
97-33-55	135	10.8	15.0
97-34-19	135	8.2	
C. Delight	166	9.6	
Chemainus	216	9.8	12.5
Cowichan	221	10.6	13.3
Esquimault	267	9.1	22.5
Malahat	320	11.5	14.2
Meeker	127	9.9	22.1
Qualicum	172	10.5	16.7
Tulameen	133	10.8	35.0
LSD	**124**	**1.6**	**11.8**

Table 4. Machine harvesting trials planted in 2002 (harvest evaluated in 2004- Honcoop).

Clone	Plot Number	Winter injery (0=no damage)	Yield 5=h	Yield potintial (% of Meeker)	How well it harvests 5=good	Green Fruit few=0	Over rip fruit over rip=5	Fruit color dark=5	harvest comments
BC 87-14-35	15	0	3.8	147	3.2	3.0	3.3	3.0	**Discard** not suited for MH, weak laterals, harvest damage
BC 90-08-20	29	1	4.0	120	3.2	4.2	4.0	3.0	**Discard**, not suited for MH
BC 90-11-44	65	1	4.4	179	3.2	1.6	2.5	3.6	No harvest damage, long strong laterals, Good **GT**
BC 91-28-4	10	1	3.8	102	3.8	1.8	1.5	2.4	Crumbly, **discard**, short upright laterals no harvest damage, nice plant
BC 92-05-47	5	0	3.4	111	4.0	2.0	2.6	4.0	some harvest damage v good over all **GT**
BC 93-34-18	36	4	3.2	169	3.8	1.8	1.7	3.5	v good, some harvest damage
BC 93-35-27	2	3	2.6	144	4.2	1.6	3.3	4.3	some harvest damage good over all
BC 93-36-10	17	0	4.0	94	4.4	2.4	2.2	4.0	**Discard,** harvest damage, long laterals, good, productive
BC 96-17R-21	7	0	4.0	84	4.5	2.3	1.0	4.0	v good, strong laterals no harvest damage, nice fruit
BC 96-19-4	68	1	4.4	73	4.0	3.8	2.0	3.7	good

Table 4. (continued)

Clone	Plot Number	Winter injery (0=no damage)	Yield 5=h	Yield potintial (% of Meeker)	How well it harvests 5=good	Green Fruit few=0	Over rip fruit over rip=5	Fruit color dark=5	harvest comments
BC 96-19R-19	9	1	2.8	121	4.3	3.4	2.8	3.5	hard to harvest , IQF good
BC 96-21R-56	30	4	2.0	70	5.0	0.4	1.3	4.8	some harvest damage **GT**
BC 96-21R-6	34	0	3.8		2.2	0.8	2.3	2.5	crumbly, no harvest damage **Discard**
BC 96-22R-55	56	2	3.5	59	4.8	1.3	2.0	3.5	harvest damage, strong laterals **GT**
BC 96-37-1	64	1	3.6	128	4.0	1.4	1.0	4.0	lot of harvest damage excelent
BC 97-30-27	39	2	3.8		3.6	3.0	2.3	3.5	Short laterals, no harvest damage, vigour growth, v good **GT**
Cowichan	70	1	3.7	122	4.7	1.0	1.0	3.5	No harvest damage good for IQF some plant die to root rot
Meeker	19	1	3.2	100	4.8	1.2	1.3	4.0	
Tulameen	31	1	4.8	106	3.2	2.0	2.8	3.0	long laterals, harvest damage v good
Willamette	58	3	3.2	77	4.8	0.8	2.7	4.8	

GT =growers trial

Table 5. Machine harvesting trials planted in 2003 (harvest evaluated in 2004- Sakuma).

Clone	Plot Number	Winter injury (0=no damage)	Yield 5=h	Yield potential (% of Meeker)	How well it harvests 5=good	Green Fruit few=0	Over rip fruit over rip=5	Fruit color dark=5	harvest comments	Laterals length long=5	Laterals angle L=1 5=V
BC 87-09-6	44	0	4.5		3.7	3.0	1.3	3.7	harvest well	4	2
BC 87-5-1	10	0	1.5		4.5	1.3	1.5	3.5	dark		
BC 89-34-41	54	0	4.3	134	5.0	2.3	0.7	4.0	harvest v well **GT**	4	2
BC 90-19-8	21	1	3.7	116	4.3	2.5	1.0	3.0	good, **GT**	3	3
BC 90-6-2	13	2	2.0	127	4.0	1.0	2.5	4.0	dark	3	3
BC 91-24-12	59	0	2.8		3.5	2.5	1.7	3.0		5	4
BC 93-1-32	60	0	3.5		3.7	2.3	2.3	3.0	**Discard**	5	4
BC 93-23-2	55	0	2.0	108	3.5	1.5	2.0	3.3	**Discard**	5	4
BC 93-26-16	84	3	3.7	87	3.7	1.5	2.3	3.3		4	4
BC 93-26-25	51	1	3.0		4.0	1.8	3.3	3.0		4	3
BC 96-17R-21	85	0	2.7	83	3.7	1.5	1.3	3.8	harvest well	4	3
BC 96-19-4	31	0	3.3	73	3.5	2.5	2.3	3.0		4	3.5
BC 96-21R-6	2	0	2.4	70	1.0	0.0	3.5	3.5	**discard** crumbly	2.5	3
BC 96-22R-55	45	0	3.3	59	4.5	2.5	1.3	3.7	nice, harvest well **GT**	4	2
BC 96-37-1	89	2	3.3	128	4.5	1.3	1.3	4.0	v good	5	4
BC 97-22-116	5	0	3.0	28	4.0	1.8	3.0	4.5	crumbly, fruit stay on plant	3	1
BC 97-27-17	87	0	3.3	60	4.0	1.8	1.7	3.0	short laterals	3	3
BC 97-27-31	74	0	2.3	67	3.0	0.8	3.8	4.0		3	3

Table 5. (continued)

Clone	Plot Number	Winter injury (0=no damage)	Yield 5=h	Yield potential (% of Meeker)	How well it harvests 5=good	Green Fruit few=0	Over rip fruit over rip=5	Fruit color dark=5	harvest comments	Laterals length long=5	Laterals angle L=1 5=V
BC 97-27-8	23	0	2.5	46	2.5	0.5		3.5	**discard** crumbly	2	4
BC 97-29-43	11	1	2.7	75	5.0	0.7	2.0	4.0	v nice, dark, short laterals	3	3
BC 97-30-3	27	0	4.3	71	5.0	2.0	0.7	4.3	v nice, harvest well **GT**	3.5	4.5
BC 97-32-22	56	0	3.0		5.0	0.8	1.0	4.7	harvest well	2	3
BC 97-34-19	49	0	3.7	46	4.5	1.3	2.0	5.0	v dark nice harvest well	3	2
Chemainus	35	0	3.7	99	5.0	0.5	0.3	3.8	excellent, best in the trial	3.5	3
Chilliwack	3	3	2.3	44	4.0	2.5	2.3	3.5		2.5	2.5
Cowichan	32	0	3.0	122		2.0		4.0	few plants died to root rot	4	3
Malahat	83	1	3.0	79	4.7	0.5	2.3	4.0	harvest very well	4	3
Meeker	24	3	4.0	100	4.7	2.0	1.7	3.7		3.5	3
Qualicum	90	1	4.0	85	4.3	3.8	0.3	3.3	harvest well, lot of green fruit	5	3
Tulameen	37	0	4.0	106	4.0	1.7	2.0	3.3	harvest well	4.5	3
Willamette	47	1	4.0	77	5.0	1.0	1.0	4.7		3	2

GT =growers trial

Project No:

Year Initiated: 2001 Current Year: 2005-2006 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,
PO Box 1000, Agassiz, BC, Canada V0M 1A0
Tel.: (604) 796-2221 Ext. 224; Fax: (604) 796-0359, email: kemplerc@agr.gc.ca

Project Description:

Develop red raspberry cultivars stressing suitability for machine harvesting, suitability for processing, 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. More than half a million Cowichan plants were already planted across the PNW since it release. 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 recently release variety Chemainus (BC89-33-84) has more than 300,000 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 rotten 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:
- 2005 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 were planted in 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 potentially selections to the propagators.
- Supervise distribution of advanced selections to North American propagators and growers and subsequently monitor their performance.
- Evaluate Cowichan, Esquimalt, Chemainus, BC89-34-41 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:

Six out of the twelve 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, BC90-19-8 and 92-6-41). All PARC releases are resistant to aphids, which is one of the insects that cause insect harvest contaminant. Many of PARC releases are suited for the fresh market and extend the harvest season and are tested for pre and postharvest fruit rot.

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 2005/2006: $US 4,000. ($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*.

Personnel: Craig B. MacConnell, WSU Whatcom County
Todd A. Murray, WSU Whatcom County
Colleen Burrows, WSU Whatcom County
Collaborators: Lynell K. Tanigoshi, WSU REU Vancouver
Stuart Gordon, SCRI, Scotland, UK

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

Accomplishments:

1. Evaluate different traps and refine monitoring flight activity of WRFW using different visual attraction traps in multiple cooperating grower fields.
2. Establish thresholds for various production methods by correlating adult fruitworm flight and abundance with percent fruit infestation by WRFW larvae in multiple cooperating grower fields.
3. Identify and correlate abiotic environmental factors with significant biological and season events of WRFW.

Results:

Fifteen growers, representing diverse pest management practices, participated in this past season's research on raspberry beetle IPM. 788 acres of red raspberry were monitored for adult raspberry beetle fight, using the Rebell® Bianco trap. Previous year's data demonstrated this trap design is superior to cheaper alternatives. Traps were placed in field edges, field centers and along alternate *Rubus* hosts. At projects end, with three years of data, trap placement recommendations will be made.

Along with flight data, we sampled raspberries at select fields during mid-harvest.
We are attempting for the second year to correlate flight data with percent fruit infection for each field and management strategy. Correlations last year were non-significant. Ultimately understanding the percent of fruit infestation and the number of adult beetles trapped will assist growers to predict fruit infestation based on trap counts and aid in developing action thresholds.

Onset Hobo data loggers were placed at two separate farms to record air and soil temperatures. Significant biological events of the raspberry beetle lifecycle such as emergence and flight have been recorded for the second year. Beetle catch begins when soil temperatures reaches above 53°F. Using this data, we have recently received funds from the EPA to develop additional temperature-based predictive models.

Budget:		2005
04	Travel	$1,242
Total		$1,242

Project No: 10A-3093-2403

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

Personnel: Peter Bristow, Patrick Moore, and Martin Nicholson

Reporting Period: 2004

Progress: A year 2000 model over-the-row Littau harvester was purchased by the Washington State Office of Finance using funds from WSU, the Washington Red Raspberry Commission (WRRC) and the WSCPR. A payment of $7,000/yr will be required to pay off the harvester in 8 years of which the WRRC has committed to $3,000/yr for that time

Year 2004: This season the Machine was used to harvest three research trials plus three additional acres of raspberries.

The trials harvested were:
Organic Management of Root Rot, funding from NWCSFR, Dr Carol Miles.this was the second of three harvests for this trial.

Annual addition of organic materials to soil: impact on root rot of red raspberry, Dr Peter Bristow. Year one of three harvests completed in 2004.

Gypsum for Root Rot control on Red Raspberry, (WRRC 13C 3761 4251). Dr Peter Bristow. Year one of three harvests completed in 2004.

The Machine has worked well for us, enabling yields from large plots to be harvested at a reduced cost. Next year there will be 3 trials harvested by machine.

For any additional information contact;

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 2004-2005 Terminating Year 2009

Personnel: Dr Pete Bristow, Dr Pat Moore, 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. ! Provide a statement that clearly defines the problem and rational for project.

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.
Gypsum for Root Rot control on Red Raspberry, (WRRC 13C 3761 4251). 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.
Annual addition of organic materials to soil: impact on root rot of red raspberry, 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.
Soil Solarization as a component of an integrated program for controlling root rot in red raspberry. Dr Peter Bristow, 11D-3761-6640, this project planted in 2001 was machine harvested for yield data in 2003. Organic Management of Root Rot in Raspberries, NWCSF. 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: In 2003 a planting was made to screen varieties for root rot resistance, this planting will be harvested for the first time in 2005.

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

Other support of project:

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: 2004 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: 2004

Accomplishments: Five insecticides were compared with our diazinon standard for efficacy and labeling/registration to control the western raspberry fruitworm, Byturus unicolor.

Diazinon and Capture were compared with Success and the experimentals Actara and Imidan for field efficacy to adult raspberry beetle, *Byturus unicolor.* The test was conducted at the Puyallup REC's Farm 5.

Arvesta's experimental acaricide, Kanemite (acequinocyl) was compared with Acramite (bifenazate) in a mature 'Meeker' field in Woodland, WA. One-inch diameter red raspberry leaf discs were excised from yellow spider mite infested red raspberry leaflets and both acaricides were compared with water controls in the lab.

The contact and translaminar mode of entry for Actara (thiamethoxam) was measured at varying times after application on red raspberry foliage for adult, rough strawberry root weevil. The contact activity of Admire (imidoclopyrid), Platinum (thiamethoxam) and Belay (clothianidin) was evaluated with a simulated test tube, soil drench bioassay for activity to both spring and fall populations of rough strawberry root weevil larvae.

Eleven registered and experimental insecticide/acaricides are being bioassayed for their toxicity or safety against field populations of the phytoseiid predator, *Neoseiulus fallacis*, field collected from a red raspberry field in Burlington and two fields in Lynden. This research is on going and the results will be reported at the December commission meeting.

Results:
Five adult fruitworm per Petri dish were place on 3-4 inch long, air-dried fruit buds that were uniformly treated with field rates applied with a Precision Spray Tower and replicated five times. Mortality was evaluated at 1, 2 and 3 days posttreatment. These fruitworms were collected from Whatcom County, WA in early May. One day after treatment, 100% mortality was observed for the Diazinon standard. At 48 hours posttreatment, there was no significant difference for the remaining 4 insecticides compared with the untreated check. Complete mortality was obtained for Actara, Capture and Imidan and Success after 72 hours posttreatment. These data corroborate similar bioassays reported last year. Success was registered on red raspberry in 2003 for leafroller/worm control during the pre-harvest interval. These data show excellent efficacy for western raspberry fruitworm larval and adult control as well.

Western raspberry fruitworm plots consisted of 3 hills each and 30 plots were randomized amongst 64 total plots based on plant vigor and relative beetle feeding on raspberry leaves. Adult beetle activity was monitored with 2 Rebel Bianco UV non-reflectance traps placed on the top trellis wire, 9 April 2004. Because of the mix of selections, bloom at time of treatment ranged from flowers still closed to 15% bloom and bee activity. Field rates were applied with a Solo backpack sprayer to run off on 5 May and presence of adults assessed on 11 May. Two teams of two persons each scanned and examined flowers and primocane terminals for live beetles for 3 minutes per plot. Capture and Actara provided good adult beetle control compared with the untreated check. Imidan, Diazinon and Success were also significantly different from the untreated check, as well. Because the primocanes were not burned-back, the population levels of raspberry beetle were higher than we observed in adjacent cane

burned blocks. The cultural practice of primocane burning in April may be associated with relative raspberry beetle abundance.

Arvesta's experimental acaricide, Kanemite was compared with Acramite in a mature 'Meeker' field in Woodland, WA. Applications were applied on 27 April 2004 to a yellow spider mite infestation with our tractor mounted, plot sprayer equipped with 14, D3 45 disk core nozzles, at 2.1 mph, at 150 psi in 108 gallons of water. The sticker Nu-Film 17 was used for both treatments. Treatments were replicated 5 times in plots 10 feet x 30 feet in a RCB design. Sample unit was 30 leaflets per plot. Leaflets were processed with a mite brushing machine and motile life stage counted. This population represented early season emergence of overwintering females and enormous level of first generation eggs. The 10 day posttreatment counts for the untreated check reflected a 3.6-fold increase of early instar larvae and nymphs. Population levels for the Kanemite and Acramite treatments averaged 2.9 and 5.9 motile stages per leaflet, respectively.

Fifteen discs each for Acramite, Kanemite and untreated checks were placed on water saturated cotton wool in standard Petri dishes. These units were treated with a precision Potter Tower. Each disk was precounted and yellow spider mite mortality assessed at 1, 2 and 3 days posttreatment. All motile life stages were killed after 2 days with Kanemite and 99% for Acramite after 3 days posttreatment. Check mortality was less than 1% after three days.

Several 'Meeker' plants were sprayed with Actara at 0.06 lb(AI)/acre on 12 July at the Vancouver REU. Ten leaves were sampled daily for 9 days posttreatment from treated and untreated plants. Three adult, rough strawberry root weevils were placed on each leaf whose petiole was placed in a water-filled vial capped with a cotton plug and held in 6 inch Petri dishes. Daily cohorts of 30 weevils each for both treatments were held for 5 days. Excellent contact and stomach poison activity was observed within 24 hours of the application through 8 days posttreatment.

Maturing late-spring root weevils were placed on top of field soil contained in 3.75 inch long glass test tubes on 19 May and 24 May. These larvae migrated 1-2 inches into the soil before they were drenched with 4 ml of field rates of Admire and Platinum. Cohorts of 15 and 20 larvae/treatment at the two respective treatment dates were destructively sampled 14 days post-drench. Larval/prepupal mortality averaged 42% for Admire and 40% for Platinum. These levels suggest that a late spring drench application(s) may not be optimal for economic control of new generation root weevils. Therefore, similar drench tests were conducted in late August to control early instar, rough strawberry root weevil that will feed on roots over the following 8 months. From 31 August to 9 September, second instar rough strawberry root weevil larvae were collected from an infested strawberry field in Vancouver, WA. Each of four treatments consisted of 10 larvae placed in soil filled test tubes. These were treated with 6 ml of field rates of Admire, Platinum (thiamethoxam), Belay (clothianidin) and water control one day later. Each regime was repeated at 5 different dates and larval mortality was determined with destructive sampling at 3 to 7 days posttreatment, respectively. Belay and Platinum provided excellent control from 4-7 days posttreatment; Admire was somewhat variable but significantly different from the control at the same time intervals. General contact mortality of immatures in soil tend to be slightly delayed compared with foliar formulations when exposed to adult root weevils.

Publications

Tanigoshi, L. K., T. A. Murray and B. S. Gerdeman. 2003. Spider mites on red raspberry. Wash. St. Extn. Bull. 1959E, 6 pp.

Tanigoshi, L. K. and J. R. Bergen. 2004. Control and management of the rough strawberry root weevil in small fruits. Proc. 6th Annual Small Fruit Grower's Workshop, pp. 15-19.

Tanigoshi, L. K. and T. Peerbolt. 2003. Further evaluation of control strategies for root weevils in strawberries and red raspberries. Proc. Northwest Center for Small Fruit Research, pp. 62-63.

Tanigoshi, L. K. and J. R. Bergen. 2004. Efficacy of soil applied insecticides to control immature root weevils. Proc. 63rd Ann. Pacific Northwest Insect Management Conference, pp. 17-19.

Tanigoshi, L. K. and J. R. Bergen. 2004. Insecticide efficacy for western raspberry fruitworm. Proc. 63rd Ann. Pacific Northwest Insect Management Conference, pp. 43.

Tanigoshi, L. K. and J. R. Bergen. 2004. Insecticide efficacy for strawberry and raspberry aphids. Proc. 63rd Ann. Pacific Northwest Insect Management Conference, pp. 49-50.

Project No: **13C 3419 3297**

Title: **Weed Control in Red Raspberries**

Personnel: Timothy W. Miller, WSU NWREC
Brian G. Maupin, WSU NWREC

Reporting Period: 2004-05

Accomplishments: Weed control and crop injury were rated in three varieties of red raspberries planted May 7, 2004 at WSU NWREC and treated twice with one of nine different herbicides.

Results: There were no significant differences in growth response among the three varieties tested, so those data are presented together in the table below. Of the nine herbicides tested, only Prowl was providing >85% weed control by the late summer evaluation. Weed control with Callisto was good (80%), but this product severely reduced the number of primocanes produced compared to non-treated raspberries (1.4 and 4.9 primocanes, respectively). Herbicide choice did not significantly affect raspberry crown survival. Length of primocanes in Prowl-treated plots was greater than for any other treatment; this was likely due to inadequate weed control in non-treated plots. Other herbicides did not shorten primocanes in relation to primocanes from non-treated raspberry plants.

Table. Weed control and baby raspberry[a] response to several herbicides.

Treatment[b]	Rate	Weed control[c]		Crown number[c]	Primocane number[c]	Avg. cane length[c]
	product/a	%	%	no/plot	no/crown	inches
Visor	1.5 pt	18	35	2.8	4.9	6
Prowl	7.3 pt	95	87	3.7	6.7	13
Spartan	5.3 oz	15	42	3.7	6.8	8
Goal	1.5 pt	88	53	3.2	4.6	7
Cobra	1.5 pt	55	8	2.8	3.6	5
Chateau	2.2 oz	62	67	3.0	4.6	8
Dual Magnum	0.8 pt	0	32	2.9	4.3	5
Outlook	0.8 pt	0	28	3.4	7.4	6
Callisto + coc	6.4 fl. oz + 1%	85	80	1.3	1.4	7
Control	---	100	20	3.4	4.9	6
$LSD_{0.05}$	---	22	21	ns	3.4	2

[a]Raspberry crowns transplanted May 7, 2004
[b]Herbicides applied May 12 and July 15, 2004; row middles mowed July 13, 2004; coc = crop oil concentrate (v/v).
[c]Weed control evaluated July 9 and September 7, 2004; cane parameters measured September 9, 2004.

Publications:
Results will be presented at Small Fruit Workshops in Lynden (December, 2004) and Vancouver (March, 2005).

Project No: **13C 3419 3297**

Title: **Weed Control in Red Raspberries**

Year Initiated: 2004-05 Current Year: 2005-06 Terminating Year: 2005-06

Personnel:

Timothy W. Miller, Extension Weed Scientist, WSU Mount Vernon
Carl R. Libbey, A/P 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*), 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 through 2004 research at WSU NWREC, 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 begun in 2004 on newly-transplanted canes, and now a second application to one-year old canes is necessary to determine their safety to young raspberry plants.

It is also important to gain new tools for controlling established perennial weeds in established raspberries. Two primary perennial weed species in the Pacific Northwest are (A) yellow nutsedge (*Cyperus esculentus*) and (B) Canada thistle (*Cirsium arvense*):

A. 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.

B. At the 2004 IR-4 food use workshop, Stinger was mentioned as potentially gaining registration for use in raspberry. Two products aimed at controlling Canada thistle, Casoron (applied postemergence rather than during the dormant season) and Stinger (clopyralid, postemergence) were tested at WSU Vancouver in 2001. Other berry studies I have conducted have shown that Stinger provides superior Canada thistle control, while the initial data from Vancouver study indicate that late spring/early summer applications of Stinger causes only slight injury to raspberry, and that a similar application timing for Casoron was also highly effective with no visible raspberry injury. Because the raspberry block being treated at WSU Vancouver was quite thin due to extensive Phytophthora root rot infection, however, the plants were

removed in fall, 2001. More reliable crop injury data resulting from applications of these products is therefore needed to document that they are safe for use in raspberry.

Objectives: To (1) complete the test of several herbicide treatments for weed control in young raspberries, (2) to test several products for control of yellow nutsedge in established raspberries, and (3) to test postemergence Stinger and Casoron for control of Canada thistle in established raspberries.

Procedures:

1. *Young raspberry trial*: Plots established in 2004 at WSU NWREC will be maintained for a second season, during which various products will be tested. Three cultivars were included in this trial ('Meeker', 'Tulameen', and 'Willamette'). Canes will be cut at the soil surface in November, 2004 and initial herbicide applications will be made just prior to cane emergence next spring, and again as a directed spray at midseason. A total of ten herbicides will be tested and their effect on weed control and primocane growth (number, height, and diameter) will be monitored during 2005.

2. *Yellow nutsedge trial*: Plots will be established in 2005 in severely-infested raspberry field, probably near Woodland, WA. Herbicide applications will be made during dormancy (2004-05) and POST directed sprays used in spring, 2005. Yellow nutsedge control will be evaluated, as will herbicide effects on raspberry yield, berry size, and primocane growth.

3. Canada thistle trial: Plots will be established in 2005 in a Canada thistle-infested raspberry field near Mount Vernon. Herbicide applications will be made at early- and late-postemergence timings for the Canada thistle in late spring and early summer, 2005. Canada thistle control will be evaluated, as will herbicide effects on raspberry yield, berry size, and primocane growth.

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 2004-2005: $ 2,500

	Requested 2005-06
Salaries	
A/P technician (Carl Libbey)	$ 3,000
Time-slip	1,500
Operations (goods & services)	800
Travel	
Projected needs[a]	500
Meetings	0
Other	0
Equipment	0
Employee Benefits	
A/P technician (34%)	1,020
Time slip (16%)	240
Total Request	7,060

[a]Travel will be used for plot work at WSU NWREC and at off-station sites near Woodland and Mount Vernon, 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 2714	$ 7,500	1/1/04 to 12/31/04	5	Biofumigation in spinach seed
Miller	10A 3093 2614	2,500	1/1/04 to 12/31/04	5	Herbicides and flame for weed control in spinach seed
Miller	10A 3093 2530	3,500	1/1/04 to 12/31/04	5	Perennial weed control in blueberry
Miller	10A 3093 2547	1,500	1/1/04 to 12/31/04	5	Postemergence herbicides in Apiaceae seed crops
	Special USDA				
Miller & Inglis	11D 3419 4194	18,670	11/1/03 to 8/31/05	10	Organic transition rotations for PNW
	WA Bulb Com.				
Miller	13C 3419 4228	8,295	1/31/05 to 1/31/06	5	Weed control in ornamental bulbs
	WA Blueberry Com.				
Miller	13C 3419 5229	4,700	7/1/04 to 6/30/05	5	Weed control in blueberries
	WA Strawberry Com.				
Miller	13C 3419 8228	10,560	7/1/04 to 6/30/05	10	Weed control in strawberries
	WA Raspberry Com.				
Miller	13C 3419 3297	2,500	7/1/04 to 6/30/05	5	Weed control in baby red rapberries
	NARF				
Miller	13K 3419 5228	5,000	7/1/04 to 6/30/05	5	Weed control in green peas
Miller	13K 3419 6228	12,135	7/1/04 to 6/30/05	10	Weed control in cucumbers
Miller	13K 3419 7228	5,500	7/1/04 to 6/30/05	5	Weed control in vegetable seed
	Pending:				
Miller	WA Com. Pest. Reg.	$ 3,150	1/1/05 to 12/31/05	5	Pendimethalin and dimethenamid-p for tolerance in tulip
du Toit & Miller	WA Com. Pest. Reg. (suppl. 10A 3093 2714)	1,000	1/1/05 to 12/31/05	5	Biofumigation in spinach seed

NEW PROJECTS

Executive Summary Sheet

Title: Integrating Insect and Mite Management in Red Raspberry

Personnel: Lynell K. Tanigoshi, Entomologist
Jeanette R. Bergen, Agricultural Research Technologist
Todd A. Murray, IPM Coordinator, Whatcom County Extension

Project No: New

Project Duration: 2005-2007

Calendar: 2004

Proposed Budget: $17,319

Other Support:

Identification of Problem or Need: Even with the recent registration of the insecticide/miticides Brigade/Capture (bifenthrin) and Success (spinosad), our current arsenal of registered pesticides for red raspberry is at risk. Of these compounds, most of the usage is center on 2-3 insecticides-miticides. The loss of these key pesticides through regulatory mechanisms or pesticide resistance would leave the industry with no cost-effective alternatives/options for root weevils, spider mites and aphids.

Benefits: Effective and timely economic control of key and secondary insect and mite pests on red raspberry.

Economic Justification: The loss of diazinon or azinphos-methyl would result in a significant impact because there are no options for the raspberry crown borer. There are no effective options to Capture/Brigade for root weevil control.

Evaluation and Accountability: The researchers are responsible for evaluating and reporting results of this project to the red raspberry industry and scientific community. Washington State Red Raspberry Commission is responsible for evaluating the project's progress and making recommendations for future directions. Growers will assess usefulness and adaptability of results to their respective programs.

Project No.: New

Title: Integrating Insect and Mite Management in Red Raspberry

Year Initiated: 2004 **Current Year:** 2004 **Terminating Year:** 2007

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

Justification: The Food Quality Protection Act (FQPA) of 1996 amends the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), the Federal Food, Drug and Cosmetic Act (FFDCA) and the Delaney Clause to empower the USEPA and other regulatory agencies to enforce the new regulations to assure our health, safety and environmental quality. This law prohibits any pesticide residues in processed foods for human consumption known to cause cancer in animals The EPA has begun to implement this new Act and will continue reviewing tolerances for organophosphates, carbamates and B2 carcinogens over the next few years. The first pesticide to be completely eliminated was methyl parathion (Penncap-M), while restrictions have been placed on azinphosmethyl (Guthion), and Diazinon. This new law threatens a wide range of pesticides used in red raspberry production. A review of insecticides and miticides in the *Pacific Northwest 2004 Insect Management Handbook* lists 11 synthetic pesticides recommended for effective insect and mite control in red raspberry. Seven of them are "older", broadspectrum, synthetic organic insecticides. Specifically the organophosphates (Malathion, Diazinon, Guthion), the carbamate Sevin and pyrethroids (Asana, Brigade/Capture, permethrin). The loss of these compounds would leave our red raspberry arsenal without the recently registered Brigade/Capture for economic control of root weevils and a few specific compounds that have been classified by the EPA as reduced-risk, OP replacements and biopesticides. EPA's FQPA guidelines and 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.

Objectives: 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.

1. 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*.

2. Continue validation of an interactive, area-wide orange tortrix program in southwestern Washington.
3. Detail occurrence, abundance, life history and failure to control re-emergence of economic populations of the rough strawberry root weevil, *Otiorhynchus rugosostriatus*, in northwestern Washington.

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 and larvae will be monitored posttreatment with pheromone traps, while larval responses will be evaluated by collecting and opening up their leaf nests on developing primocanes. Relative abundance and field efficacy of insecticides to adult western raspberry fruitworm will be monitoring with the Rebell® Bianco trap and visual field monitoring of opening flowers.

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 concentration equivalents to full, half and one quarter of the recommended field rates. After the deposits are air-dried, *N. 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.

Beginning in March, 2005, we will again initiate on-farm grower meetings, subject to urgency, to develop details on implementation of the orange tortrix management project. Aspects of these meetings will discuss:

1. In-field scouting for over-wintering larvae; sampling scheme for pheromone trap placement, evaluation and individual grower updates.
2. Discussion and review about the life history of the orange tortrix and oblique banded leafrollers, their current treatment thresholds, timing of applications and choices of insecticides.
3. Weekly meetings and email updates will review weather information, heat-unit accumulations, honey bee activity during prebloom, life stage activity of leafrollers as determined by field sampling/pheromone traps and interactive discussions with growers about these real-time parameters.
4. Major emphasis will be placed on area-wide, coordinated field application of an agreed upon insecticide that will be applied, nearly simultaneous, over the red raspberry acreage within 1-2 days.
5. A calibration workshop and oversight activity will be coordinated to standardize proper calibration (e.g., gallonage, nozzle type, speed, and pressure) customized for the growth phase of red raspberry to be targeted.
6. Our research team will conduct treatment evaluation and sampling. These results will be discussed as soon as possible posttreatment with all of the area-wide growers.

Late winter weather permitting, naked-eye search amongst the decomposing floricanes will reveal presence/absence of overwinter adult rough strawberry root weevil. Soil samples, taken with a standard golf-cup cutter around emerging fruiting canes, will detect the presence of root weevil larvae and their life stage development. Larval samples will be reared to adults to determine species identification because there is potential for the presence of four species of *Otiorhynchus* in the same field. Early prebloom basal (i.e., April/May) treatments of bifenthrin and experimental insecticides will be applied with a tractor mounted plot sprayer equipped with an over-the-row boom. Only the lower 3 nozzles (D3-25 TeeJets) on each side of the row will be used to apply a basal application to drench the crown area thoroughly and lower canes and surround soil and debris. Harvest and postharvest populations will be monitored as well.

Anticipated Benefits and Information Transfer:

Pending registrations of additional insecticides and miticides with different modes of action (e.g., neonicotinoids, carbazates, pyridine compounds), a weevil, worm and spider mite control program that integrates biological control for spider mite control in red raspberry may be realized. 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 (e.g., western raspberry fruitworm, aphids and raspberry crown borer). Results from the area wide orange tortrix will demonstrate first hand how important timing and placement of insecticides are when targeting adults or larvae of the orange tortrix

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:

		2005
01	Salaries[1]	$13,125
03	Goods and services[2]	750
04	Travel[3]	2,000
07	Employee benefits (11% of 01)	1,444
Total		**$17,319**

[1]Time slip assistance for weevil and orange tortrix sampling and pheromone trap monitoring.
[2]Purchase of pheromone traps and lures for multiple grower fields, sprayer nozzles.
[3]Mileage at $0.325/mile per VREU in-house policy.

Project No: New

Title: Effect of Kaolin Clay Particle Mulch on Phytophthora Root Rot and Soil Moisture Content in Red Raspberry

Year Initiated 2005 Current year 2005 Terminating year 2011

Personnel: Peter Bristow and Patrick Moore
Washington State University Puyallup Research and Extension Center, Puyallup, WA 98371
F. Takeda and D.M. Glenn, USDA-ARS, Appalachian Fruit Research Station, Kearneysville, WV 25430

Justification:
Phytophthora root rot continues to be an increasing problem for raspberry production in the Pacific Northwest. There is no one simple control measure for this root rot disease. Wilcox *et al.* (1999) state that *Phytophthora* root rot is best controlled through a multi-faceted approach. There are different practices or methods one can use to avoid or reduce losses. These strategies include exclusion (planting clean nursery stock), planting resistant genotypes and avoiding highly susceptible cultivars (genetic resistance), raised bed production and gypsum applications (cultural), introduction of *Trichoderma* and *Gliocladium* (biological control), and fungicides Aliette® (a.i. aluminum tris (O-ethyl phosphonate, 80.0%)) and Ridomil Gold® (a.i. metalaxyl) (chemical control).

The disease is most severe in excessively moist soils, thus growing raspberries on raised beds may reduce the severity of root rot (Heiberg, 1999; Maloney et al., 1993). However, raised beds alone may not be adequate to control root rot or to ensure the long-term viability of the raspberry planting.

The raspberry crown borer (*Pennisetia marginata* (Harris) can be one of the most damaging pests of Rubus crops in North America (Ellis et al., 1991). If this insect pest is not controlled, it will severely debilitate bramble plants in several years and the field may have to be abandoned (Sampson, personal communication).

Recently, hydrophobic soil mulches were reported to be an attractive alternative to the conventional black plastic mulches for weed control (Takeda et al., 2005). Satisfactory results were obtained from the application of hydrophobic mulches (e.g. excellent weed control during establishment year and no adverse effect on blackberry transplant mortality, growth, or fruit yield) when the 4-cm hydrophobic mulch was applied after the transplants were established. These hydrophobic mulches may have added applications in the management of several other raspberry pests by regulating soil moisture content and physically blocking the movement of small pests.

In previous studies, hydrophobic kaolin particles were combined with sifted, air-dried field soil to produce a mulching material that maintained a high hydrophobicity so that rain would not penetrate it, yet would be stable enough to persist on the soil surface for extended periods. As with plastic mulch, the soil-based mulch will divert rainwater away from the plants and prevent periods of high soil moisture conditions. An application of hydrophobic kaolin particles to the soil should have no adverse effect on animals and should not significantly alter the physical and chemical characteristics of soil. Approximately 100 to 200 kg of processed kaolin particles is required to treat a hectare of brambles. At these rates, the clay content in the top 15 cm of soil would increase about 0.001% when the crop is removed and the field is tilled. Tilling the soil will break apart the hydrophobic layer and disperse kaolin particles into the soil.

Objectives:
1. To examine the effects of an integrated approach that includes an application of hydrophobic and oil-based mulches for their potential to suppress and control *Phytophthora* root rot disease.
2. If crown borer is present in this planting, evaluate the mulch for potential to suppress and control crown borer.

Procedures:

1. Raise beds will be constructed at WSU Puyallup Farm 5.
2. ECHO soil moisture probes will be inserted into the beds to monitor soil moisture.
3. Processed kaolin particles will be applied to the soil of 10 plots and 10 will be left untreated.
4. A root rot susceptible (Malahat) and a tolerant (WSU 1162) raspberry cultivar will be planted in 10 plots each (5 treated and 5 untreated plots). The plots will be drip irrigated.
5. Soil moisture will be monitored at two depths for treated and untreated plots for each cultivar.
6. Vigor and growth of the planting will be rated each year.

Anticipated Benefits and Information Transfer:
Hydrophobic clays could be an additional treatment that could be a beneficial treatment for root rot control. It may also help control some insect pests. The hydrophobic clays may also provide weed control.
Results of this study will be transferred to growers at field days and grower meetings.

Budget:	2005-2006
01 Timeslip labor	$500
03 Goods and Services[z]	3,120
07 Benefits	80
Total $3,700	

[z] The Goods and Services would be for 16 soil moisture probes, 4 temperature probes, and 4 data recorders.

Voluntary grower survey for *Phytophthora fragariae* var. *rubi* in pre-plant stocks and planted root samples of red raspberry in Washington State

Year Initiated 2005 Current Year 2004 Terminating Year 2005

Personnel: Craig MacConnell, Todd Murray - WSU Extension, Whatcom
Peter Bristow - WSU Plant Pathology, WSU Puyallup

Proposed Budget: $40,000.00

Identification of Problem or Need:
Phytophthora fragariae var. *rubi* (*P.f.r.*), raspberry root rot, is a serious key pest of red raspberry that limits production in the Pacific Northwest. European plant pathologists most familiar with this disease insist that the most effective method of control is to ensure that planting stock is free of disease and that testing using PCR , or polymerase chain reaction, on roots of planting material is the correct approach for *P.f.* This project proposes to offer Washington red raspberry growers an opportunity to survey both pre- and post-plantings for *P.f.* using PCR technologies. Understanding where *P.f.r.* infestations originate (pre or post planting) will offer growers a method to focus appropriate management efforts. Increased knowledge of *P.f.r.* infection risks will aid in the decision-making process of integrated pest management.

Benefits:
Compilation of this survey data is of itself an outcome that does not currently exist. This survey is an attempt to identify whether *P.f.r.* is a pre-, post-planting or mutual problem for raspberry growers. Pending results are unknown however, outcomes of survey results will impact pre-planting cultural methods to avoid *P.f.r.* infestations if positive samples are identified in pre-plant root stock or change fungicide pesticide usage on virgin land if no infected root stock are identified.

Economic Justification:
Growers currently rely on costly fungicide applications to slow the infection of root rot in new and old plantings with no knowledge of pest presence, abundance and distribution. Through demonstration of root rot detection methods through, growers will have the opportunity to confirm root rot presence, or lack of, in existing fields and pre-plant stock. Fungicides used for root rot control can be reduced or eliminated if fields and/or root stock is free of disease, thus saving direct costs of fungicide applications in addition to environmental costs.

Evaluation and accountability:
The results of this survey should drive changes by growers in knowledge, attitudes and practices regarding *Phytophthora* root rot management, including avoidance. Follow up surveys with participating growers will seek to evaluate changes in management practices.

Voluntary grower survey for *Phytophthora fragariae* var. *rubi* in pre-plant stocks and planted root samples of red raspberry in Washington State

Project Number: New

Year Initiated 2005 Current Year 2004 Terminating Year 2005

Personnel: Craig MacConnell, Todd Murray - WSU Extension, Whatcom
Peter Bristow - WSU Plant Pathology, WSU Puyallup

Justification:
Phytophthora fragariae var. *rubi* (*P.f.r.*), raspberry root rot, is a serious key pest of red raspberry that limits production in the Pacific Northwest. Traditional *Phytophthora* detection technologies for raspberry are slow and not specific for *Phytophthora fragariae*. European plant pathologists most familiar with this disease insist that the most effective method of control is to ensure that planting stock is free of disease and that testing using PCR , or polymerase chain reaction, on roots of planting material is the correct approach for *P.f.* Current understanding of root rot incidence in the Pacific Northwest is limited. Recent developments of PCR techniques have enabled other raspberry production regions to rapidly identify *Phytophthora fragariae* from pre-plant root stock and in-field raspberry plants. This project proposes to offer Washington red raspberry growers an opportunity to survey both pre- and post-plantings for *P.f.* Understanding where *P.f.r.* infestations originate (pre or post planting) will offer growers a method to focus appropriate management efforts. Increased knowledge of *P.f.r.* infection risks will aid in the decision-making process of integrated pest management while reducing unnecessary applications of fungicides.

Objectives

- Reduce the occurrence and spread of *P. fragariae* var. *rubi* (*P.f.r.*) in commercial plantings of red raspberry
- Using definitive PCR technology, aid growers and others in determining the presence of *P. fragariae* in pre-plant raspberry bare root stock or existing fields.
- Refine knowledge of pest management tactics and the necessity of pesticide use for managing raspberry root rot.
- Develop first definitive data on presence or absence of *P. fragariae* in Washington raspberries which will influence the pesticides used to control *P.f.r.*

Procedures
The following study proposes to invite raspberry growers to submit root samples to be tested for the presence of *P. fragariae* var. *rubi* (*P.f.r.*). Investigators will offer education on sampling protocols similar to those used in horticultural certificate programs. Growers will be encouraged to voluntarily submit anonymously coded samples from pre-plant stock and samples from suspect plants in commercial fields. Growers will code their own samples for their own personal tracking. The information required for sample submission will include grower code, county, cultivar (variety), field age (if from field stock), and whether the sample originated from pre-plant stock (boxed sample) or from the field. All other information pertaining to the samples will be retained by the grower.

Growers will be encouraged to sample 2% of bare root stock or up to 40 samples per lot (or field) in pre-plant raspberries. Growers will be educated about *P.f.r.* symptoms and habitats in order to provide samples from the field that are suspect of *P.f.r.* infection. Samples will be submitted and retained at the Ag Central office of the Washington Red Raspberry Commission in Lynden, WA. Investigators will process samples by protocols defined by the diagnostic lab in preparation for shipment. For every 50 plant samples, a control plant known to be infected with *P.f.r.* will be included with the shipment to provide Quality Assurance. Grower participation and lab costs will determine the amount of samples to be submitted. Growers will be expected to pay 30% of the lab fee.

Samples will be shipped to a diagnostic lab with PCR-ELISA capabilities for identifying *Phytophthora* species. The Washington State Department of Agriculture Lab Services Division in plant pathology and Oregon State University Plant Diagnostic Labs have indicated that they can undertake sample diagnosis; at the time of this proposal's submission, other alternate diagnostic labs are also being investigated.

Anticipated Benefits and Information Transfer:
Complete lab results will be disseminated to participating raspberry growers. Results will include grower-generated codes, county, raspberry variety, field age and sample origin from pre-plant root stock or field stock. Test results, using codes known only to the submitting grower, will be published on the Internet as a way to inform the industry of the source (propagule or field), magnitude and distribution of this pest at the county level.

Gaining knowledge of *P.f.r.* presence will empower growers to make pest management decisions based on risk assessments without solely relying on prophylactic pesticide management. Pest management tactics for raspberry root rot will be re-evaluated based on survey results. Results could redirect growers' strategies for managing root rot in raspberry production.

Compilation of this survey data is of itself an outcome that does not currently exist. This survey is an attempt to identify whether *P.f.r.* is a pre-, post-planting or mutual problem for raspberry growers. Results will be disseminated and discussed with growers through e-mail newsletters, reports, breakfast meetings, workshops and WSU Whatcom County's website. Pending results are unknown however, outcomes of survey results will impact pre-planting cultural methods to avoid *P.f.r.* infestations if positive samples are identified in pre-plant root stock or change fungicide pesticide usage on virgin land if no infected root stock are identified. The results of this survey should drive changes by growers in knowledge, attitudes and practices regarding *Phytophthora* root rot management, including avoidance. Follow up surveys with participating growers will seek to evaluate changes in management practices. Grower responses may be useful for directing future studies of root rot management in red raspberry.

Budget
Request for FY 2005-2006

Time-Slip	7,000.00
Employee Benefits	1,120.00
Operations (goods & services)	31,380.00
Travel	500.00
Total:	40,000

Budget Details
Time-Slip
One technical assistant III will be supported for 350 hours of work throughout the project. Work will include developing, preparing and providing education, sample processing and preparation, and data management and summarizing.
Wages: $7,000.00

Benefits
Employee benefits are calculated at 16% of time-slip

Operations (goods & services)
Sampling supplies include field supplies such as bags, coolers, storage, refrigeration equipment and labeling equipment totaling $1,500.00. $2,500.00 is budgeted for shipping of samples to the diagnostic lab. $27,380.00 is allocated for services for PCR identification with the diagnostic lab. With an estimated cost of $70 per sample, the budget would allow for at least 390 samples to be submitted.

Travel
$500.00 is allocated for travel reimbursement of investigators to travel to the field and aid in sample submission, processing and educational efforts.

Literature Review

Bonants, P., M. Hagenaar-de Weerdt, M. van Gent-Pelzer, I. Lacourt, D. Cooke and J. Duncan. 1996. Detection and identification of *Phytophthora fragariae* Hickman by the polymerase chain reaction. *Europ. Journ. Plant Path.* 103:345-355.

Bristow, P. R. 1980. Raspberry root rots in the Pacific Northwest. *Acta Hort.* 112: 33-38.

Cooke, D.E.L., A. Drenth, J.M. Duncan, G. Wagels and C.M. Brasier. 2000. A molecular phylogeny of *Phytophthora* and related oomycetes. *Fungal Genetics Biol.* 30:17-32.

Duncan, J.M. and D.E.L. Cooke. 2002. Work on Raspberry Root Rot at the Scottish Crop Research Institute. pp. 271-276. In R.M. Brennan et al. (eds) Proc. 8th Internat'l Rubus and Ribes Symposim.*Acta Hort.*585(1)427 pp.

Menzies, G. 1999. Crop profile for red raspberries in Washington State. http://www.tricity.wsu.edu/~cdaniels/profiles/rsprev.pdf

Olsson, C.H.B. and N. Heiberg. 1997. Sensitivity of the ELISA test to detect *Phytophthora fragariae* var. *rubi* in raspberry roots. *J. Phytopathology* 145:285-288.

Ristaino, J.B., M. Madritch, C.L. Trout and G. Parra. 1998. PCR amplification of ribosomal DNA for species identification in the plant pathogen genus *Phytophthora*. *Appl. & Environ. Microbiol.* 64(3):948-954.