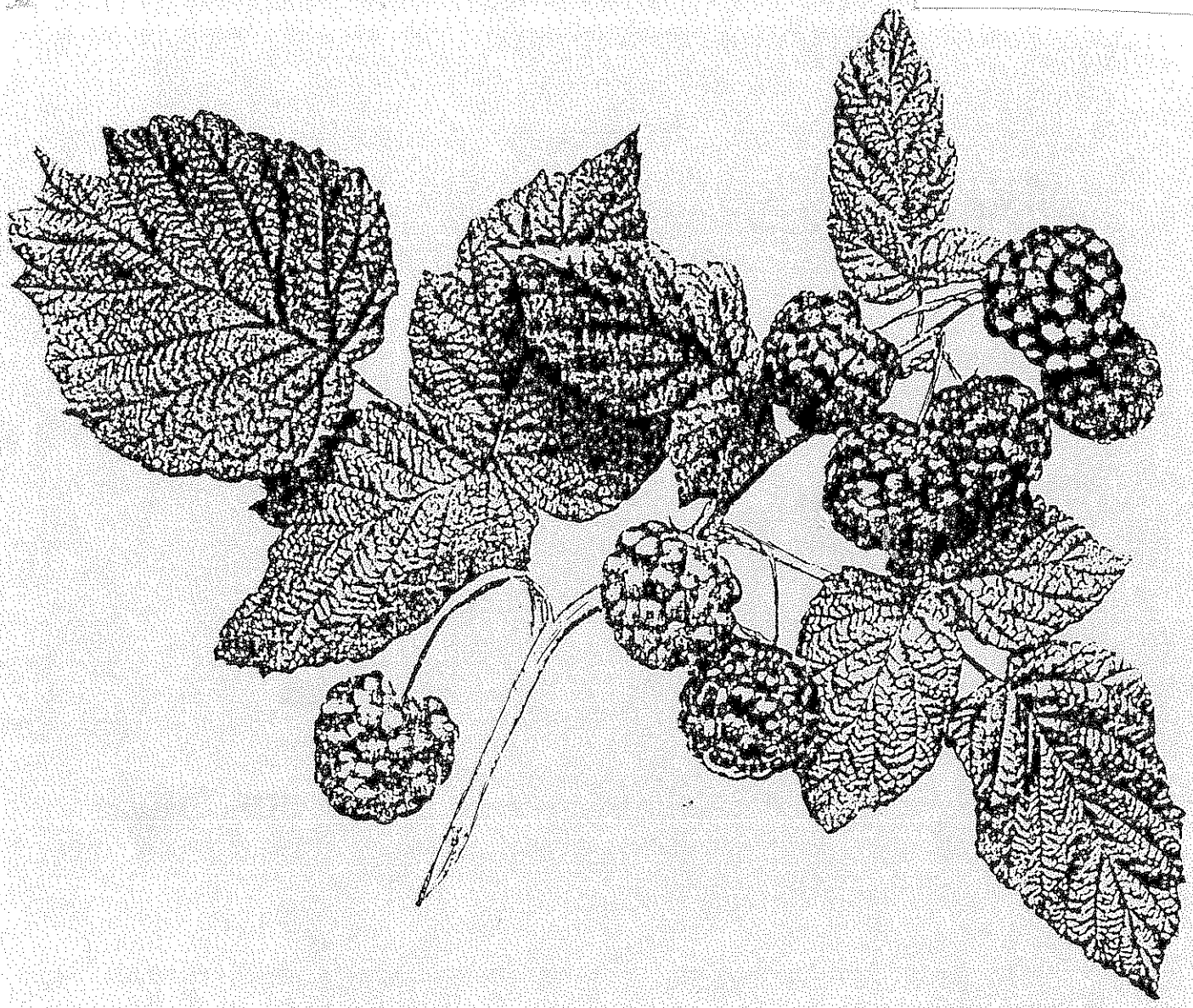

2003

RED RASPBERRY RESEARCH PROPOSALS

2002 PROGRESS REPORTS

to the

WASHINGTON STATE RED RASPBERRY COMMISSION

WASHINGTON RED RASPBERRY COMMISSION
BOARD OF DIRECTORS
2002-2003

Ralph Minaker, President
6862 Nooksack Rd.
Everson, WA 98247
360-966-5645
Fax 966-5645

Rob Dhaliwal
722 Vine Street
Lynden, WA 98264
360-318-8501
Fax 318-8501
rdhaliwall@earthlink.net

Brad Rader
1270 E. Badger Rd.
Lynden, WA 98264
360-354-6574
Fax 354-7070
brad@raderfarms.com

Tena Ondeck
2096 Halverstick Rd.
Lynden, WA 98264
360-988-6324
Fax 988-4304
ondeck@earthlink.net

Derrick Youngquist
16402 Jungquist Rd.
Mount Vernon, WA 98273
360-424-7220
Fax 424-7225
MJBerry@Fidalgo.net

Mary Beth Lang
WSDA
PO Box 42560
360-902-1812
Fax 902-2092
mblang@agr.wa.gov

Glenn Sakuma
17400 Cook Rd.
Burlington, WA 98233
360-661-4168
Fax 757-6611

Jerry Dobbins
1405 Goerig Rd.
Woodland, WA 98674
360-225-8556
Fax 225-4946
Cell 607-2445

Jon Cotton
3808 NE 152 Ct.
Vancouver, WA 98682
360-606-6961
Fax 256-0195
FOCOTTON@aol.com

Henry Bierlink, Executive Director
1796 Front Street
Lynden, WA 98264
360-354-8767
Fax 354-0948
waredberry@aol.com

Thomas J. Payne, Marketing Director
TJP Market Development
865 Woodside Way
San Mateo, WA 94401
650-340-8563
tpayne@tjpmd.com

Tom Peerbolt, Reasearch Coordinator
Peerbolt Crop Management
5261 North Princeton St.
Portland, OR 97203
503-289-7287
Fax 289-7229
Tom@Peerbolt.com

TABLE OF CONTENTS

ONGOING PROJECTS

PAGE

Moore, Patrick

Red raspberry breeding, genetics and clone evaluation **1-9**

Progress Report 1-5

Proposal 6-8

Current & Pending Support 9

Moore, Patrick and Martin Nicholson

Advanced testing of WSU of raspberry selections at Vancouver Research and Extension Unit **10-12**

Progress Report 10

Proposal 11-12

Moore, Patrick and Gary Moulton

Advanced testing of WSU raspberry selections at Mount Vernon Research and Extension Unit **13-14**

Progress Report 13

Proposal 14

Kempler, Chaim, Brian Harding, and Hugh Daubeny

Red raspberry cultivar development for the Pacific Northwest **15-26**

Progress Report 15-23

Proposal 24-26

Bristow, Peter and Gwen Windom

Investigating rates and sources of gypsum to reduce damage from Phytophthora root rot in an integrated control program **27-32**

Progress Report 27-28

Proposal 29-30

Current & Pending Support 31-32

Tanigoshi, Lynell, Jeanette Bergen, and Todd Murray

Insect and mite control in red raspberry **33-39**

Executive Summary 33

Progress Report 34-35

Proposal 36-38

Current & Pending Support 39

Tanigoshi, Lynell, Carol Miles, Martin Nicholson, Peter Bristow, Patrick Moore, and Timothy Miller

***Acquisition of a mechanical red raspberry harvester for WSU Vancouver Research and Extension Unit*.....40-42**

Proposal.....40-41

Current & Pending Support.....42

Miles, Carol and Madhu Sonde

***Guide for integrated raspberry management in the Pacific Northwest*.....43**

Report.....43

Bristow, Peter and Gwen Windom

***Gray mold fruit rot (Botrytis cinerea): field evaluation of new fungicides and timing of fungicide applications based on the stage of flower and berry development*.....44-47**

Termination Report.....44-47

Miller, Timothy, Steve Klauer and Martin Nicholson

***Caneburning and weed control in red raspberries*.....48-52**

Termination Report.....48-52

Miles, Carol, Peter Bristow, and Martin Nicholson

***Organic management of raspberry root rot*.....53-55**

Termination Report.....53-54

Current & Pending Support.....55

NEW PROJECTS

Bristow, Peter, Gwen Windom and Todd Murray
***Gray mold fruit rot (Botrytis cinerea): field evaluation of new fungicides and the effect of fungicides on mite populations in red raspberry*.....56-58**
Proposal.....56-58

Murray, Todd A. and Craig B. MacConnell.....
***Threshold development and monitoring of the western raspberry fruitworm, Byturus unicolor*.....59-61**
Proposal.....59-60
Current & Pending Support.....61

Miller, Timothy and Brian Maupin
***Weed control in red raspberries*.....62-64**
Proposal.....62-63
Current & Pending Support.....64

Miles, Carol, Peter Bristow, and Martin Nicholson
***Organic management of raspberry root rot*.....65-66**
Proposal.....65-66

Summary
Budget Requests

Ongoing Projects

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

New Projects

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

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: 2002

Accomplishments:
In 2002, 90 crosses made in 2002 for cultivar development. No seedlings were planted at Puyallup in 2002, but seed from 77 crosses were saved for sowing in 2003. There will be seed of 167 crosses available for sowing in 2002-03. Sixty-two selections were made among the over 10,000 seedlings planted in 1999 and 2000. Thirty-one of the selections have a RBDV resistant parent or possibly resistant parent. Forty-two of the selections have a root rot resistant parent. Fifty-four of the 62 selections have either a RBDV or root rot resistant parent and 19 have both RBDV and root rot resistant parents. Fifty-two selections were made among the almost 3,200 seedlings planted in 1999, with 25 selections made in 2001 and 27 selections in the same seedling field in 2002. There were 6,900 seedlings planted in 2000 and 35 selections were made among these seedlings in 2002. Additional selections will be made in 2003 among the seedlings planted in 2000. A non-replicated planting was established with a cooperating grower in Lynden for evaluation of machine harvestability. Fifty WSU selections, 16 BC selections and 4 cultivars were planted in 10 plant plots. Because the initial plants were small greenhouse grown tissue culture plants, many plants, although very healthy and growing vigorously, will not be large enough to machine harvest in 2003. This planting will be harvested in 2004 for the first time. The 50 WSU selections plus an additional 10 selections (germplasm selections) were planted in single plots at WSU Puyallup for observation, these will not be harvested but will be used in crosses and for possible future propagation.

The 1998 replicated planting was harvested for the second time in 2002 (Table 1). The average yield in 2002 was 7.4 t/a compared to 10.0 t/a in 2001. All clones had lower yield in 2002 than 2001, except Cascade Delight (WSU 1090). The clones with the highest yield in 2002 were Cascade Delight, Cascade Nectar (WSU 1129), WSU 1253 and WSU 1226. The clones with the highest two-year total yield were Cascade Nectar and WSU 1253, both over 20 t/a. WSU 1201 is the only selection that has a RBDV resistant parent (Schonemann). WSU 1201 and WSU 1253 are being propagated for planting in a new machine harvesting trial. WSU 1226 was not harvested last year, because of rough fruit and difficult harvest. Several growers were interested in this selection for fresh market use. It appeared to have poor bud break and was being affected by root rot. However, it still had one of the highest yields. Many of the early season fruit had split receptacles and rough fruit. Later season fruit was much more acceptable. Fruit of WSU 1226 was very large, averaging 6.0 g over the season, with some individual fruit over 13 g. It also was very firm, averaging 304 g. WSU 1226 is being propagated for small-scale grower trial in 2003.

The 1999 replicated planting was harvested for the first time in 2002. Only 88 of the 168 plots were harvested in 2002. The average yield was 8.0 t/a. WSU 1309 had the highest yield with 11.8 t/a and WSU 1112 had 10.5 t/a. Single plots of WSU 1313 and Qualicum also had high yields. WSU 1309 will be propagated for planting in a new machine harvesting trial and WSU 1112 was planted in the 2002 machine harvesting trial. WSU 1112 had high yields of large firm fruit that releases easily. After a brief period of hot weather, WSU 1112 had many "sunburned" fruit. After this, normal fruit was produced. WSU 1068 had a midpoint of harvest slightly earlier than Willamette and produced 30% greater yield. However, fruit of WSU 1068 is not machine harvestable. There is interest in WSU 1068 for fresh market uses. If acceptable after grower trial, it will be released as a new cultivar.

The 2000 replicated planting will be harvested for the first time in 2003. This planting is in an area with a high level of root rot. Many of the plots are weak or have died. Several selections have all plots growing vigorously. WSU 1162 and four other selections from the same cross are very vigorous in this planting. WSU 1162 and WSU 1182 (apparently root rot resistant) were planted in the machine harvesting trial in Lynden this spring. They will be evaluated for machine harvestability beginning in 2004. The other selections from that cross will be planted in the 2003 machine harvesting trial.

Publications/Presentations:

Finn, C. E., F. Lawrence, G. Langford, P.P. Moore, B. Yorgey and B. Strik. 2001. Lewis Raspberry. HortScience 36:1155-1158.

Finn, C., H. Swartz, P.P. Moore, J.R. Ballington, and C. Kempler. Use of 55 Rubus species in four North American Breeding Programs-Breeders Notes. Acta Hort. (accepted)

Burrows, C and P.P. Moore. Genotype x Environment Effects on Raspberry Fruit Quality. Acta Hort. (accepted)

Moore, P.P., C. Burrows, J. Fellman and D.S. Mattinson. Genotype x Environment Variation in Raspberry Fruit Aroma Volatiles. Acta Hort. (accepted)

January, 2002. Strawberry and Raspberry fruit display. Northwest Food Processors, Portland, OR.

July 2002. Raspberry Field Day, Puyallup, WA.

July 2002. Small Fruit Open House, Mt. Vernon, WA

August 2002. Vancouver Field Day, Vancouver, WA

Cultivar Releases:

Cascade Delight Raspberry, patent pending

Cascade Nectar Raspberry

Table 1. 2001-2001 harvest of 1998 planted raspberries, Puyallup, WA

	Yield (t/a)			Cull fruit (%)		Fruit weight (g)		Fruit firmness (g)		2002 Harvest Season			
	2002	2001	Total	2002	2001	2002	2001	2002	2001	5%	50%	95%	Length of season (days)
C Delight	9.1 a	8.6 bc	17.7 ab	26.9 a	2.8 a	4.9 b	4.9 a	246 b	197 ab	7/9 a-c	7/21 bc	8/1 a-c	23 b
C Nectar	8.6 a	12.3 a	20.9 a	19.5 a-c	2.1 a	3.1 ef	3.3 c-e	160 g	132 d	7/7 bc	7/21 bc	8/2 ab	26 ab
WSU 1253	**8.4 a**	**12.1 ab**	**20.5 a**	**22.6 a-c**	**0.6 a**	**2.9 f**	**3.1 e**	**191 e-g**	**185 a-c**	**7/8 a-c**	**7/21 bc**	**8/1 a-c**	**24 ab**
WSU 1226	**8.3 a**			**19.6 a-c**		**6.0 a**		**304 a**		**7/14 a**	**7/27 a**	**8/8 a**	**25 ab**
WSU 1250	7.9 a	9.8 a-c	17.7 ab	24.4 a	2.8 a	3.3 ef	3.3 c-e	219 b-e	178 bd	7/3 cd	7/16 c	7/27 bc	24 ab
Meeker	7.4 a	8.5 bc	15.9 ab	13.2 bc	0.6 a	3.1 ef	3.5 c-e	200 d-g	176 bd	7/10 a-c	7/22 b	8/2 ab	23 b
Tulameen	7.0 a	9.9 a-c	16.9 ab	23.5 ab	2.1 a	4.0 cd	4.4 a	205 c-f	185 a-c	7/5 cd	7/20 bc	8/4 a	30 a
WSU 1210	6.6 a			24.1 ab		4.4 bc		238 bc		7/13 ab	7/25 ab	8/6 a	24 ab
WSU 1219	6.6 a	10.5 a-c	17.1 ab	18.3 a-c	1.6 a	3.8 de	4.1 bc	235 b-d	223 a	7/13 ab	7/24 ab	8/4 a	22 b
WSU 1201	**6.5 a**	**11.5 ab**	**18.0 ab**	**17.5 a-c**	**1.6 a**	**3.4 d-f**	**4.1 b-d**	**207 c-f**	**182 a-d**	**7/10 a-c**	**7/23 ab**	**8/6 a**	**27 ab**
Willamette	6.1 a	7.8 c	14.0 b	10.8 c	2.1 a	3.3 ef	3.3 de	182 fg	147 cd	6/29 d	7/10 d	7/25 c	26 ab
WSU 1252	6.1 a	9.5 bc	15.6 ab	25.0 a	1.0 a	3.0 f	3.4 c-e	190 e-g	180 a-d	7/12 ab	7/24 ab	8/7 a	26 ab
Average	7.4	10.0	17.4	20.4	1.7	3.77	3.74	215	179	7/8	7/21	8/2	25

Table 2. 2002 harvest of 1999 planted raspberries, Puyallup, WA

	Yield (t/a)	Cull Fruit (%)	Fruit Weight (g)	Fruit firmness (g)	2002 Harvest Season 5%	50%	95%	Length of season (days)
WSU 1309	11.77 a	9.28 a	3.82 a-e	211 c-i	7/5 b-i	7/18 c-h	7/31 b-h	26 a-g
WSU 1313[1]	11.18	23.4	3.74	215	7/6	7/21	8/5	30
WSU 1112	10.50 ab	18.27 a	4.49 ab	286 a	7/8 a-f	7/22 a-e	8/4 a-c	27 a-g
Qualicum[1]	10.34	17.4	4.46	223	7/5	7/17	7/31	26
WSU 1307	10.08 a-c	17.92 a	3.82 a-e	211 c-I	7/2 e-j	7/17 c-h	7/31 b-g	29 g
WSU 1290	9.19 a-d	9.49 a	2.90 ef	230 b-f	7/12 ab	7/23 ab	8/3 a-d	23 a-g
WSU 1300[1]	8.84	16.8	4.39	262	7/8	7/23	8/6	29
Meeker	8.68 a-d	14.57 a	2.89 ef	190 e-k	7/11 a-c	7/22 a-c	8/2 a-f	23 b-g
WSU 1297	8.60 a-d	16.48 a	3.98 a-d	218 c-g	6/30 h-j	7/12 g-j	7/27 d-k	27 a-g
WSU 1306	8.57 a-d	6.71 a	3.75 a-e	215 c-h	7/10 a-d	7/20 b-g	7/30 b-i	20 d-g
WSU 1302	8.55 a-d	11.08 a	3.25 c-f	214 c-h	6/28 j	7/11 h-j	7/25 g-l	27 a-f
WSU 1296	8.37 a-d	10.29 a	3.57 b-f	176 g-k	7/14 a	7/25 a	8/8 a	25 a-g
WSU 1314	8.35 a-d	15.96 a	4.02 a-e	214 b-g	7/9 a-e	7/22 a-d	8/4 a-d	26 a-g
WSU 1319	8.28 a-d	9.82 a	3.09 c-f	177 g-k	7/3 e-j	7/16 d-i	7/28 d-k	25 a-g
WSU 1289	8.24 a-d	14.94 a	3.35 c-f	187 f-k	7/3 e-j	7/16 d-i	7/29 c-j	25 a-g
WSU 1324	8.16 a-d	18.44 a	2.99 d-f	176 g-k	7/5 c-i	7/18 b-g	7/30 b-i	25 a-g
WSU 1068	8.07 a-d	8.43 a	3.61 a-f	198 d-k	6/28 ij	7/9 ij	7/23 I-L	25 a
WSU 1293	8.04 a-d	12.22 a	2.68 f	186 f-k	7/4 d-j	7/18 b-g	7/30 b-i	26 b-g
Tulameen	7.96 a-d	14.56 a	4.08 a-c	208 c-j	7/6 b-h	7/19 b-g	8/4 a-c	28 ab
WSU 1090	7.70 a-d	16.24 a	4.07 a-c	217 c-h	7/6 b-h	7/19 b-g	7/31 b-h	25 a-g
WSU 1322	7.62 a-d	15.12 a	4.71 a	255 a-c	7/8 a-e	7/20 a-g	8/3 a-e	25 a-g
WSU 1333	7.59 a-d	10.63 a	3.17 c-f	174 g-k	7/9 a-e	7/22 a-f	8/4 ab	27 a-e
WSU 1275	7.38 b-d	7.88 a	2.91 ef	157 k	7/3 e-j	7/12 g-j	7/25 h-l	22 a-g
WSU 1301	7.13 b-d	9.16 a	3.81 a-e	200 e-k	7/1 g-j	7/15 f-i	7/27 f-k	26 a-c
WSU 1323	7.00 b-d	11.62 a	3.29 c-f	266 ab	7/5 c-i	7/19 b-g	7/31 b-g	26 a-f
WSU 1321	6.93 b-d	15.69 a	4.46 ab	237 a-e	7/7 b-g	7/19 b-g	7/31 b-g	24 a-g
WSU 1283	6.86 b-d	11.10 a	3.50 b-f	162 jk	7/4 d-j	7/16 f-i	7/29 b-i	25 e-g

WSU 1325	6.63 b-d	13.92 a	3.63 b-f	202 e-k	7/5 c-i	7/17 c-h	7/31 b-h	26 a-g
BC 89-2-89[1]	6.62	24.4	3.02	240	7/9	7/25	8/4	26
WSU 1274	6.50 b-d	11.50 a	3.83 a-e	252 a-d	7/7 b-f	7/20 b-g	8/2 b-f	25 a-d
WSU 1303	6.18 b-d	9.02 a	2.85 ef	165 l-k	6/28 j	7/7 j	7/19 l	21 a-e
Willamette	6.12 cd	8.61 a	3.02 c-f	169 h-k	7/2 f-j	7/11 h-j	7/22 k-l	20 fg
WSU 1277	5.09 d	14.90 a	3.67 a-e	179 g-k	7/2 f-j	7/11 h-j	7/22 j-l	21 c-g
WSU 1276	4.88 d	13.46 a	3.01 d-f	230 b-f	7/5 b-i	7/16 e-l	7/27 d-k	22 c-g
Average	8.00	13.51	3.58	209	7/5	7/17	7/30	25

[1] only a single plot was harvested for WSU 1313, Qualicum, WSU 1300 and BC 89-2-89. All other values represent means of 3 plots of 3 plants.

Project: 13C-3755-5641
Title: Red Raspberry Breeding, Genetics and Clone Evaluation
Year Initiated:2000
Current Year:2003
Terminating Year:2004
Personnel: Patrick P. Moore, Scientist,
WSU Puyallup Research and Extension Center, Puyallup, WA

Justification: The Pacific Northwest (PNW) raspberry industry is dependent upon the research programs that 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.

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 which 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 (8 acres of seedlings, 2 acres of replicated yield plots and 1 acre of breeding plots) will be maintained. Plants in the greenhouse and screenhouses will be maintained.

2. Crosses will be made for summer fruiting cultivar development. Primary criteria for selecting parents will be RBDV resistance, root rot tolerance, and yield. Other traits are ease of fruit removal, fruit firmness, fruit size, fruit color, harvest season, fruit rot resistance, and growth form.

3. Seed from crosses made in 2001 and 2002 will be sowed in 2003. There were 87 crosses stored from 2001 and 90 crosses made in 2002 for a total of 177 crosses to be sowed in 2002-03. Because of limitations on field space, fewer plants per cross will be planted. Depending on germination rates, there should be 6,000-9,000 seedlings planted.

4. Selections will be made among the seedlings planted in 2000 and 2001. 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 2002 will be propagated for testing. Shoots of all selections will be collected and placed into tissue culture. Selections that are not established in tissue culture will be propagated

by root cuttings and grown in the greenhouse. Shoots will then be collected from these plants for tissue culture propagation.

6. Ten plants of each of the selections in #5 above will be planted in a grower planting for machine harvesting evaluation. It is estimated that about 40 WSU selections will be planted in the field in 2003. Three plants of each selection will also be planted at WSU Puyallup for observation, use as a parent or future propagation.

7. The replicated plantings established in 1999 and 2000 at WSU Puyallup will be harvested for yield, fruit weight, fruit rot and fruit firmness.

8. Plants will be multiplied in tissue culture and propagated for testing at other locations and grower trials. WSU 1068, WSU 1112, WSU 1161, WSU 1162 and WSU 1226 are currently being propagated by commercial propagators and may be available for grower trial in 2003.

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

Anticipated Benefits and Information Transfer:
This program will develop new raspberry cultivars that are more productive or more pest resistant. Such cultivars may result from crosses made this year or may already be under evaluation. As a result of reduced funding, previously developed material will not be evaluated until sufficient funding is obtained.

Proposed Budget: For 2003-2004 I will keep my request to the WRRC at $48,000 even though personnel expenses have increased. As a result of budget reductions from WSU, the 2003-04 budget request to the WRRC includes $7,913 more for salaries and benefits for support staff. Funding at this level will actually result in less support (2.6 FTE for the total breeding program) for 2003-04 than the program had in 2002 (3.0 FTE). This budget represents reductions of $5,000 for timeslip, $800 for timeslip benefits, and $2,000 for materials. I do not know where I will be able to make savings of this size.

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

Budget:		**2002-2003**	**2003-2004**
00 Salaries			
Plant Tech II	0.15 FTE	$5,250	$5,250
Agr. Res. Tech. I	0.30 FTE	10,023	10,024
Agr. Res. Tech. II	0.20 FTE	0	5,653
Lab Tech.	0.10 FTE	3,048	3,040
01 Timeslip Labor		18,000	10,000
03 Service and Supplies		4,997	3,464
04 Travel		500	400
07 Benefits			
Plant Tech II		1,418	1,449
Agr. Res. Tech. I		3,960	4,090
Agr. Res. Tech II		0	2,109
Lab Tech 0.10 FTE		924	921
Timeslip		2,880	1,600
Total		**Requested $51,000**	**$48,000**
		Funded $48,000	

Current & Pending Support

Name (List PI #1 first)	Supporting Agency and Project #	Total $ Amount	Effective and Expiration Dates	Title of Project
Moore, P.P.	**Pending:** Oregon Raspberry and Blackberry Commission	$2,500	2002-2003	Development of New Raspberry Cultivars for the Pacific Northwest

Project: 13C-3755-7641

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

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

Reporting Period: 2002

Accomplishments:
A new raspberry planting was established in 2001 at WSU Vancouver that was designed for machine harvesting evaluations. The new planting included Cowichan (BC 87-14-20), WSU 1068, Cascade Delight (WSU 1090), WSU 1112, WSU 1161, WSU 1162 and Meeker as a standard. WSU 1161 will be trained to both a conventional trellis system and a split trellis system. The WSU 1112 plots did not establish and will be omitted from this planting.

Publications:
Vancouver Field Day August 2002.

Project: 13C-3755-7641
Title: Advanced Testing of Washington State University Raspberry Selections at Vancouver Research and Extension Unit

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

Year Initiated: 1996
Current Year: 2003
Terminating Year: 2004

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

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

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

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

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

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

2. The station now has a current Littau harvester and can evaluate the machine harvestability of selections. The planting established in 2001 will be harvested in 2003 and yield and fruit weight measured.

The primary objective of future plantings at WSU Vancouver will be to evaluate machine harvestability of selections.

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

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

Budget:	**2002-2003**	**2003-2004**
01 Timeslip Labor	$750	$1380
03 Service and Supplies	130	100
07 Benefits	120	220
Total	**$1,000**	**$1,700**

Project: 13C-3755-8641

Title: Advanced Testing of Washington State University Raspberry Selections at Mt. Vernon Research and Extension Unit

Personnel: Patrick P. Moore, Scientist, WSU Puyallup
Gary Moulton, Scientific Assistant, WSU Mt. Vernon.

Reporting Period: 2002

Accomplishments:
A planting of 12 clones was established at WSU Mt. Vernon in 2000. It has been maintained since then, but in 2002 was converted into a demonstration planting. Subjective evaluations were made, but no harvest data collected. WSU advanced selections in this planting are: WSU 1068, WSU 1112, WSU 1161 and WSU 1162.

Publications:
Berry Field Day at WSU Mt. Vernon, July 18, 2002

Project: 13C-3755-8641

Title: Advanced Testing of Washington State University Raspberry Selections at Mt. Vernon Research and Extension Unit

Personnel: Patrick P. Moore, Scientist, WSU Puyallup;
Gary Moulton, Scientific Assistant, WSU Mt. Vernon.

Year Initiated: 1996
Current Year: 2003
Terminating Year: 2004

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

Objectives:
1. To establish and maintain a demonstration raspberry planting at WSU Mt. Vernon Research and Extension Unit.

Procedures:
This is an ongoing project that depends on continuity of effort. Each year promising selections are propagated for possible grower trial. When promising selections are identified, they will be added to the demonstration planting.

A new replicated planting of 12 raspberry clones was established in 2000. It includes WSU 1068, WSU 1112, WSU 1161 and WSU 1162, selections that have performed well at WSU Puyallup, but have not been adequately tested at WSU Mt. Vernon. In 2002, three of the replications were removed and this planting was converted to a demonstration planting and no data collected.

Additional WSU clones, WSU 1068, Cascade Delight, Cascade Nectar, WSU 1099, and WSU 1226 will be added to the existing planting. Additional advanced selections will be added to the planting as plants are available.

Anticipated Benefits and Information Transfer:
This program will develop new raspberry cultivars, which are more productive or more pest resistant. Such cultivars may result from crosses made this year or may already be under evaluation. The objective of this project is to make final evaluations of the most promising selections and to evaluate material from other programs. Research results will be communicated at grower meetings, commission meetings, and field days.

Proposed Budget:
Support is requested for maintenance raspberry plots at WSU Mt. Vernon. This will include obtaining posts, wire, and herbicides.

Budget:	**2002-2003**	**2003-2004**
01 Timeslip Labor	300	$300
03 Service and Supplies	152	152
07 Benefits		
Timeslip	48	48
Total	**$500**	**$500**

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/english/1agassiz/crop_science/kempler.htm

Reporting period: 2002

Funding in 2001/2002 was received from the BC Raspberry Industry Research Council, Washington Red Raspberry Commission, Lower Mainland Horticultural Improvement Association (LMHIA), royalties collected on PARC cultivars and Agriculture and Agri-Food Canada's Matching Investment Initiative (MII).

Accomplishments: In 2002 approximately 1,700 new seedlings were planted from 117 crosses made in 1999, 2000 and 2001. Prior to planting in the field they were all evaluated for resistance to the aphid *Amphorophora agathonica* which is the vector of the raspberry mosaic virus (RMV). Forty-seven new crosses were made with RBDV resistance clones. Sixty PARC selections were planted in replicated and unreplicated plots. Seven of these were advanced selections and fifty-three were new selections being planted in the field for the first time. Sixteen other clones were also planted. These included control varieties as well as new releases and advanced selections from other breeding programs. In 2002 270 plots were sampled and tested for the presence of RBDV, 38 selections were tested positive and most of them will be eliminated. The selection field planted in 2000 was observed for the first time and some selections were made however those will be evaluated again next year.
During the 2002 harvest season the 1996, 1997, 1998, 1999 and 2000 plantings were evaluated. Data on yield, fruit traits and harvest season is presented in tables 1 to 4.

Notes on cultivars and potential new cultivars:

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

Malahat (Meeker x BC/SCRI 7853/116)
Produces high yields of large, firm fruit that ripens up to a week earlier than any other recommended variety and is well suited to the fresh market. It should be particularly useful for the early fresh market where early production and good quality are important. Malahat is suitable for machine harvesting producing a high quality IQF and processing crop. Malahat is very suited for switching between hand and machine harvesting depending on the season and labour availability. Because Malahat ripens earlier than Meeker, it has allowed the producer a longer

harvest season and a better utilisation of harvesting equipment. Plants of Malahat are susceptible to root rot, therefor it should be planted on well-drained soil that is free of root rot. Malahat should be planted on raised beds to provide a better-drained root zone. Canes have small spines over most of the cane surface. Laterals are short. Fruit is very easy to harvest. It is susceptible to RBDV but the rate of infection appears to be slow. Malahat is resistant to the aphid vector of the raspberry mosaic virus complex.

Cowichan [BC87-14-20 (Newburgh x Qualicum)]
The most 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 x 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. The combination between Newburgh and Qualicum resulted in Cowichan that is productive, has large fruit size and good fruit quality and vigorous growth habit. The variety is very fast to establish and produce high yield after the first planting year. Although it has not been confirmed and more testing is needed, Cowichan plants tested in greenhouse trials showed a very good resistance to root rot. In the research plots it was very vigorous, fast to establish and producing moderate yields higher or similar to the yield of Meeker (Tables 1). In a grower's field trial, although exposed to RBDV, it has tested negative to RBDV, while Meeker and other PNW varieties grown in the same field have shown very high infection rate. It can be assumed that Cowichan is resistance to RBDV. In large-scale growers trial it showed that it is very suitable for mechanical harvesting. It produces an acceptable yield of large fruit that ripens a few days earlier then Meeker and fruit that appears to be suitable for IQF. Cowichan fruit is soft and appears to be not suited for long distance shipping and the fresh market. 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*).
BC89-2-89 (Comox x Glen Ample)
Produces high yields of large fruit that are firm and well adapted for fresh market and IQF. The selection is a cross between Comox and the Scottish variety Glen Ample. Fruit will ripen later than any other PNW recommended variety. Fruit is larger than Tulameen, light in colour with large droplets. The plant is a very vigorous, with strong spineless canes and strong long upright lateral. It is not recommended for machine harvest. The fruit is very meaty, having and large drupelets that tend to break upon harvest. It is not resistant to RBDV but appears to have slow rates of infection. It is susceptible to cane botrytis (*B. cinerea*) and its reaction to root rot is unknown.
BC89-33-84 (BC82-5-84 x Tulameen)
A mid season processing and fresh market type that produces attractive dark berries with some resistance to fruit rot. The fruit is easy to harvest and in growers' trials has machine harvested well. The fruit is glossy, large, firm, perfect in shape with fine drupelets, and so is very suitable for IQF. The plant has excellent vigour. Its primocanes are green with no spines and its laterals are short and strong with a good upright angle and well spaced fruit. It is not resistant to RBDV but appears to have a slow rate of infection. The selection appears to have some root rot resistance showing some good growth in comparison to Meeker and Malahat.
BC89-34-41 (BC82-5-161 x BC80-28-50)
Selected from a cross between two PARC selections. This is an early fresh market or processing selection producing high yields with fruit size that is slightly larger than Meeker. It is very productive producing some of the highest yields. The glossy, firm excelent quality fruit have fine drupelets and a very pleasant flavour that is comparable to Tulameen. The canes are spineless

with laterals that are short and bend easily without breaking and so are able to carry the high yield. This year in a grower's trial the fruit appeared to release well from the receptacle and did harvest well mechanically, this will require further observations as in 2001 harvest year the comments were made that it did not harvest well. This selection although exposed to high pressure of RBDV for many years has never tested positive and therefor might be resistance. Its pedigree for one parent, 82-5-161 (Algonquin x Chilliwack) suggest a likely susceptible parent. However, the second parent 80-28-50 (Nootka x Glen Prosen) which is a sibling to Tulameen, might be the source of resistance to RBDV inherited from Nootka.

BC90-6-2 (BC86-41-15 x BC83-15-15)

Selected from a cross between a root rot resistant *R. strigosus* derivative and a selection from a cross between Comox and Algonquin. We have noted it for its short internodes, compact plant habit, extremely late production season and its very large meaty fruit. It produces numerous primocanes, but has been rated as being hard to harvest. BC90-6-2 is most suitable for the fresh market due to its long harvest duration, late producing period and large fruit.

New selections for grower trials:

BC90-8-11 (BC86-41-15 x Qualicum)

This is a 3rd backcross from *R. strigosus*. It produces a large mid to late crop that is most suited for the fresh market but might be also excepted for processing. The fruit is large, firm and is well spaced and presented on the laterals. The plant has an upright habit.

BC90-8-20 (BC86-41-15 x Qualicum)

A productive selection that has a mid-season production period with light fruit that is most suitable for the fresh market but also acceptable for IQF and processing. The large low-gloss fruit strongly resembles Qualicum. Plant vigour is not excessive; leaves are large and light. It is resistant to aphids and might be also resistant to the resistant-breaking biotype of aphid.

BC90-11-44 (Algonquin x Qualicum)

This is a very productive selection that produces over an extended harvest season heaving good size fruit that is firm and attractive with very fine drupelets. It is easy to harvest and appears suitable for processing and fresh market.

BC91-17-10 (87-14-35 x Tulameen)

This is a productive selection that although exposed to high pressure of RBDV stayed free of infection producing high quality processing type fruit. The fruit is large, firm, glossy with large drupelets.

BC92-5-1 (Kitsilano x BC86-40-6)

This selection is high yielding and produces a long-shaped, mid-size dark, glossy berry that is most suitable for processing. It has low susceptibility to fruit rot. The plant has light coloured leaves and vigorous canes with long laterals and some spines. This year it has tested positive to RBDV and will be eliminated.

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

Table 1. Yield, fruit weight and harvest dates of raspberry cultivars harvested in 2002, Abbotsford, BC.

Clone	No. of Plots	Total Yield (kg/hill)	Total Yield (t/ha)	Total Yield (ton/a)	Early Yield[z] (%)	Late Yield[y] (%)	Fruit Weight (g)	First Harvest (date)	50% Harvest (date)	Harvest Duration (days)	Harvest Ease[x]
1997 Planting											
89-2-89	2	3.81	13.7	6.1	4.7	29.7	5.0	14-Jul	31-Jul	29	2.7
89-33-84	3	3.50	12.6	5.6	26.3	20.4	3.6	7-Jul	23-Jul	36	1.8
89-34-41	3	4.85	17.4	7.8	25.0	16.8	3.1	7-Jul	25-Jul	31	2.0
91-15-40	3	3.94	14.1	6.3	29.4	11.6	4.7	7-Jul	18-Jul	36	1.9
92-10-27	1	3.82	13.7	6.1	38.9	5.6	3.5	7-Jul	21-Jul	29	1.8
92-5-1	2	4.65	16.7	7.4	22.2	12.7	4.1	7-Jul	21-Jul	36	2.5
92-9-39	2	2.86	10.3	4.6	46.4	1.6	5.0	7-Jul	14-Jul	29	2.5
WSU 1024	1	2.55	9.2	4.1	2.2	29.0	3.8	14-Jul	4-Aug	29	1.8
WSU 1068	1	2.47	8.8	3.9	53.5	5.5	4.2	3-Jul	14-Jul	33	2.0
WSU 1090	1	3.95	14.2	6.3	21.5	13.0	4.5	7-Jul	21-Jul	36	2.5
Chilliwack	2	2.39	8.6	3.8	29.7	5.4	3.5	7-Jul	21-Jul	29	1.7
Malahat	3	3.58	12.9	5.7	54.7	5.2	4.7	5-Jul	14-Jul	33	1.6
Meeker	3	3.50	12.6	5.6	16.1	16.7	3.1	9-Jul	25-Jul	31	2.3
ORUS1025-10	1	2.80	10.0	4.5	6.6	24.7	4.2	14-Jul	28-Jul	29	2.0
ORUS1072-11	1	2.85	10.2	4.6	40.9	1.2	3.6	3-Jul	14-Jul	33	2.0
Qualicum	3	4.23	15.2	6.8	26.3	12.0	5.1	7-Jul	21-Jul	34	1.8
Tulameen	3	3.76	13.5	6.0	16.3	26.8	4.8	9-Jul	25-Jul	38	1.9
1998 Planting											
89-33-84	3	4.30	15.4	6.9	15.8	18.2	3.3	7-Jul	21-Jul	36	1.6
91-17-10	2	5.26	18.9	8.4	16.5	17.3	4.1	7-Jul	24-Jul	36	2.3
91-17-11	1	6.64	23.8	10.6	15.6	29.5	3.9	7-Jul	28-Jul	43	1.7
91-28-4	3	3.07	11.0	4.9	27.9	12.2	3.2	7-Jul	21-Jul	36	2.1
92-6-41	3	3.78	13.6	6.1	28.3	7.0	3.6	7-Jul	21-Jul	29	1.5
Meeker	3	3.53	12.7	5.6	23.3	4.5	3.1	7-Jul	21-Jul	29	2.3
1999 Planting											
87-14-35	3	4.18	15.0	6.7	4.6	52.5	3.4	11-Jul	1-Aug	38	2.0
87-5-1	2	2.71	9.7	4.3	6.7	10.2	4.0	14-Jul	24-Jul	26	1.9
89-2-89	3	3.35	12.0	5.4	8.6	30.4	3.6	11-Jul	28-Jul	31	1.9
89-33-84	2	3.72	13.4	6.0	60.2	2.8	4.0	3-Jul	14-Jul	26	2.0
89-34-41	3	3.33	11.9	5.3	11.0	28.6	2.7	9-Jul	28-Jul	34	1.8
90-6-2	2	5.24	18.8	8.4	10.1	36.3	5.3	10-Jul	28-Jul	40	2.4
90-8-20	2	3.67	13.2	5.9	14.0	8.9	5.1	7-Jul	21-Jul	33	2.3
91-26-26	3	4.06	14.6	6.5	5.8	36.8	3.5	11-Jul	28-Jul	36	1.8
92-5-47	2	4.14	14.8	6.6	30.2	19.0	3.6	10-Jul	21-Jul	26	1.6
93-1-32	2	3.81	13.7	6.1	18.1	10.6	3.2	10-Jul	24-Jul	33	1.7
93-34-18	2	4.58	16.4	7.3	10.2	34.6	3.9	10-Jul	28-Jul	40	2.0
93-36-10	1	2.66	9.5	4.3	47.8	7.0	3.7	7-Jul	14-Jul	29	2.3
93-36-31	2	4.68	16.8	7.5	50.0	7.0	4.3	3-Jul	17-Jul	33	2.3
EM 5928	1	7.25	26.0	11.6	0.5	47.6	3.4	14-Jul	28-Jul	36	2.0
Cowichan	3	3.35	12.0	5.4	17.2	12.4	4.0	9-Jul	23-Jul	31	1.9
Kitsilano	2	4.70	16.9	7.5	4.7	35.8	2.9	14-Jul	28-Jul	29	1.8
Malahat	3	2.89	10.4	4.6	47.3	6.8	4.2	3-Jul	14-Jul	33	1.6
Meeker	3	3.16	11.3	5.1	21.1	11.0	3.2	7-Jul	21-Jul	34	2.1
Qualicum	3	4.19	15.0	6.7	24.7	11.4	4.2	5-Jul	21-Jul	33	1.8
Tulameen	3	4.41	15.8	7.1	17.1	22.9	4.2	7-Jul	21-Jul	41	2.0

Clone	No. of Plots	Total Yield (kg/hill)	Total Yield (t/ha)	Total Yield (ton/a)	Early Yield[z] (%)	Late Yield[y] (%)	Fruit Weight (g)	First Harvest (date)	50% Harvest (date)	Harvest Duration (days)	Harvest Ease[x]
2000 planting											
89-2-89	3	6.03	21.6	9.7	10.2	16.6	4.8	9-Jul	25-Jul	31	1.9
89-33-84	3	3.23	11.6	5.2	25.7	9.7	3.0	5-Jul	21-Jul	33	2.0
89-34-41	3	5.85	21.0	9.4	17.4	12.9	2.8	7-Jul	25-Jul	36	2.2
90-6-2	1	2.89	10.4	4.6	27.5	1.7	2.7	3-Jul	21-Jul	33	2.2
90-8-20	2	5.02	18.0	8.0	35.7	1.2	4.1	5-Jul	21-Jul	31	2.3
91-15-40	3	6.35	22.8	10.2	12.3	13.6	4.2	9-Jul	28-Jul	29	1.9
93-5-41	1	3.05	11.0	4.9	42.1	16.9	4.0	3-Jul	21-Jul	40	2.4
93-15-32		5.04	18.1	8.1	55.3	0.0	3.5				1.3
93-15-37	3	4.80	17.2	7.7	16.5	8.8	4.1	7-Jul	25-Jul	34	1.7
93-15-38	1	6.93	24.9	11.1	33.3	6.0	4.0	3-Jul	21-Jul	33	1.7
93-15-40	3	3.66	13.1	5.9	20.4	6.5	3.3	7-Jul	23-Jul	31	2.3
93-15-41	1	3.53	12.7	5.7	38.5	13.6	3.1	3-Jul	21-Jul	40	1.4
93-18-20	2	3.25	11.7	5.2	20.2	9.7	3.5	7-Jul	21-Jul	33	1.9
93-20-11	2	3.45	12.4	5.5	16.2	23.6	3.6	7-Jul	28-Jul	36	1.9
93-21-26	3	4.26	15.3	6.8	4.6	21.6	3.9	14-Jul	28-Jul	29	2.4
93-22-11	2	3.31	11.9	5.3	35.9	6.5	3.8	3-Jul	21-Jul	37	2.1
93-22-41	3	3.62	13.0	5.8	26.3	11.6	3.9	4-Jul	23-Jul	34	1.9
93-22-62	1	3.46	12.4	5.5	39.2	0.0	4.1	3-Jul	21-Jul	33	2.4
93-23-2	2	6.15	22.1	9.8	17.6	0.5	3.3	7-Jul	21-Jul	29	1.9
93-26-9	1	4.12	14.8	6.6	34.8	4.5	5.5	7-Jul	21-Jul	29	2.3
93-26-13	2	3.61	12.9	5.8	23.7	12.4	4.1	5-Jul	24-Jul	35	3.0
93-26-16	2	2.70	9.7	4.3	48.4	0.0	3.5	3-Jul	14-Jul	26	2.4
93-26-25	3	4.30	15.4	6.9	19.4	16.7	3.8	5-Jul	23-Jul	37	2.1
93-26-63	2	3.78	13.6	6.1	61.6	0.0	4.8	3-Jul	10-Jul	30	2.2
93-27-26	3	4.65	16.7	7.5	12.3	22.9	3.4	11-Jul	28-Jul	31	2.3
WSU 1112	1	5.00	17.9	8.0	1.0	32.6	4.3	14-Jul	28-Jul	29	2.6
Cowichan	4	3.45	12.4	5.5	41.2	4.4	3.8	5-Jul	19-Jul	29	2.0
Kitsilano	1	2.77	9.9	4.4	15.0	0.0	3.1	7-Jul	21-Jul	29	2.0
Malahat	2	3.90	14.0	6.3	54.3	0.8	4.0	3-Jul	14-Jul	30	1.4
Meeker	2	2.66	9.5	4.3	29.5	0.7	2.7	5-Jul	21-Jul	31	2.1
ORUS 1149-2	1	3.06	11.0	4.9	40.0	5.6	3.6	3-Jul	21-Jul	33	2.6
Qualicum	3	4.50	16.1	7.2	27.6	5.6	3.5	5-Jul	21-Jul	33	1.8
Tulameen	3	3.89	14.0	6.2	22.9	14.5	4.0	7-Jul	23-Jul	34	2.0
LSD		1.85	6.6	3.0	16.6	17.5	0.9	5	8	8	NS

Plants were grown in hills with a spacing of 3 ft between plants and a row spacing of 10 ft (3588 plants/ha or 1407 plants/acre).
Plants were pruned to 6 canes per hill and topped to a height of 5 ft.
Data from replicated plots was subjected to analysis of variance,
With least significant difference (LSD) of 5 % used to separate means.

[z] Early yield harvested between July 4 and July 22, 2002.

[y] Late yield harvested after August 12, 2002.

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

Table 2. Fruit traits of raspberry cultivars and selections harvested in 2002, Abbotsford, BC.

Clone	Firmness (g/cm^2)		Soluble Solids Concentration (%)	
	Means	STDEV	Means	STDEV
89-2-89	178	73	8.87	0.92
89-6-12	205	68	6.78	0.64
89-33-84	201	46	10.42	1.17
89-34-41	173	57	9.89	1.11
90-6-02	171	66	7.29	2.11
90-8-20	205	57	10.18	1.13
91-15-40	171	63	8.1	1.27
91-17-10	222	55	8.53	0.70
91-24-12	163	59	9.06	0.83
92-4-11	173	54	8.53	1.23
92-5-01	152	27	8.44	1.51
92-5-47	176	40	7.9	1.28
92-6-17	176	53	9.62	1.23
92-6-41	175	81	10.46	0.65
92-9-39	188	50	8.28	0.67
92-9-57	182	27	7.56	0.84
92-10-39	198	66	8.46	1.00
92-10-53	170	47	8.68	1.03
93-1-32	203	73	8.89	0.65
93-15-37	207	57	10.37	0.74
93-15-40	128	45	9.96	0.96
93-21-26	137	45	10.37	0.83
93-22-41	131	51	9.92	1.22
93-23-02	168	44	9.22	1.03
93-26-13	101	28	11.32	1.04
93-26-63	109	30	10.15	1.47
93-27-26	122	23	10.87	0.90
93-34-18	187	39	9.44	0.88
93-36-10	150	39	6.45	1.09
93-36-31	67	41	7.96	1.20
WSU1090	261	48	10.5	0.75
Chilliwack	212	72	12.13	0.89
Cowichan	175	53	10.18	1.62
Malahat	161	62	10.56	0.92
Meeker	165	77	10.5	0.88
Nootka	129	63	9.79	1.81
Qualicum	189	62	11.52	0.70
Tulameen	184	49	11.37	0.96

Firmness, the force required to close the opening of the fruit, was obtained for 10 fruits.

Table 3. Postharvest fruit rot of raspberry cultivars and selection.

Clone	No. of reps	Fruit Rot (%)	
		48 hrs	72 hrs
87-5-01	4	6.9	30.6
89-2-89	12	12.1	48.4
89-6-12	8	5.6	34.0
89-33-84	8	6.9	37.8
89-34-41	8	9.0	49.3
90-6-02	8	10.4	68.8
90-8-20	12	16.7	60.6
91-15-40	4	5.6	80.6
91-24-12	4	5.6	62.5
92-5-01	4	1.4	56.9
92-9-39	12	6.9	51.9
92-9-57	4	1.4	62.5
92-10-39	4	19.4	56.9
92-10-53	4	8.3	87.3
93-15-37	8	16.0	59.7
93-15-38	4	2.8	52.8
93-15-40	8	6.3	51.4
93-18-20	4	2.8	51.4
93-21-26	8	12.5	56.3
93-22-41	4	0.0	37.5
93-23-02	8	17.4	70.1
93-26-09	4	5.6	69.4
93-26-63	8	26.4	73.6
93-27-26	8	17.4	68.1
93-34-18	4	5.6	26.4
93-36-10	4	9.7	73.6
93-36-31	8	23.6	74.3
Chilliwack	8	2.8	30.6
Cowichan	16	12.5	64.6
Malahat	12	5.6	50.0
Meeker	16	6.9	59.0
Nootka	4	5.6	45.8
Qualicum	12	9.3	63.0
Tulameen	12	16.7	60.2
LSD		9.5	17.1

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

Table 4a. 1999-2002 harvest data for 1996 and 1997 planted raspberries, Abbotsford, BC.

CLONE	Total Yield (t/ha)			Mean Yield (t/ha)
	2001	2000	1999	
1996 planting				
87-11-33	15.9	14.3		15.1
87-12-11	20.3		16.9	18.6
87-12-32	15.8	11.8	11.6	13.1
87-14-16	18.4	19.1	22.6	20.0
87-14-35		18.0	19.2	18.6
87-3-37	10.6	13.8	22.9	15.8
87-5-1	11.6	13.6	14.5	13.2
89-33-84	13.6	16.1	16.0	15.2
89-34-41	18.0	20.5	19.4	19.3
90-11-44	24.6	22.4	23.0	23.3
90-1-42		12.0	18.4	15.2
90-5-30	13.1	15.0	14.9	14.3
90-8-11	18.4	16.9	18.4	17.9
Chilcotin	11.9	10.3	19.6	13.9
Chilliwack	7.7	10.7	12.5	10.3
Comox	14.6	18.0	21.1	17.9
Cowichan	14.4	15.3	14.1	14.6
Elida		11.9	16.1	14.0
Encore		13.6	10.7	12.1
Glen Ample		14.7	27.5	21.1
Glen Clova		13.6	23.6	18.6
Glen Magna		17.0	20.2	18.6
Glen Moy		13.9	22.2	18.0
Glen Prosen		15.2	17.4	16.3
Glen Rosa		13.6	16.0	14.8
Glen Shee		12.0	23.3	17.6
Haida		17.8	22.0	19.9
Kitsilano	20.3	23.8	21.1	21.7
Malahat	14.3	13.2	18.2	15.3
Meeker	11.0	13.2	14.9	13.0
Nootka	8.7	8.8	9.1	8.9
Prelude		10.4	23.3	16.8
Qualicum	16.5	15.9	15.8	16.1
Skeena		8.5	13.6	11.1
Tulameen	12.2	15.5	14.9	14.2
Williamette		10.4	9.6	10.0
LSD 5%	**6.4**	**6.0**	**8.2**	**6.9**

CLONE	Total Yield (t/ha)				Mean Yield (t/ha)
	2002	2001	2000	1999	
1997 planting					
89-2-89	13.7	22.4	22.1	41.1	24.8
89-33-84	12.6	16.8	17.0	16.1	15.6
89-34-41	17.4	24.5	20.1	30.9	23.2
89-6-12	10.3	15.4	12.0	22.7	15.1
89-6-13		15.5	18.8	16.8	17.0
90-8-20		18.0	13.1	28.6	19.9
91-15-40	14.1	16.1	18.7	27.4	19.1
92-10-27	13.7	13.9	9.3	15.9	13.2
92-10-53		16.3	17.0	20.6	18.0
92-5-1	16.7	21.6	19.5	24.1	20.5
92-5-52	9.4	22.4	19.6	25.7	19.3
92-9-12		11.2		13.0	12.1
92-9-39	10.3		10.5	16.9	12.6
Chilliwack	8.6	13.6	12.3	22.0	14.1
Coho		14.7	12.1	18.7	15.1
Malahat	12.9	15.6	16.0	18.9	15.8
Meeker	12.6	16.8	15.1	20.1	16.1
ORUS1025-10	10.0		15.0	18.0	14.3
ORUS1072-11	10.2	14.9	12.2	18.9	14.1
ORUS870R-12		13.8	13.1	17.9	14.9
Qualicum	15.2	19.0	13.3	28.7	19.0
Tulameen	13.5	20.8	17.4	27.9	19.9
WSU1024	9.2		18.5	25.3	17.7
WSU1066			16.6	17.9	17.3
WSU1068	8.8	15.2		27.7	17.2
WSU1099		22.3		32.3	27.3
LSD	**6.6**	**6.4**	**6.0**	**8.2**	**6.8**

Table 4b. 1999-2002 harvest data for 1998 and 1999 planted raspberries, Abbotsford, BC.

CLONE	Total Yield (t/ha)			
	2002	2001	2000	Mean Yield (t/ha)
1998 planting				
89-33-84	15.4	14.2	16.8	15.4
90-6-2		18.4	12.3	15.4
91-17-10	18.9	19.4	14.1	17.5
91-17-11	23.8	19.1	12.6	18.5
91-24-12	15.6	15.2	9.9	13.5
91-28-4	11.0	12.8	17.2	13.6
92-10-53		12.4	15.9	14.2
92-20-17		10.8	10.0	10.4
92-4-11		20.5	21.0	20.8
92-4-49		19.1	16.9	18.0
92-6-17	14.9	15.6	16.0	15.5
92-6-41	13.6	15.7	17.3	15.5
92-7-43		16.2	12.1	14.2
92-9-15		17.3	16.0	16.7
92-9-33		12.9	17.3	15.1
92-9-57		15.7	7.1	11.4
Meeker	12.7	12.7	15.0	13.4
LSD	**6.6**	**6.4**	**6.0**	**6.3**

CLONE	Total Yield (t/ha)		Mean Yield (t/ha)
	2002	2001	
1999 planting			
84-12-22		17.3	17.3
87-14-35	15.0	13.8	14.4
87-5-1	9.7	11.6	10.6
87-9-6		27.5	27.5
89-2-89	12.0	14.6	13.3
89-33-84	13.4	20.5	16.9
89-34-41	11.9	24.6	18.3
89-6-12	9.9	12.5	11.2
90-4-23	13.3	14.9	14.1
90-6-2	18.8	17.4	18.1
90-8-20	13.2	15.8	14.5
91-26-26	14.6	15.4	15.0
92-5-47	14.8		14.8
92-10-39		35.8	35.8
93-1-32	13.7	19.6	16.7
93-31-19		29.5	29.5
93-34-18	16.4	28.7	22.5
93-34-81	12.8	20.7	16.7
93-35-27		19.1	19.1
93-36-10	9.5	15.4	12.5
93-36-31	16.8	26.4	21.6
93-4-3		7.2	7.2
EM5928	26.0		26.0
Coho		18.6	18.6
Cowichan	12.0	13.3	12.6
Kitsilano	16.9	28.6	22.7
Malahat	10.4	17.9	14.2
Meeker	11.3	15.3	13.3
Nootka		10.7	10.7
Qualicum	15.0	26.1	20.5
Tulameen	15.8	23.9	19.9
LSD	**6.6**	**6.4**	**6.5**

Project No:

Year Initiated: 2001 **Current Year:** 2003-2004 **Terminating Year:** 2005

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, 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 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 named Cowichan (BC87-14-20) has given some hope to the industry that there is a cultivar that is suitable for mechanical harvesting, that escapes RBDV and stands up to root rot. More than 50,000 Cowichan test plants were already planted in the last few years across the PNW. The plantings are evaluated by the growers for their production and suitability for their operation. Recently another advance selection BC89-34-31 has shown the possibility of being resistant to RBDV. This selection has been already released to the propagators for testing on grower's trials and if it will prove to be resistant it will be of major benefit to the growers.

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 from such cross, which has root rot resistant and appears to be suited for mechanical harvesting and processing. It has been planted in growers' trials.

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, cultivars with 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. The last three cultivars released (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, and BC 90-6-2 has the 'Dalhousie Lake' selection of *R. strigosus* Maxim. in its derivation.

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

Objectives:
Develop red raspberry selections stressing suitability for machine harvesting, dark fruit, winter hardiness, resistance to root rot, resistance to divergent aphid biotype, and RBDV.
- Winter hardy plants that withstand low temperatures and desiccating winds throughout winter months, and/or late breaking dormancy.
- Manageable plant habit that is suitable for machine harvesting and produces high yields.
- Aphid resistance, which controls the Raspberry Mosaic Virus Complex (RMVC).
- Superior fruit quality, which includes flavour, size, firmness, ease of harvest, and rot resistance.
- Processing fruit needs to be dark and have high acidity and soluble solids content.
- Resistance to pollen infection from the raspberry bushy dwarf virus (RBDV).
- Resistance or tolerance to root rot (*Phytophthora fragariae)*, and lesion nematodes.
- 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 rotted fruit, 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:
- 2003 crossing blocks -continue backcross on the F1 to F3 rot root resistance selections, using RBDV resistance parents.
- Evaluation of the seedling population that was planted in 2000 and 2001.
- 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.
- Supervise distribution of advanced selections to North American propagators and growers and subsequently monitor their performance.
- Evaluate Cowichan, BC89-2-89, BC89-33-84, and BC89-34-41 on large grower's trials.
- Collaborate research with Robert R. Martin, USDA-ARS, Corvallis, to develop a marker assistant process to identify RBDV resistance at the seedling stage. When available, this procedure can shorten the usual 10 years or more that it takes for testing for resistance into a simple screening process that can be done before the seedlings are planted in the field.

Anticipated Benefits and Information Transfer:
Four out of the six research priorities determined by the Red Raspberry Commission are addressed within this research proposal and are of major importance in the objectives of the breeding program. It is well established that, when possible, breeding for resistance is the most sustainable and preferable way to address industry concerns and needs. The PARC program emphases developing and releasing RBDV resistance cultivars (Cowichan and BC89-34-41) and cultivars that will withstand to *Phytophthora* root rot pressure (Cowichan, BC89-31-84, 90-8-11 and 90-8-20). All PARC releases are resistant to aphids, which is one of the insects that are the cause of 'insect harvest contaminants'. The results of the evaluations will be directly available to the red raspberry industry in the PNW. In the coming years the evaluations will help determine if selections like Cowichan, BC89-2-89, BC89-33-84, BC89-34-41, BC90-6-2 and others 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 2002: <u>$US 7,000.</u>** ($US1=$CDN1.6)
The Washington State Red Raspberry Commission contribution could be matched by Agriculture and Agri-Food Canada Matching Investment Initiative (MII) funds with up to CDN$11,000.

Resource commitments:

Research assistance	$ 14,200
Summer students (5 x $7,500)	$ 37,500
Land preparation (fertilizer, field fumigation, etc.)	$ 4,500
O&M (drip irrigation, trellis, etc.)	$ 5,800
Contract virus testing	$ 1,500
Travel	$ 2,000
Total	**$ 65,500**

Other collaborative partners (committed funding in 1998-2002):
Raspberry Industry Development Council (RIDC)
Lower Mainland Horticultural Improvement Association (LMHIA)

Project: 13C-3761-4251

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

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

Personnel: Peter Bristow, Associate Plant Pathologist and Gwen Windom, Agric. Res. Tech. III, Washington State University, Puyallup Research and Extension Center

Reporting year: 2002

Accomplishments: Gypsum from three sources The gypsum was applied, raised beds formed and the plots planted to two red raspberry varieties: Meeker (some field tolerance to root rot) and Malahat (highly susceptible to root rot). The Appendix outlines the treatments.

Results: The trial was established at the WSU-Vancouver Research and Extension Unit in soil naturally infested with the root rot fungus *Phytophthora fragariae* var. *rubi.* Each treatment is replicated four times in a randomized complete block experimental design. Individual plots consist of 5 plants. The plants established well in 2002, but did not have enough cane growth to warrant tying canes to the trellis for harvest in 2003. Growth in 2002 was measured by cutting the plants off at ground level and recording fresh weight of the canes (with leaves). Plant survival and disease severity data collection will begin when plant growth resume in spring 2003. Primocanes produced in 2003 will be trained to the trellis for the first harvest in 2004. Adequate space was left between plot within the row so the planting can be harvested by machine.

Appendix

Table 1. Treatments for the gypsum source and rate trial.

Material applied	Gypsum rate (tons/acre)
1. none	
2. Fungicide standard*	
3. Ag gypsum[(2)] + fungicide std.[(1)]	6.0
4. Ag gypsum	8.0
5. "	6.0
6. "	4.5
7. "	3.0
8. "	1.5
9. "	0.75
10. "	0.38
11. Gypsum, anhydrite form[(3)]	5.0
12. "	3.5
13. "	2.0
14. Gypsum, recycled wallboard[(4)]	6.0
15. "	4.5
16. "	3.0

[1] Fungicide standard: Ridomil Gold at planting (P) and then every fall (F) and spring (S) plus Aliette twice every fall (F_1,F_2) and twice every spring (S_1,S_2).

[2] Agricultural gypsum ($CaSO_4 \bullet 2H_20$), pelletized

[3] Gypsum ($CaSO_4$ anhydrite)

[4] Paper removed wallboard before the gypsum core was processed.

Project: 13C-3761-4251

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

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

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

Justification: Root rot, caused by the soil-borne fungus *Phytophthora fragariae* var. *rubi*, is the most serious root disease of red raspberry in the Pacific Northwest. In attempting to develop control measures for this disease, it has become clear that any single control measure or method will not provide the level of control required for this high value crop. Recently, we have demonstrated that incorporating high rates of agricultural gypsum into infested soil prior to planting helps to control the disease and that control is enhance when gypsum is used in combination with raised beds and the application of Ridomil. Ridomil and now Ridomil Gold has successfully controlled the disease at many sites. However, in increasing numbers of sites, it is apparent that Ridomil is no longer effective. In test plots at the WSU-Vancouver Research and Extension Unit we experienced our first failure in nearly 20 years of working with the compound. Fosetyl-Al also has activity against the fungus, but it has not been as effective as metalaxyl. Other products have been tested but the best ones will not be developed. Efforts to breed for the high levels of resistance needed have been frustrating. Even the most resistant source identified to date yielded more when treated with metalaxyl. Progress is being made in combining resistance with desirable horticultural traits, but it takes time and there are no shortcuts.

Questions regarding the use of gypsum remain. The most frequent question is "do you need to apply 6 tons of gypsum per acre to be effective?" Other questions include: "how often does gypsum need to be reapplied?" and "can less expensive forms of gypsum – such as recycle wall board – be used?" The objectives of this research will address those and other questions.

Objectives:

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

Procedures: A field trial will be established on a site with a history of Phytophthora root rot. Two susceptible varieties will be planted (one will be Meeker). Agricultural gypsum will be applied to the soil and work in as the raised beds are shaped. Soil from the different treatments will be monitored for pH and the concentration of the calcium ion. Plant growth, yield and disease incidence and severity will be assessed yearly.

Naturally infested field soil and other soils artifically infested with the fungus will amended with gypsum in greenhouse experiments to establish a method for testing the effectiveness of gypsum. Developing a greenhouse potted plant test in the long run will be more efficient that field testing.

Anticipated Benefits and Information Transfer: Testing different rates of gypsum will help to maximize disease control while keeping the cost of using gypsum at a minimum. Identifying non-chemical control measures should help to maintain the useful life of traditional fungicides that are registered for this use. Because soil types that are ideal for growing red raspberries are limited, sites that become infested with the pathogen could still be used to grow the crop.

The results of this field study and others investigating different aspects of this disease will be presented at grower meetings, workshops, and field days. The information will also be disseminated through local and regional publications including the Pacific Northwest Plant Disease Control Handbook and the Pest Management Guide for Commercial Small Fruits. Demonstration plots may also be established on the farms of cooperating growers.

Budget:

Amount allocated by Commission for 2002-03:	**$5,000**
Request for FY2002-03	
Timeslip labor	$1,700
Operations (goods and services)	528
Travel	
Project needs	300
Meetings	100
Employee benefits	272
Total	**$2,900**

Other Support of Project: See attached sheet for other funded root rot projects. Gypsum is included in three of the seven treatments in the Organic Amendment Project funded by the IFAFS grant.

Current & Pending Support

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

Name (List PI #1 first)	Supporting Agency and Project #	Total $ Amount	Effective and Expiration Dates	% of Time Committed	Title of Project
	Current:				
Bristow, P. R. Windom, G.E.	WRRC	$5,000	Mar 02-Mar 03	4	Investigating rates and sources of gypsum to reduce damage from Phytophthora root rot in an integrated control program.
Bristow, P. R Pinkerton, J.N.	NCSRF (USDA)	$6,370	Oct 01-Oct 04	4	*Soil solarization as a component of an integrated program to control Phytophthora root rot of red raspberry.*
Cogger, C.G., Ostrom, M., Bristow, P.R.	IFAFS (USDA)	$112,614	May 01-Sep 05	8	Small scale agriculture organic waste stream use.
	Pending:				

A:instructions01/cp2/cm
9/01

Washington State University

(Grant Proposal)

Peter R. Bristow
(*Name*)

Washington Red Raspberry Commission
(*Granting Agency*)

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

(*Proposal Title*)

16 October 2002
(*Date*)

The grant proposal has included funds in the budget for safety equipment

Peter R. Bristow (sig.)
(*Principle Investigator*)

saftyfrm.dag

Executive Summary Sheet

Title: Insect and Mite Control in Red Raspberry

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

Project No: 13C-3543-4370

Project Duration: 2002-2004

Calendar: 2002

Proposed Budget: $9,460

Other Support:

Identification of Problem or Need: Even with the recent registration of Brigade, the arsenal of 13 recommended pesticides for red raspberry is at risk. Of these compounds, most of the usage is center on 2-3 insecticides-miticides. The regulatory or resistance selection loss of any of these key pesticides 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 western raspberry fruit worm and raspberry crown borer. There are no effective options for root weevil control in Washington.

Evaluation and Accountability: The researchers are responsible for evaluating and reporting 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: 13C-3543-4370

Title: Insect and Mite Control in Red Raspberry

Year Initiated: 2001 **Current Year:** 2002 **Terminating Year:** 2004

Personnel: **Lynell K. Tanigoshi**, Associate 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: 2002

Accomplishments:
Several promising biorational or reduced risk insecticides and those EPA call OP alternatives were tested in the laboratory at recommended field rates on the black vine, strawberry and rough strawberry root weevils. This was the third year we conducted these bioassays with a precision Potter spray tower. This year's bioassays further reinforced our understanding that the root weevil complex in Washington red raspberry respond differently to the recommended field rate for Capture® and several promising new experimental insecticides.

Seven different pheromone blends were tested in field with know infestations of raspberry crown borer to determine if there is a difference in composition for attracting this clearwing moth. The blends tested shared the component E3Z13-18OH or a closely related compound.

This past season we evaluated the Rebell® bianco trap from the Federal Research Station, Waedenswil, Switzerland to sample the western raspberry fruit worm. This trap is a visual attractive trap that is non-UV reflective and is proven to be highly attractive to European raspberry beetle species. Traps were placed in the field in late April and checked twice a week for trapped beetles. For early season sampling, standard ten beating tray samples were taken weekly from each field. After harvest, 200 fruiting laterals were sample from each field for feeding damage by raspberry fruitworm larvae even after fruit had been harvested.

Results:
After nearly a decade of consistent usage, multiple lab bioassays for different populations and species of root weevils to Capture® are showing trends to increase weevil tolerance or reduced field efficacy. After 3 days of direct exposure to Capture treated residues on red raspberry foliage, lab mortality for black vine weevil, strawberry and rough strawberry weevil was 80%, 60% and 100%, respectively. Evaluation of field applied residues of Capture at 0.1 lb AI/acre on the Vancouver REU revealed 40% mortality of black vine weevil adults after 24 hours of exposure in Petri dishes at 5 days posttreatment. Another residual test applied on potted red raspberry with a hand sprayer revealed unsatisfactory residual activity of 10-30% mortality after 5 days posttreatment. These trends and empirical results reported by commercial producers further underscore the urgent need to register new mode of action insecticides.

Very few raspberry crown moths were trapped through the season that extended from July through October. Moreover, all pheromone blends appear to be ineffective for trapping or attracting raspberry crown borer. Poplar clearwing borer blend attracted the only raspberry clearwing moths throughout the season. The only difference between the various species' lures was the pheromone dispenser.

Comparison of the beating tray with sticky trap from 22 April to 28 May showed the Rebell® trap collected far more beetles than the beat tray method. When we compared the number of infested fruit receptacles from three fields that did not receive a diazinon application for raspberry fruitworm, the fields that received a bifenthrin clean-up spray had significantly less fruit infested compared with the field with organic production.

Publication:

Tanigoshi, L. K. and J. R. Bergen. 2002. Managing root weevils in Washington State red raspberries. Acta Horticulture (in press).

Tanigoshi, L. K. 2002. Project Update: Insect pests of small fruits. Proceedings 4th Annual Small Fruit Grower's Workshop, 19 March 2002.

Tanigoshi, L. K. and J. R. Bergen. 2002. Studies on the biology, phenology and control of root weevils on red raspberry. Proceedings 61st Annual Pacific Northwest Insect Management Conference, Portland, OR.

Tanigoshi, L. K., J. R. Bergen and T. J. Peerbolt. 2002. Evaluation of novel insecticides for the rational control of the orange tortrix. Proceedings 61st Annual Pacific Northwest Insect Management Conference, Portland, OR.

Tanigoshi, L. K. and M. Bounfour. 2002. Spider mite dynamics on red raspberry in Washington State. XI International Congress of Acarology, Merida, Mexico (poster abstract).

Tanigoshi, L. K., G. W. Menzies and T. A. Murray. 2001. Clay-colored weevil biology and management in red raspberry. Ext. Bull. 1901.

Peerbolt, T. J. and L. K. Tanigoshi. 2001. Development of an IPM program for leafrollers in caneberries. Proceedings Northwest Center for Small Fruit Research, Boise, ID.

Project: 13C-3543-4370

Title: Insect and Mite Control in Red Raspberry

Year Initiated: 2001 **Current Year:** 2002 **Terminating Year:** 2004

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

Justification: Federal passage of the USEPA's Food Quality Protection Act (FQPA) in August, 1996 has put continued registration of organophosphates, carbamates and even pyrethroids at great risk. Issues regarding older pesticides (e.g., chlorpyripyhos, diazinon, endosulfan, azinphos methyl) under EPA's rigorous risk assessment process are beginning to impact registrant decisions to no long support agricultural uses through cancellation and selective amendments to their product registrations. A review of insecticides and miticides in the *Pacific Northwest 2002 Insect Management Handbook* lists 13 pesticides recommended for effective insect and mite control in red raspberry. Three of them are "older" organophosphates, the carbamate carbaryl and broadspectrum pyrethroids esfenvalerate and bifenthrin. The loss of the six older pesticides would leave our red raspberry arsenal with the newly registered Capture® and specific compounds which EPA euphemistically call, "reduced-risk pesticides" and "biorationals." These are formulations of the microbial, *Bacillus thuringiensis* an IGR for caterpillar control, an IGR for spider mites, lime sulfur (eriophyid mites), cryolite bait (root weevils) and insecticidal soap (spider mites). The reduced risk characteristics for the aforementioned pesticides are important. Most of them are not cheap and their minimal residual activity and selectivity may not make them especially cost and pest effective for current red raspberry production. EPA's FQPA guidelines and criteria for chemical registrations have created a strong reason to intensify our efforts to evaluate new chemistries, particularly the reduced risk and OP alternative insecticides for which EPA has expedited registration guidelines.

Objective:

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

2. Bioassay and rate the toxicity of select insecticides and acaricides to the phytoseiid predator of spider mites, *Neoseiulus fallacis*, and the spider mite destroyer, *Stethorus punctum picipes*.

3. Continue evaluating the Rebell® bianco, non-UV reflective sticky trap to monitor adult raspberry beetle activity during 5% bloom stage to optimize spray application(s).

4. Continue evaluating the efficacy of experimental raspberry crown borer pheromones for field detection.

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 after 24 and 48 hours or longer. 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 and western raspberry fruitworm. Raspberry crown borer evaluation of a fall or spring drench application will consist of October visual examinations of crowns for frass and canes that exhibit galls on cane bases. There is no certainty populations of raspberry root borer will be found in abundant densities given our current pest management program in commercial settings.

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, four disc replicates will be treated with concentrations equivalent to full, half and one quarter of the recommended field rate when applied in about 100 gallons of water per acre. The pesticides will be applied in aqueous suspension using a Precision Spray Tower applied to predators on the leaf discs. Discs will be provisioned with spider mites as food for the predatory mites. The predators are examined for mortality after 24 and 48 hours and data corrected for control mortality if it exceeds fifteen percent.

Multiple red raspberry fields positive for western raspberry fruitworm in 2002 will be used next season to further evaluate a visual attractive trap. When compared with the number of fruitworm sampled per 10 beating tray samples, the Rebell bianco trap collected far more beetles than were sampled with the beating tray. After harvest fruiting laterals laterals from field that received no treatment will compared with those receiving a diazinon application at five percent bloom. This procedure will provide insight to relating western raspberry fruitworm abundance as measured from trap counts with percent fruit contamination.

In collaboration with the British Columbia Ministries of Agriculture, another season of field monitoring for the raspberry crown borer will involved testing several pheromone blends to determine if there is a difference in their composition for attracting adult male crown borer. Several of these blends are associated with other clearwinged-moth species. We believe the current commercial pheromone (E3Z13-18H) is incomplete for attracting raspberry crown borer. Sticky traps loaded with specific and blended pheromone will be placed in fields that are aged and candidates for attracting in-field raspberry crown borer populations from July through October. Trap effect will be minimized by rotating each trap so no one trap remains in the same area for the duration of the test.

Anticipated Benefits and Information Transfer:
Registration of additional insecticides with different modes of action and their use in a pesticide rotation program will prolong the development of spider mite resistance or potential for their posttreatment flare-up. Pending registrations of additional insecticides and miticides with different modes of action (e.g., neonicotinoids, carbazate, pryridine compounds), a weevil and spider mite control program that integrates biological control for spider mite control in red raspberry may be realized. Pesticide use as experienced in crops such as hops and grapes may be tailored so that it provided effective control of target pests but also preserves predators and parasitoids. In tern this will lead to increased biological control and reduced pesticide use in the crop. Research must refine monitoring tools and identify compatible/selective chemical controls for secondary pests such as the western raspberry fruitworm, aphids and raspberry crown borer. In cooperation with WSU Cooperative Extension personnel, research information will be disseminated at regional and national grower's meetings as well as through local, regional and national publications. Newsletters and WSU Vancouver REU's website will update industry on new developments as appropriate.

Budget:

	2002
01 Wages	$6,000
03 Goods and services	500
04 Travel	2,000
07 Employee benefits (16% of 01)	960
Total	**$9,460**

We would like this grant to be submitted to the Washington State Commission on Pesticide Registration and to ask for a split of $9,460 for Washington State Red Raspberry Commission and $16,500 from the Washington State Commission on Pesticide Registration. Donations of land and crops by the Vancouver Research Unit and growers can be used as a match.

Current & Pending Support

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

Name (List PI #1 first)	Supporting Agency and Project #	Total $ Amount	Effective and Expiration Dates	% of Time Committed	Title of Project
Tanigoshi, Lynell	Current: Wash. St. Comm. Pesticide Registration	$18,318	2002-2005	15%	Insect and mite control in red raspberry
Tanigoshi, Lynell	Northwest Center for Small Fruits Research	$17,743	2001-2002	15%	Further evaluation of control strategies for root weevils in strawberries and red raspberries
Tanigoshi, Lynell	Pending: Northwest Center for Small Fruits Research	$19,140	2002-2003	15%	Further evaluation of control strategies for root weevils in strawberries and red raspberries

A:instructions01/cp2/cm

Project No: 11C-3555-3780

Title: Acquisition of a mechanical red raspberry harvester for WSU Vancouver Research and Extension Unit

Year Initiated 2000 Current Year 2003-2004 Terminating Year 2010

Personnel: Dr Lynell K. Tanigoshi, Associate Entomologist, Dr Carol A. Miles, Agricultural Systems Specialist, Martin Nicholson, Agriculture and Research Operations Manager, WSU Vancouver Research and Extension Unit 1919 NE 78th St, Vancouver, WA 98665, Phone: 360 576 6030, Fax: 360 576 6032. Email nicholsm@coopext.cahe.wsu.edu. Dr Peter R Bristow, Associate Plant Pathologist, Phone: 253 445 4529, Dr Patrick P. Moore, Associate Horticulturist, Phone (253) 445-4525, WSU Puyallup Research and Extension Center; 7612 Pioneer Way E., Puyallup, WA 98371-4998

Dr Timothy W. Miller, Extension Weed Scientist, WSU Mount Vernon Unit, 1468 Memorial Highway, Mt. Vernon, WA 98273-9788, Phone: (360) 424-6121

Justification: The WSU Vancouver Research and Extension Unit (WSU-VREU) has been a center for raspberry research for four decades. Research is conducted on a commercial planting of red raspberry and smaller adjacent plantings. Current research is focused on managing raspberry pest problems and addresses numerous IPM strategies. These projects involve disciplines and departments including horticulture, entomology, plant pathology, genetics, weed science and sustainable agriculture. . 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 WWRC will allow WSU-VREU to make payments on the harvester loan.

Objectives: *The plans that are being formulated for future research at WSU-VREU have all been scaled up to use the harvester that is currently available. 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.*

Procedures, Anticipated Benefits and Information Transfer:

PEST MANAGEMENT PROJECTS AT WSUVREU - OVERVIEW:

Entomology: Insect and Mite Control in Red Raspberry (new project WRRC $9120 and WSCPR $18 240). Dr Lynell K. Tanigoshi et al. Objectives are to evaluate traditional and biorational products for control of raspberry crown borer, raspberry aphid, root weevils, thrips and mites on red raspberry. Evaluate monitoring techniques for efficacy in determining actual populations. Project requires field monitoring of insect populations and field trials of experimental chemicals. Monitoring and some field trials will be conducted at WSU-VREU. The anticipated benefits are; improved knowledge of the biology of red raspberry insect pests, improved control techniques through innovative timing and control methods, chemical and/or non chemical, registration of new insecticides with different modes of action to those currently available.

Root rot: In the search for a cure to the number one priority problem for southwest Washington red raspberry growers, a few potential strategies have emerged and slowly the development of a root rot management system is occurring. Dr Peter Bristow and Dr Carol Miles are both working on root rot management. 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. This will clear up some of the questions that remain about the long term use of gypsum as a root rot management tool. Annual addition of organic materials to soil: impact on root rot of red raspberry, 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 red raspberry. 11D-3761-6640, this project planted in 2001 will be machine harvested for yield data in 2003. Organic Management of Root Rot in Raspberries, (WRRC 13C 3555 3375). Dr Carol Miles is testing the efficacy of two organic pesticides and dairy manure for disease suppression. In addition Dr Miles has received funding to expand research on the root rot management system using organic and sustainable control methods. There is also a proposal in to WRRC for 2003 funding. The expanded project is a large plot design and was machine harvested for yield in 2002. The project has the potential to reduce dependence on the few chemical tools available and establish a true IPM approach to root rot management.

Cane burning: Cane burning and Weed Control in Red Raspberries, (WRRC 13C 3419 3297, 3rd year 2002), Dr Timothy Miller, Extension Weed Scientist. Herbicides have been used for many years to suppress primocane growth in the spring, primarily as a mechanical harvest aid, but also for weed control. 2002 was the final year of a 3-year study looking at yield effects of cane burning and potential adverse effects on plant health. The plots were machine harvested and yield is essential in comparing the impact of cane burning.

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

IPM and General: *Yield is collected from many of these studies, but it must be stressed that all studies require the cultural environment that is created by machine harvesting to most accurately represent commercial/industry conditions, and consequently, obtain accurate data. All of these pests can have a major impact on raspberry yield and quality.*

Approximately 5 acres are to be commercially harvested in the next season. The fields are managed with the latest techniques in IPM for root rot control and any pests that present themselves, and may potentially be used for future studies. All marketable fruit is sold to processors and the receipt money is used to fund operations at the research unit. Many of the above mentioned trials are located within the five acres to be harvested next season. Each of the trials benefits from being placed within the larger production field by maintaining pest and environmental conditions that are more uniform than in isolated small plot fieldwork. Although many projects are also carried out in growers fields it is useful to have a controlled site where harvest cannot occur without the researcher knowledge resulting in the loss of a years data.

Budget:

Amount allocated by Commission for FY 2002-2003: $3000

Request for FY 2003-2004

Salaries	
Time-Slip	
Operations (goods & services)	
Travel	
Projected Needs	
Meetings	
Other	
Equipment	$3000
Employee Benefits	

Other support of project:

WSCPR see funding form.

Martin Nicholson - Agriculture and Research Operations Manager

Current & Pending Support

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

Name (List PI #1 first)	Supporting Agency and Project #	Total $ Amount	Effective and Expiration Dates	% of Time Committed	Title of Project
Martin Nicholson	Current: WSCPR 10A-3093-2529	$4750	2002		**Acquisition of a mechanical red raspberry harvester for WSU Vancouver Research and Extension Unit**
Martin Nicholson	Pending: WSCPR 10A-3093-2529	$4750	2003		**Acquisition of a mechanical red raspberry harvester for WSU Vancouver Research and Extension Unit**

A:instructions01/cp2/cm

Project No:

Title: Guide for Integrated Raspberry Management in the Pacific Northwest

Personnel: Carol Miles and Madhu Sonde, WSU Vancouver Research & Extension Unit.

Reporting Period: 2002

Accomplishments: We have drafted several sections for a new guide on integrated management of raspberries in the Pacific Northwest. The guide will include organic, integrated and conventional management techniques and will also include fresh raspberry production procedures in addition to processed raspberry production procedures.

Results: We have begun to compile sections pertaining to integrated management of raspberries in the Pacific Northwest. Sections include site selection, soil preparation and fertility, weed management variety descriptions, and nutritional value of raspberries.

Publications: None as yet.

Project No.: 13C-3761-6251

Title: Gray mold fruit rot (*Botrytis cinerea*): field evaluation of new fungicides and timing of fungicide applications based on the stage of flower and berry development.

Reporting Year: 2002 (Terminal report)

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

Accomplishments: Experiments addressing all three objectives of the project were completed, however, cold weather that delayed bloom and the lack of rain from early bloom through harvest had a detrimental impact on most parts of the project. Because of these conditions, the incidence of fruit rot at harvest was extremely low. Consequently, all fruit rot data were obtained from post harvest tests. Both BAS 510 and BAS 516 were as effective in controlling fruit rot caused by *Botrytis* as treatments that included Switch, Elevate, Captan, and Quadris. The incidence of *Cladosporium* in the post harvest test with processing ripe berries was markedly reduced by BAS 510 and BAS 516. Some treatments had an impact on the buildup on mites.

Results:

A) Fungicide trial. Thirteen different fungicide treatments were compared to a water check treatment for control of gray mold fruit rot (*Botrytis cinerea*) in a replicated trial conducted in a commercial 'Meeker' field west of Lynden, WA (Appendix). Except for two fungicide timing treatments, all treatments were applied on six dates from early bloom through early harvest. Disease pressure was extremely low in 2002 with very few berries becoming moldy before harvest (field rot). Consequently, yield differences between treatments were small; only one treatment significantly increased yield over the water check and that increase cannot be explained. Lesions from *Botrytis* and *Didymella applanata* (spur blight) on laterals of fruiting canes and on primocanes were rarely found in 2002.

Useful information was obtained from the two different types of post harvest tests carried out using fruit picked by hand on three dates during harvest. In one test, fully ripe berries (processing stage) were incubated individually in a moist chamber for three days and then assessed for fruit rot. For the other test, slightly under ripe berries (fresh market stage) in clear–plastic clamshell packs were incubated for 6 days under condition thought to simulate those in marketing channels before being evaluated for rot. All treatments, except the biological fungicide Serenade and Topsin M, significantly reduced the incidence of fruit rot caused by *Botrytis cinerea* (gray mold) on processing berries. No significant differences were found between the early, late and full season programs of Switch alternated with Elevate. BAS 516, BAS 510, Switch alternated with Quadris and TM 450-02 were the most effective in reducing post harvest fruit rot from all causes. The two BAS products and the alternating program of Switch and Quadris were particularly effective in controlling rot caused by *Cladosporium*. In the tests with berries at the fresh market stage, the most effective treatments were BAS 516, Switch alternated with Quadris, BAS 510, TM 405-02, Elevate plus Captan, and Captan alone. Results from tests with berries at the two stages of ripeness (processing and fresh market) were correlated.

B) Flower tagging. Fully opened flowers (anthesis) were tagged and then either left untreated or sprayed with Switch fungicide at different times after tagging (DAA = days after anthesis). Tagged flowers were harvested when ripe and the incidence of gray mold for each spray date was to be used to answer the question "When do infections that lead to fruit rot occur?". The

experiment was conducted in two commercial Meeker fields (Sumner, WA and Abbotsford, BC). Because very few berries were moldy when harvested, the original question could not be answered. However, harvested berries were incubated individually in a moist chamber for up to 10 days and assessed daily for gray mold fruit rot. For the WA site, a single application of fungicide at 0 DAA (~33 days before berries ripened) reduced the incidence of gray mold from 69 to 50%. Single applications at later dates further reduced rot as did the treatment where the fungicide was applied on all five dates (0, 7, 14, 21, and 28 DAA). In contrast, at the BC site the only treatment to significantly reduce post harvest loss from gray mold was the one that received five applications of Switch.

C) Flower parts. Data from this part of the project have not been summarized yet. As with the other portions of the project, only a couple of the berries developed rot by harvest, so again, results will have to come from the post harvest test.

Switch contains two active ingredients (fludioxonil and cyprodinil). TM 405-02 is a mixture of Captan and fenhexamid (the active ingredient in Elevate). BAS 516 also has two active ingredients (BAS 500 and BAS 510). The mode of action of each of the six active ingredients is unique which means all will be useful in managing fungicide resistance once they are approved for use on caneberries.

Appendix

Table 1. Impact of treatment on yield.

Treatment (application dates*)	Kg per plot**	
Switch (A,C) **alternated with** Elevate (B) [early season schedule]	22.0	a
Switch (D,F) **alternated with** Elevate (E) [late season schedule]	21.3	ab
Elevate (A-F)	21.0	ab
BAS 510 (A-F)	21.0	ab
Elevate (A-F) **plus** Captan (A-F)	20.8	abc
Switch (A,C,D,F) **alternated with** Elevate (B,E) [full season schedule]	20.6	abc
BAS 516 (A-F)	20.4	abc
Switch (A,C,E) **alternated with** Quadris(B,D,F)	20.1	abc
TM 450-02 (A-F)	20.1	abc
Switch (A,C,E) **alternated with** Messenger (B,D,F)	19.8	abc
Serenade QRD 137 (A-F)	18.7	bc
Water check (A-F)	18.3	bc
Topsin-M (A-F)	17.9	c
Captan (A-F)	17.8	c
Pr≥F		0.0324

* A=5 Jun, B= 12 Jun, C=19 Jun, D=26 Jun, E=3 Jul, and F=10 Jul

** Harvest area in each plot is 20 feet of row. Plots harvested with a Littau harvested on 10 dates between early Jul and mid Aug. (5 tons/A = 20.8 kg/plot)

Table 2. Effect of treatment on rot developing after harvest (**processing ripe berries**)*.

Treatment	% rot**					
	Botrytis		Clado-sporium		All fungi	
Water check	7.3	a	76.9	a	84.2	a
Switch **alternated with** Elevate (early season)	1.9	b	75.7	a	79.9	a
Topsin-M	4.2	ab	69.6	ab	78.6	ab
Switch **alternated with** Elevate (late season)	2.4	b	76.4	a	78.1	ab
Serenade (QRD 137)	7.1	a	68.2	ab	74.7	bc
Switch **alternated with** Elevate (full season)	0.3	b	72.4	a	74.0	bc
Switch **alternated with** Messenger	2.8	b	61.4	bc	67.5	cd
Elevate	0.5	b	57.6	c	61.5	d
Captan	1.2	b	30.7	d	43.4	e
Elevate **plus** Captan	0.7	b	28.7	d	36.5	ef
TM 450-02	1.0	b	23.4	d	32.6	fg
Switch **alternated with** Quadris	2.3	b	11.8	e	25.9	g
BAS 510	0.9	b	3.6	ef	15.1	h
BAS 516	1.2	b	0.3	f	11.1	h

* means are for berries harvest on three separate dates.

** incubation at 50-60 F and 100% relative humidity for 3 days,

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

Treatment	% rot**	
Water check	36.5	a
Serenade (QRD 137)	33.7	ab
Switch **alternated with** Elevate (late season)	29.3	abc
Switch **alternated with** Elevate (early season)	27.3	abc
Topsin-M	26.6	ab
Switch **alternated with** Elevate (full season)	24.0	c
Elevate	23.2	cd
Switch **alternated with** Messenger	22.2	cd
Captan	14.5	de
Elevate **plus** Captan	12.5	e
TM 450-02	11.0	e
BAS 510	10.4	e
Switch **alternated with** Quadris	10.2	e
BAS 516	8.6	e

* incubation in clamshell packs for 6 days.
** means are for berries harvest on three separate dates and for **all** fungi.

Table 4. Incidence of gray mold fruit rot (*Botrytis cinerea*) on flowers/berries treated with Switch fungicide on different dates after flower opening (DAA = days after anthesis).

Date(s) flower sprayed with Switch fungicide	% rot	
	Washington	British Columbia
Untreated check	68.9 a	80.4 a
0 DAA	49.7 b	76.4 a
7 DAA	19.6 c	66.5 a
14 DAA	16.7 c	66.8 a
21 DAA	16.8 c	61.2 a
28 DAA	18.7 c	65.6 a
O, 7, 14, 21, and 28 DAA	1.2 c	18.8 b

* means are for flowers tagged (fully opened) on three separate dates at each site.
** incubation at 50-60 F (WA) or 68-71 F (BC) and 100% relative humidity for 10 days,

Project No: 13C 3419 3297

Title: Caneburning and Weed Control in Red Raspberries

Personnel: Timothy W. Miller, WSU Mount Vernon
Steve Klauer and Martin Nicholson, WSU Vancouver

Reporting Period: 2000-03 (termination)

Accomplishments:
During the last three years the long term effects of caneburning compounds either with or without residual application of Casoron in 'Meeker' red raspberry have been evaluated. Replicated plots were treated with the following rates: Casoron (4 lbs ai/a) alone or in sequential combination with Goal (0.4 lb ai/a), Aim (0.1 lb ai/a) or Enquik (10 gal/a used in 2000) or Rely (1 lb/a used in 2001 and 2002), and the same rates of Goal, Aim, and Enquik/Rely alone (without Casoron).

Results:
1. Decline in this raspberry planting, presumably to root rot, was apparent by the beginning of 2002, although the amount of injury attributable to the herbicide program was less obvious. Certain treatments in certain replicates showed significant decline, but raspberries treated with the same treatments in other reps remained healthy. For example, in two plots of Aim used alone (replicates 1 and 3), raspberries showed marked stand injury, while Aim plots in replicates 2 and 4 showed no significant decline. And since the Casoron + Aim combination caused very slight or no raspberry injury in all four replicates, it appears that herbicide application was not primarily responsible for raspberry decline at this site.

2. Raspberry yield was moderately affected by herbicide application. Most treatments did not yield significantly higher than untreated check plots. The poorest yielding treatments were Casoron + Goal, Aim alone, and the two untreated checks. Interestingly, the Casoron + Aim treatment was numerically the highest yielder, indicating that Aim used as a caneburning product is as safe as any of the tested herbicides. If those plots sustaining > 50% decline were dropped from the analysis, there was no statistical difference between treatments, but all yielded numerically better than the untreated check plots, and Casoron + Aim and Enquik/Rely alone were statistically superior to untreated check #2.

It is difficult to say that the herbicide treatments were causing a reduction in raspberry plant vigor over time as evaluated in berry yield. If all plots are included in the analysis, there was no significant herbicide by year interaction. If those plots with > 50% decline were dropped from the analysis, however, the interaction was strongly significant ($P > 0.0002$). The majority of that response was likely due to a substantial reduction in overall yield in 2002 (24.8 kg/plot in 2000, 33.4 kg/plot in 2001, and 17.3 kg/plot in 2002) that held true for all treatments (including the non-treated control plots).

3. Fruit size did not respond to herbicide application as neither caneburning nor Casoron treatment improved berry weight. Fruit size was consistent in 2000 and 2001 (0.64 and 0.63 g/fruit, respectively) but size was significantly lower by some 15% in 2002 (0.54 g/fruit). This reduction is attributable primarily to weather conditions in 2002, given the lack of significance in the herbicide data or herbicide by year interaction.

4. Primocane burn was acceptable for all caneburning treatments, ranging from 90 to 98%. Primocane regrowth was slowest when Goal was used either with or without Casoron, followed

by Aim and then by Enquik/Rely. Raspberry primocanes treated with Goal were thinner than primocanes from all other treatments until mid-July and shorter until mid-August. Casoron did not restrict primocane growth when used alone, and regrowth from combination treatments was not slower than the regrowth after caneburning products were used alone.

5. Casoron alone or in combination gave excellent weed control (97 to 99%) after three years applications at 4 lb ai/a. Caneburning products used alone resulted in lower weed control than when used sequentially with Casoron, and Aim alone performed statistically poorer (58% control) than either Goal or Enquik/Rely used alone (79 and 75%, respectively).

6. Primocane and floricane counts differed between years, but only primocanes displayed a significant difference due to herbicide treatment. Untreated plots produced from 224 to 228 primocanes per plot in 2001, while Aim and Casoron + Goal produced only 134 and 136, respectively. If those plots with > 50% decline were dropped from the analysis, non-treated plots produced more primocanes than plants treated with Casoron + Enquik/Rely, and all treated plots dropped an average 44 primocanes per plot by the end of the second season. The largest reductions in primocane counts were in the Goal-treated plots, with or without Casoron (64 and 69 fewer canes, respectively) and Casoron + Rely (70 fewer canes). The third year data has not yet been analyzed.

7. Dry weight partitioning in individual floricanes did not change due to herbicide treatment. Neither floricane nor fruit weight were significantly different between years, but branch and leaf weights generally increased from 2000 to 2001. When poor vigor plots were removed from the analysis, leaf weight was also significantly reduced in plots treated with Casoron alone or in the untreated checks. This may have resulted due to the larger number of primocanes being produced in these plots (see Result #6).

8. Floricane height, berry number per floricane, and lateral number and length did not change much between 2000 (1st treatment year) and 2002 (3rd treatment year). When poor vigor plots were removed from the analysis, floricanes were shorter in 2002 compared to 2000 and 2001, more laterals were produced in 2001 compared to 2000 or 2002, while average lateral length and berry number were shortest/fewest in 2000 compared to 2001 and 2002. In addition, berry number per floricane was lowest in raspberries treated with Casoron alone, Aim alone, or in the untreated checks. As with yield, however, raspberry floricanes treated with Casoron + Aim produced the numerically highest berry count, indicating that Aim was not causing this effect.

Conclusions:

It appears from these data that a caneburning program does not drastically alter raspberry productivity. While the herbicide programs did not modify floricane height or lateral production, there was a trend toward more fruiting sites on treated raspberries compared to untreated checks. This trend did not result in greatly improved yield, although caneburned plots tended to have a higher three-year average than untreated plots. Berry size was not significantly impacted by herbicide treatment, but did vary by year. While weed control was notably improved by caneburning (some 60 to 80% compared to untreated checks), the residual program (Casoron) was in this case more important to ultimate annual weed control than was caneburning. All tested herbicides tended to reduce the number of primocanes produced, but caneburning did not as a rule reduce those numbers more than from a residual product alone. Of caneburning products, Goal provided the longest suppression of primocane growth, followed by Aim, and then by Enquik/Rely.

Table 1. Yield and fruit size of raspberries after treatment with residual (dormant) and caneburning (spring) herbicides.

Residual		Caneburning[a]		Berry yield			Berry size		
Product	Rate	Product	Rate	2000	2001	2002	2001	2001	2002
	lbs ai/a		lbs ai/a	---------- kg/plot ----------			---------- g/berry ----------		
Casoron	4	None	0	27	29	20	0.64	0.63	0.56
Casoron	4	Aim	0.1	26	39	18	0.66	0.63	0.53
Casoron	4	Goal	0.4	22	32	15[b]	0.65	0.60	0.50[b]
Casoron	4	Enquik, Rely	10 gal, 1.0	25	33	17[b]	0.64	0.63	0.54[b]
None	0	Aim	0.1	22	25[b]	12[b]	0.62	0.57[b]	0.50[b]
None	0	Goal	0.4	26	34	14[b]	0.63	0.63	0.54[b]
None	0	Enquik, Rely	10 gal, 1.0	25	36	17[b]	0.64	0.62	0.55[b]
None	0	None	0	25	29	16	0.64	0.60	0.53
None	0	None	0	26	24	14	0.63	0.63	0.50
Significance[c]				------- $P < 0.6252$ ---------			------- $P < 0.9813$ ---------		

[a]Enquik used during 2000 and Rely used during 2001 and 2002.
[b]Greater than 50% root rot in one replicate of these treatments (in two Aim replicates).
[c]If the P value is larger than 0.05, means are not statistically different.

Table 2. Weed and primocane control and floricane injury after treatment with residual (dormant) and caneburning (spring) herbicides.

Residual		Caneburning[a]		Weed control			Primocanes		Floricanes	
Product	Rate	Product	Rate	2000	2001	2002	2001	2002	2001	2002
	lbs ai/a		lbs ai/a	---------- % ----------			--- % control ---		---- % injury ----	
Casoron	4	None	0	97	98	97	3	30	4	21
Casoron	4	Aim	0.1	100	99	99	94	96	4	26
Casoron	4	Goal	0.4	99	99	98	96	93	23	44[b]
Casoron	4	Enquik, Rely	10 gal, 1.0	100	100	98	90	91	10	31[b]
None	0	Aim	0.1	70	79	58	95	98	35[b]	55[b]
None	0	Goal	0.4	94	83	79	96	93	18	34[b]
None	0	Enquik, Rely	10 gal, 1.0	90	81	75	94	90	3	39[b]
None	0	None	0	0	0	0	0	0	1	13
None	0	None	0	0	0	0	0	5	8	24
$LSD_{0.05}$	—	—	—	8	17	9	6	12	ns	ns

[a]Enquik used during 2000 and Rely used during 2001 and 2002.
[b]Greater than 50% root rot in one replicate of these treatments (in two Aim replicates).

Table 3. Weed and primocane control and floricane injury after treatment with residual (dormant) and caneburning (spring) herbicides.

Residual		Caneburning[a]		Floricane height			Berry number			Lateral number			Average lateral length		
Product	Rate	Product	Rate	2000	2001	2002	2000	2001	2002	2000	2001	2002	2000	2001	2002
	lbs ai/a		lbs ai/a	cm			per cane			per cane			cm		
Casoron	4	None	0	252	260	250	129	155	163	17	19	16	38	38	41
Casoron	4	Aim	0.1	240	280	241	126	204	192	16	22	18	37	42	39
Casoron	4	Goal	0.4	243	242	169	160	165	129	17	20	12	38	36	30
Casoron	4	Enquik, Rely	10 gal, 1.0	227	241	233	155	178	199	18	19	18	34	38	40
None	0	Aim	0.1	259	250	142	134	158	103	19	19	11	35	33	27
None	0	Goal	0.4	271	250	224	139	176	191	18	20	17	38	39	36
None	0	Enquik, Rely	10 gal, 1.0	249	266	220	132	186	199	15	19	19	39	40	36
None	0	None	0	232	271	250	119	154	140	17	19	16	35	39	36
None	0	None	0	251	247	229	145	126	144	17	18	16	37	37	37
Significance[c]				P < 0.0001			P < 0.0208			P < 0.0020			P < 0.1689		

[a]Enquik used during 2000 and Rely used during 2001 and 2002.
[b]Greater than 50% root rot in one replicate of these treatments (in two Aim replicates).
[c]If the P value is larger than 0.05, means are not statistically different.

Table 4. Cane number and dry weight partitioning after treatment with residual (dormant) and caneburning (spring) herbicides.

Residual		Caneburning[a]		Cane weight		Branch weight		Leaf weight		Berry weight		Primocanes		Floricanes	
Product	Rate	Product	Rate	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001
	lbs ai/a		lbs ai/a	g (%)		g (%)		g (%)		g (%)		no./plot		no./plot	
Casoron	4	None	0	29.9(46)	33.4(46)	13.9(21)	16.3(20)	14.9(22)	17.8(23)	7.2(11)	8.6(11)	223	193	156	195
Casoron	4	Aim	0.1	30.3(45)	35.7(39)	13.4(20)	21.7(23)	14.2(22)	23.2(23)	7.7(12)	10.8(12)	240	177	176	172
Casoron	4	Goal	0.4	33.3(44)	27.8(39)	15.9(21)	15.3(22)	17.3(24)	18.2(28)	8.4(11)	7.8(11)	184	136	137	163
Casoron	4	Enquik, Rely	10 gal, 1.0	26.7(43)	30.5(40)	12.8(21)	18.1(22)	14.7(25)	20.4(27)	6.9(11)	8.9(11)	210	140	151	175
None	0	Aim	0.1	36.3(48)	27.3(38)	15.1(19)	12.9(21)	16.4(22)	16.9(28)	8.3(11)	8.8(13)	192	134	150	147
None	0	Goal	0.4	34.3(48)	26.4(37)	14.7(20)	16.9(23)	16.7(22)	20.7(29)	7.2(10)	8.3(12)	212	143	170	157
None	0	Enquik, Rely	10 gal, 1.0	37.1(50)	33.4(41)	14.7(19)	18.8(21)	15.4(21)	22.3(28)	8.4(10)	8.8(10)	198	166	160	194
None	0	None	0	28.7(47)	35.9(48)	12.2(20)	15.4(20)	13.8(23)	17.0(22)	6.1(9)	6.8(9)	215	224	149	203
None	0	None	0	31.8(49)	28.7(47)	12.8(19)	12.4(20)	13.9(21)	13.2(22)	7.7(11)	6.6(11)	249	228	145	223
Significance[c]				P < 0.0522		P < 0.0697		P < 0.1457		P < 0.7023		P < 0.5853		P < 0.1235	

[a]Enquik used during 2000 and Rely used during 2001 and 2002.
[b]Greater than 50% root rot in one replicate of these treatments (in two Aim replicates).
[c]If the P value is larger than 0.05, means are not statistically different.

Table 5. Primocane growth after treatment with residual (dormant) and caneburning (spring) herbicides in 2001.

Residual		Caneburning[a]													
Product	Rate	Product	Rate	5/25	6/12	6/19	6/27	7/5	7/12	7/23	8/2	8/13	8/20	8/28	9/13
	lbs ai/a		lbs ai/a	mm											
Primocane diameter															
Casoron	4	None	0	8.7	8.8	9.2	9.6	9.6	9.5	8.9	9.1	8.7	8.1	7.5	6.4
Casoron	4	Aim	0.1	7.6	8.0	8.3	8.3	8.4	8.3	8.0	7.8	6.7	5.9	5.6	5.4
Casoron	4	Goal	0.4	0	6.9	7.5	7.7	7.6	7.4	6.7	6.7	6.6	5.9	5.8	5.5
Casoron	4	Enquik, Rely	10 gal, 1.0	7.8	8.3	8.5	8.7	8.9	8.6	9.0	9.1	8.9	8.3	7.2	6.5
None	0	Aim	0.1	7.1	7.4	7.8	8.1	8.1	7.8	8.5	8.8	7.4	7.1	7.3	6.3
None	0	Goal	0.4	2.0	6.9	7.4	7.4	7.3	7.1	7.0	7.2	7.2	6.3	5.9	3.9
None	0	Enquik, Rely	10 gal, 1.0	7.6	8.1	8.4	8.7	8.7	8.8	9.2	8.5	8.5	7.8	7.6	6.9
None	0	None	0	8.1	8.3	8.7	9.0	8.9	8.8	8.6	8.0	8.1	8.0	8.3	7.0
None	0	None	0	8.4	8.3	9.1	9.1	9.2	9.1	9.0	8.9	8.6	8.2	7.1	5.2
$LSD_{0.05}$				0.8	0.7	0.7	0.8	0.8	0.9	1.4	1.6	ns	ns	ns	ns
Primocane height				cm											
Casoron	4	None	0	32	44	46	53	58	61	59	62	67	65	62	59
Casoron	4	Aim	0.1	17	32	35	42	46	48	48	49	47	45	44	49
Casoron	4	Goal	0.4	0	22	25	33	37	39	36	37	42	40	42	47
Casoron	4	Enquik, Rely	10 gal, 1.0	21	36	38	44	48	51	54	57	61	60	56	57
None	0	Aim	0.1	21	31	33	40	45	47	51	56	54	51	52	55
None	0	Goal	0.4	4	20	23	29	32	33	34	35	40	35	33	23
None	0	Enquik, Rely	10 gal, 1.0	22	38	40	47	52	55	61	57	65	62	62	66
None	0	None	0	34	45	46	54	58	61	62	60	65	70	73	68
None	0	None	0	33	44	46	53	58	61	64	66	71	68	61	50
$LSD_{0.05}$				3	5	5	6	6	7	10	11	14	17	19	22

[a]Enquik used during 2000 and Rely used during 2001 and 2002.
[b]Greater than 50% root rot in one replicate of these treatments (in two Aim replicates).

Project No: 3555-3375

Title: Organic Management of Raspberry Root Rot

Personnel: Carol Miles, Peter R. Bristow, and Martin Nicholson, WSU Vancouver Research & Extension Unit, and WSU Puyallup Research & Extension Center.

Reporting Period: 2000-2002 (Termination Report)

Accomplishments: Our results indicate that biological control organisms *Trichoderma* and *Gliocladium* can be used to partially alleviate pressure from root rot but neither biological control organism is sufficient to prevent a heavily infected planting from declining. Treatments may only be effective for 1-3 years in a field situation with high disease pressure.

Results: We conducted a 3-year study of some organic options to control root rot (*Phytophthora fragariae* var. *rubi*). We tested 2 biological control organisms, *Trichoderma* and *Gliocladium*, and manure to control root rot. In 2000 and 2001, yield was measured in 5-feet of row by hand harvest. In 2002, yield was measured in 25-feet of row by mechanical harvest. In all 3 years of the study, yields in the plots that received the biological control organisms were greater than yields in untreated plots and were nearly equal to yields in plots that received Ridomil (Table 1). The manure treatment produced increased yields as compared to the untreated check in 2 out of 3 years. However, none of these differences were statistically significant. Root rot in the field plots appears to be a location effect and not a treatment effect (Figure 1).

Table 1. Berry yield per plot (kg) measured by hand harvest in 5-feet of row in 2000 and 2001, and measured by mechanical harvest in 25-feet or row in 2002; weight per berry (g); and percent change relative to the untreated check for raspberry fruit harvested.

Year	Treatment	Berry yield (kg)		%Change	Wt/Berry (g)		% Change
2000	Dairy manure	3.3	A*	32	1.90	A	9
	Ridomil	3.0	AB	21	1.93	A	11
	G-41	2.9	AB	15	1.86	A	7
	T-22	2.8	AB	13	1.90	A	9
	Dairy manure + T-22	2.6	B	5	1.91	A	10
	Gypsum	2.6	B	5	1.81	A	4
	Untreated check	2.5	B		1.73	A	
2001	Dairy manure	2.8	A	-4	3.06	A	28
	Ridomil	4.1	A	40	3.10	A	30
	G-41	3.9	A	34	3.75	A	57
	T-22	3.5	A	20	2.87	A	20
	Dairy manure + T-22	2.7	A	-7	2.60	A	9
	Gypsum	3.6	A	23	2.75	A	15
	Untreated check	2.9	A		2.38	A	
2002	Dairy manure	6.1	A	36	1.13	A	-14
	Ridomil	10.5	A	133	1.47	A	-15
	G-41	9.9	A	120	1.78	A	1
	T-22	6.2	A	38	1.60	A	-6
	Dairy manure + T-22	6.1	A	36	1.56	A	-2
	Gypsum	7.7	A	71	1.78	A	0
	Untreated check	4.5	A		1.72	A	

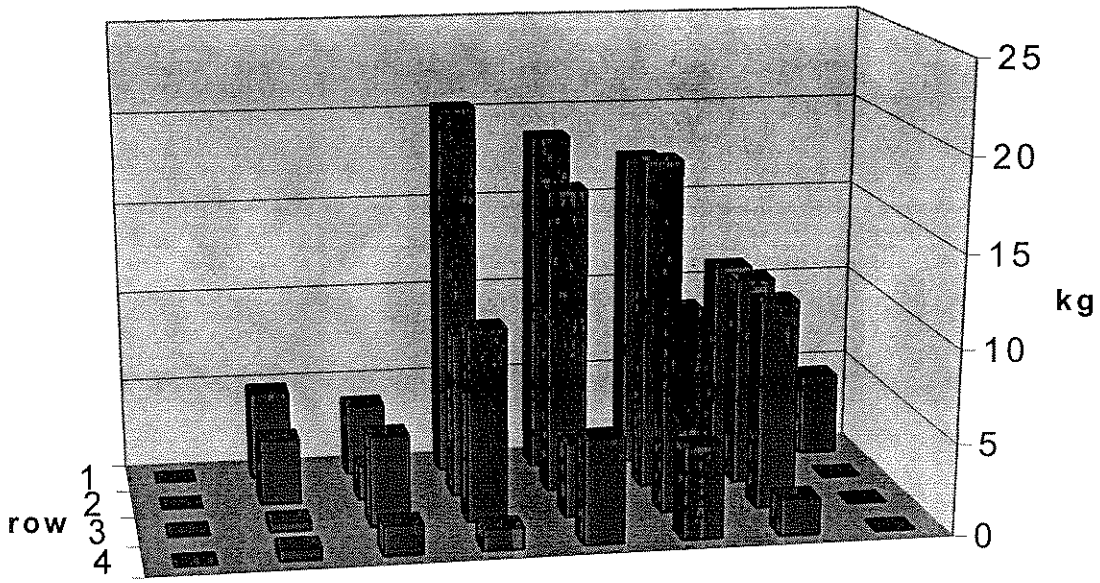

Figure 1. Yield distribution in the field plots.

PUBLICATIONS:

Miles, C., C. Chen, and P. Bristow. 2002. Alternative methods of raspberry production and root rot control. Organic Farming Research Foundation, No. 12:25-26.

Chen, C., and C. Miles, and S. Klauer. 2001. Organic raspberry production and root rot control. Am. Soc. Hort. Sci. Abstr. 2001:475-476.

Miles, C., and T. Flores. 2000. Raspberry Root Rot Busters. Western Fruit Grower, Sept. 2000:12C.

Current & Pending Support

Instructions:

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

Name (List PI/PD #1 first)	Supporting Agency and Agency Number	Total $ Amount	Effective and Expiration Dates	% of Time Committed	Title of Project
Carol A. Miles	Current: Northwest Center for Small Fruits Research	$13,000	1/1/02 – 12/21/02	5%	Organic Raspberry Root Rot Control
	Pending:				

Form CSREES-663 (6/95)

NEW PROJECTS

Project No.: New

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

Year initiated: 2003

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

Justification: In both 1997 and 1998, red raspberry producers sustained unacceptable losses due to gray mold fruit rot. Berries rotted in the field before harvest and berries harvest for the fresh market turned moldy in containers before they could be sold. These losses occurred despite the use of fungicides registered at the time. In addition to weather conditions favorable to *B. cinerea,* widespread resistance to fungicides in the benzimidazole (Benlate) and dicarboximide (Ronilan and Rovral) groups contributed to rapid disease buildup. Beginning with the 1999 season, growers have been able to use the new fungicide Switch on annually granted Section 18 Emergency exemptions. Switch has two active ingredients, one acts systemically and the other as a protectant. Syngenta the manufacturer of Switch recently submitted its registration package for caneberries to EPA. Arvesta received a Section 3 regisratio0n for Elevate fungicide just in time for the 2002 crop season. Two BASF compounds (BAS 510 and BAS 516) field-tested in WA in 2002 provided excellent control of Botyrtis in post harvest tests.

In our 1999 fruit rot fungicide trial damage caused by the two-spotted spider mite (TSSM)(*Tetranychus urticae*) was significantly greater in plots treated with captan of the formulation of the biofungicide Serenade used that year. Mites populations were not as explosive in the 2001 trial but in 2002 three types if mites were present: TSSM, European red mite (ERM)(*Panonychus ulmi*) and yellow spider mite (YSM)(*Eotetranychus carpini-borealis*). Mite counts were taken on several dates during the 2002 crop season and that data is currently being summarized. Damage was greater in plots of some fungicide treatments than others.

Objectives:

1. Evaluate new fungicides control of gray mold fruit rot under field conditions.
2. *Determine which fungicides promote increased damage from mites.*

Procedures: A field trial will be established in a commercial field with a history of fruit rot and mites. Fungicides will be applied with an over-the-row boom sprayer. Treatments will be replicated four times and individual plots will be 25-30 feet long. Newer fungicides will be tested individually and a water check will be included for comparison. Data to be taken will include machine-harvested yield, evaluation is post harvest fruit rot tests and evaluation of laterals and primocanes for cane diseases (cane Botrytis and spur blight). If the season is dry like 2002 was it may be unnecessary to date data on cane diseases.

Leaves will be sampled from every plot of several dates during the summer to determine the species of mites present and their respective numbers. HOBO recorders will be placed in the plant canopy to continuously record temperature and relative humidity. A weather station will be maintained on-site to monitor other environmental conditions.

Anticipated Benefits and Information Transfer: We expect to be able to identify new fungicides for effective control gray mold fruit rot. Efficacy data from this trial will help support

registration requests to EPA by the manufacturer or through the IR-4 Program. Mite data will be valuable to growers particularly if one or more of the new fungicides cause increased damage from mites. Information of the interaction of fungicides used for fruit rot control and mites found on red raspberries will have an impact on IPM decisions. The results of this study will also be disseminated through local and regional publications including the Pacific Northwest Plant Disease Management Handbook and the Pest Management Guide for Commercial Small Fruits when and where appropriate.

Budget:

Notes:

- WSU is no longer funding 100% of the salary for the Agricultural Research Technologist III position in my program. For this reason, a portion of that salary is included in this budget.
- Because of the financial constraints the Commission is working under again this year, the budget is broken down by objective.

Request for FY 2003-04

Category	Objective1 Fungicide trial	**Objective** 2 Infection timing
Salaries (Agr. Res. Tech.)	$1,000	
Timeslip labor	1,900	1,000
Services and Supplies	500	100
Travel	800	100
Benefits		
Agr. Res. Tech.	260	
Timeslip labor	304	160
	$4,764	$1,360
Grand total	**$6,124**	

Other Support for the Project:

1) A grant-in-aid request will be submitted to each company with a fungicide in the trial.
2) One or more grant proposals will also be submitted to:

- Washington State Pesticide on Registration Commission (WSPRC) for funds to a) reimburse the cooperating grower for fruit that must be destroyed because it has been treated with experimental chemicals and b) support other project costs. In-kind contributions (insect and weed control, harvesting, etc.) from the cooperating grower can also be used for the match.
- The Oregon Raspberry and Blackberry Commission.

Project No.: New
Title: Threshold Development and Monitoring of the Western Raspberry Fruitworm, *Byturus unicolor.*
Year Initiated: 2003 **Current Year:** 2002 **Terminating Year:** 2005

Personnel:

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

Collaborators:

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

Justification:

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

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

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

Objective:

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 product grades 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.

Procedures:

1. Using our previous field experiences with visual trapping and Stuart Gordon's expertise, we will trial different manufacture sources of white, non-UV reflective insect traps. Traps will be placed in participating growers' fields in mid-April. Traps will be placed 10 post-lengths apart to minimize any interaction between traps. Weekly counts will be taken at each trap site to build a seasonal pattern of activity for WRFW at each site surveyed. Pre-bloom, post-

bloom and post-harvest intervals will be monitored for WRFW adult flight in order to construct thresholds and precision timing recommendations for management.

2. *In 2002, it was found that fruitworm infestations could be calculated by looking at receptacles left on the canes after harvest. Using this method, total percent of fruit infestation can be correlated with flight trap data collected. Additionally, percent fruit infestation will be determined in regular intervals during harvest by picking a standard number of fruit and receptacles from each field monitored. We will be looking to collect data from those fields established for juice grade and do not have a WRFW program. When data collection is completed, we will correlate flight trap data for pre-bloom, post-bloom and post harvest intervals with percent fruit infestation. Given enough data points, we can regress these points to form a predictive fruit infestation rate based on flight trap data.*
3. Using new technologies available, we will record weather events through the season. The newly installed Public Agriculture Weather System (PAWS) and onsite data loggers, we can monitor biological activities of WRFW in relationship to macro and microclimatic events. Forming temperature and climatic dependant models of WRFW phenology will aid in the prediction of WRFW activities.

Anticipated Benefits and Information Transfer:

In close collaboration with Dr. Tanigoshi, this specific effort compliments existing red raspberry research to identify new, alternative strategies for managing WRFW. Anticipated benefits of this research will lead raspberry growers to a reduced reliance on diazinon and remove calendar-based pesticide applications from their pest management program. Firstly, this research will be able to recommend a trap design that is readily available for purchase by growers. Secondly, by looking at infestation rates relative to adult flight we can develop a functional threshold based on trap counts for management decisions. Finally, using environmental data and observing significant biological events of the WRFW, we can look to build a predictive model of fruitworm activity. Using a predictive model based on temperature data, growers will have that ability to precisely time management efforts and avoid unnecessary or ill-timed diazinon applications. Having an effective trap design and monitoring program will empower growers to make decisions on whether to manage WRFW or not, ultimately leading to a reduction in diazinon use. This effort will result in a threshold for fruitworm tolerances, crucial for the decision-making processes of IPM.

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

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

Other Support of Project:

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

Current & Pending Support

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

Name (List PI #1 first)	Supporting Agency and Project #	Total $ Amount	Effective and Expiration Dates	% of Time Committed	Title of Project
	Current:				
MacConnell, Craig	Whatcom County	$75,000	2000-2003	20%	Whatcom County Integrated Pest Management Project
Tanigoshi, Lynell	Washington Red Raspberry Commission	$18,318	2002-2005	02.5%	Insect and Mite Control in Red Raspberries
Tanigoshi, Lynell	Northwest Center for Small Fruits Research	$17,743	2001-2002	2.5%	Further evaluation of control strategies for root weevils in strawberries and red raspberries
	Pending:				
MacConnell, Craig	EPA Region 10/American Farmland Trust	$50,000	02/03 – 01/05	50%	Integrated Pest Management for Western Raspberry Fruitworm, *Byturus unicolor* (Coleoptera: Byturidae).
Tanigoshi, Lynell	Northwest Center for Small Fruits Research	$19,140	2002-2003	15%	Further evaluation of control strategies for root weevils in strawberries and red raspberries

Project No: New
Title: Weed Control in Red Raspberries
Year Initiated: 2003-04 **Current Year:** 2003-04 **Terminating Year:** 2005-06
Personnel:

Timothy W. Miller, Extension Weed Scientist, WSU Mount Vernon
Brian Maupin, Research Technologist, WSU Mount Vernon

Justification:

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

Weed control in newly-transplanted (baby) raspberries therefore merits further examination. Broadleaf herbicides currently registered for this use include simazine, Devrinol (napropamide), Surflan (oryzalin), Basagran T/O (bentazon), and Gallery (isoxaben) and of these, only Basagran has postemergence activity. In 2002 research at WSU Mount Vernon, eight additional herbicides were tested in baby raspberries, applied at planting (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%). This trial is being continued in 2003 on one-year old canes, but combination treatments with various herbicides applied PRE and POST, directed need further evaluation to determine their safety to raspberries newly planted in the spring of 2003.

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

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

Procedures:

1. *Baby raspberries*:

   (a) Plots established in 2002 at WSU Mount Vernon will be maintained the second growing season and various products and rates applied. Three cultivars were included in this trial ('Meeker', 'Tulameen', and 'Willamette'). Canes were cut at the soil surface in fall, 2002. Herbicide applications will be made during dormancy (2002-03) and directed sprays used

following budbreak in spring, 2003 and again at mid-season. A total of ten treatment combinations will be tested and their effect on weed control and primocane growth (number, height, and diameter) will be monitored during 2003.

(b) Long-term plots will be established at a currently undetermined site where perennial weeds of various species have been problematic in the past. This may be at a grower's field or at WSU Vancouver/Mount Vernon. Baby raspberries will be transplanted in spring of 2003 and various herbicides will be applied alone and in combination. Effect of the products on primocane growth, weed control, and ultimately on berry yield will be evaluated. Plots will be maintained for three growing seasons (2003-2005).

2. *Yellow nutsedge*: Plots will be established in 2003 in severely-infested raspberry field, probably near Woodland, WA. Herbicide applications will be made during dormancy (2002-03) and POST directed sprays used in spring, 2003. Yellow nutsedge control will be evaluated, as will herbicide effects on raspberry yield and berry size.

Anticipated Benefits and Information Transfer:
These studies will improve weed control practices in baby raspberries by adding to the knowledge of growers when they make decisions regarding herbicide selection and application. Data from this experiment will be used to support new herbicide registrations in baby raspberries and to fine-tune existing labels. The data resulting from these studies will be disseminated through extension bulletins and during grower meetings sponsored by extension faculty and the agricultural industry.

Budget:
Amount allocated to PI by Commission for FY 2002-2003:
Caneburning and weed control in red raspberries, $ 4,000

	Requested 2003-04
Time-slip	$ 3,000
Operations (goods & services)	500
Travel	
Projected Needs	250
Meetings	0
Other	0
Equipment	0
Employee Benefits (16%)	480
Total Request	$ 4,230

Other Support of Project:

Herbicides are typically provided by herbicide manufacturers. Additional funding will be requested from the manufacturers of tested herbicides.

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.				
Miller & Libbey	10A 3093 2507	$ 1,790	7/1/01 to 6/30/02	5	Weed control in organic strawberries
Miller & Libbey	10A 3093 2508	13,020	7/1/01 to 6/30/02	5	Weed control in cauliflower
Miller & Libbey	10A 3093 2530	4,500	7/1/01 to 6/30/02	5	Organic caneburning in red raspberries
Boydston, Miller, and Yenish	10A 3093 2547	4,000	7/1/02 to 6/30/03	5	Flumioxazin and sulfentrazone in peas and lentils
	WA Bulb Com.				
Miller & Libbey	13C 3419 4228	10,950	2/1/02 to 1/31/03	10	Weed control in ornamental bulbs
	WA Blueberry Com.				
Miller & Libbey	13C 3419 5229	4,230	7/1/02 to 6/30/03	5	Weed control in blueberries
	WA Strawberry Com.				
Miller & Libbey	13C 3419 8228	10,120	7/1/02 to 6/30/03	10	Weed control in strawberries
	WA Raspberry Com.				
Miller & Libbey	13C 3419 3297	4,000	7/1/02 to 6/30/03	5	Caneburning and weed control in raspberries
	NARF				
Miller & Libbey	13K 3419 5228	8,710	7/1/02 to 6/30/03	10	Weed control in green peas
Miller & Libbey	13K 3419 6228	12,530	7/1/02 to 6/30/03	10	Weed control in cucumbers
Miller & Libbey	13K 3419 7228	10,450	7/1/02 to 6/30/03	10	Weed control in vegetable seed
	Pending:				
du Toit & Miller	WA Com. Pest. Reg.	$ 20,530	7/1/03 to 6/30/04	5	Biofumigation in spinach seed
Miller & Maupin	WA Com. Pest. Reg.	9,000	7/1/03 to 6/30/04	5	Weed control in cucurbits

Project: New

Title: Organic Management of Raspberry Root Rot

Year Initiated: 2003 **Current Year:** 2003 **Terminating Year:** 2006

Personnel: Carol Miles, Peter R. Bristow, and Martin Nicholson, WSU Vancouver Research & Extension Unit, and WSU Puyallup Research & Extension Center.

Justification: There is increased interest among growers to explore organic options for controlling root rot (*Phytophthora fragariae* var. *rubi*). Research conducted by Dr's Bristow and Pinkerton has shown that one strategy alone, such as raised beds or gypsum, is not adequate to control raspberry root rot in the Pacific Northwest. A 3-year study conducted by Dr's Miles and Bristow was inconclusive regarding the use of two biological control organisms *Trichoderma* and *Gliocladium* to control root rot. In all 3 years of the study, yields in the plots that received the biological control organisms were greater than yields in untreated plots and were approximately equal to yields in plots that received Ridomil. However, none of these differences were statistically significant. Also included in this 3-year study was a manure treatment that produced increased yields (though not statistically significant) when compared to the untreated check in 2 out of 3 years. The beneficial effects of manure may be due to suppression of the root rot pathogen or to nutritional benefits to the plant. To separate the effects of manure on root rot suppression from benefits due to improved nutrition, we have begun a new study at WSU VREU. Results of the study of manure effects on root rot suppression and overall plant health will benefit many growers including those who require effective organic or non-chemical strategies for root rot control and will especially benefit growers in Northwest Washington where manure is a readily available resource.

Objectives: (1) Explore the effects of manure on the suppression of the root rot pathogen and impact on raspberry plant health and fruit yield.
(2) Determine if there are any human pathogen risks due to the use of manure in raspberry production.

Procedures: This study will be conducted on a two-acre field of 'Meeker' established in 1997 at WSU Vancouver Research and Extension Unit (VREU). The planting is on raised beds with drip irrigation, and plots are 60 feet long. The soil is naturally infested with *P. fragariae* var. *rubi* and results in medium to high disease pressure. Fruit are mechanically harvested. Benefits of manures on raspberry productivity will be studied in a randomized complete block design with 4 replications and 6 treatments: poultry manure, dairy manure, Ridomil, poultry manure + Ridomil, dairy manure + Ridomil, and the control. This study will enable us to investigate the potential benefits of manure applications on plant health and fruit yield and to determine if there is an interaction between manure and the chemical fungicide. Harvested raspberries will also be assayed for potential human pathogens *E. coli* 157 and *Salmonella* at the Oregon State University Food Science and Technology laboratory.

Anticipated Benefits and Information Transfer: The results from this study will support the transition of berry production in the Northwest to organic and sustainable farming systems. It will provide all berry growers with IPM strategies that are cost effective. This research will help the Washington raspberry industry gain a competitive edge in the US and international berry markets with increased berry quality and reduced production costs. Each spring, Dr. Miles will compile results into a project report to be published in regional magazines and newsletters such as

Western Fruit Grower, Washington Tilth Journal and Pacific Northwest Sustainable Agriculture Newsletter. Results will be available at regional grower's and researchers meetings and the field research site will be available for a field day. Updates and reports will be posted on the Agricultural Systems website, http://agsyst.wsu.edu.

Budget:

Request for FY 2003-2004: $ 6180

Time-slip	$3000
Operations	$ 500
Travel	$ 200
Equipment[1]	$2000
Employee Benefits	$ 480

[1] *Funds from WRRC will be used to match NWCSFR funds to purchase a manure spreader. A manure spreader is needed to effectively apply manure treatments to large plots at WSU Vancouver REU.*

Other support of project:
NWCSFR currently supports this project – see attached form on current and pending support.

WRRC funds are necessary for us to seek a match from WSCPR.