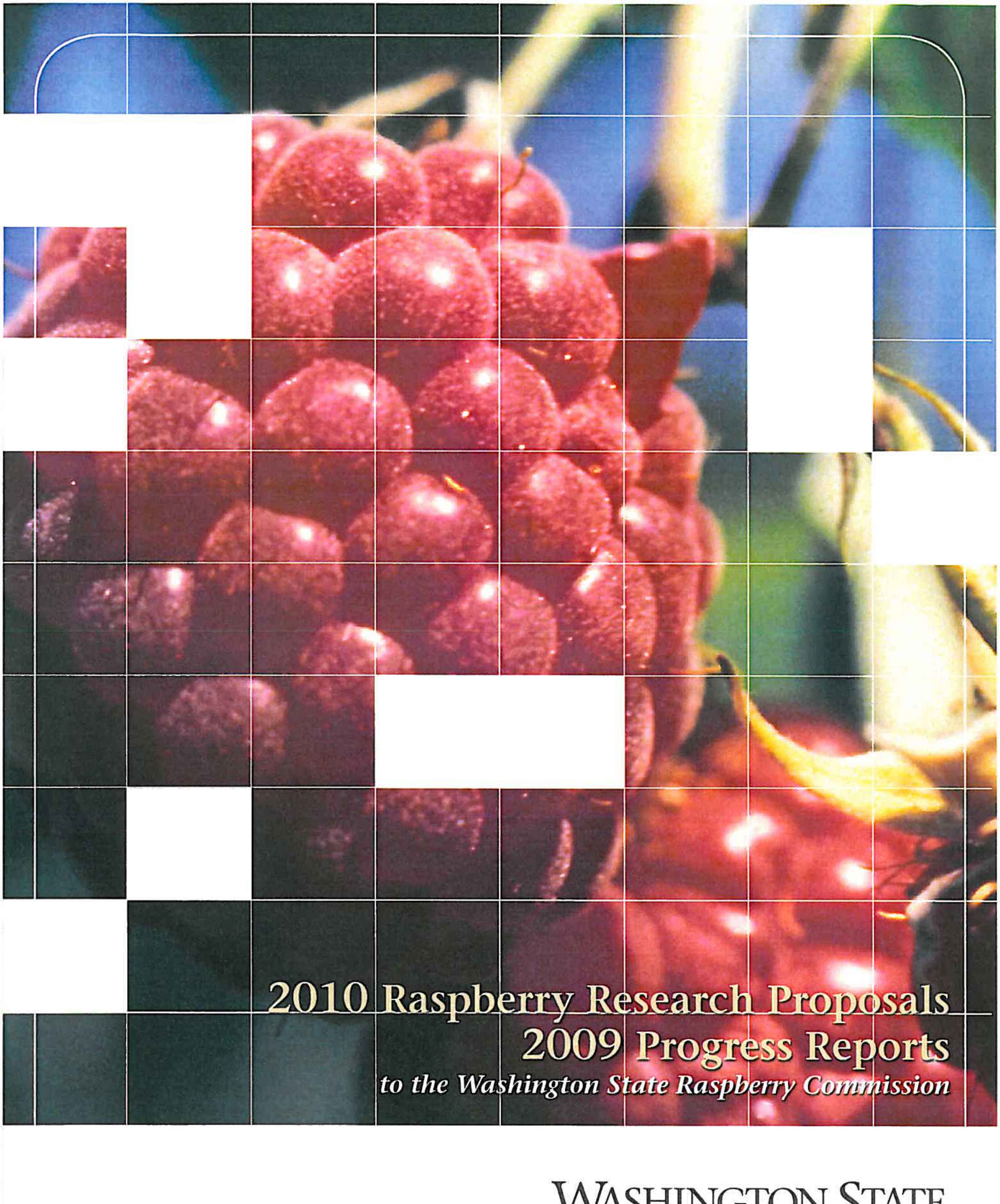

2010 Raspberry Research Proposals
2009 Progress Reports
to the Washington State Raspberry Commission

WASHINGTON STATE UNIVERSITY

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Summary of
Budget Requests

Terminating Projects, 2009:

Project No.	Short Title	Lead Scientist	Requested
13C-3543-4370	Integrating Insect & Mite Mgmt	Tanigoshi	$ 9,060

Ongoing Projects, 2009:

Project No.	Short Title	Lead Scientist	Requested
13C-3755-5641	Red Raspberry Breeding	Moore	$45,000
13C-3755-3641	Machine Harvesting	Moore	$ 6,842
13C-3419-7297	Postemergence Can Thistle	Miller	$ 3,932
	RR Cultivar Development	Kempler	$ 7,000
13C-3455-4635	Efficacy of a Phosphite	Walters	$ 6,150
	Coop Raspberry Cultivar	Finn	$ 7,500
	Indentifying Root Traits	Bryla	$12,604
	Eval of Novel Nematicides	Zasada	$ 7,633

Current Year Funding Requests, 2010:

Project No.	Short Title	Lead Scientist	Requested
13C-3755-5641	Red Raspberry Breeding	Moore	$60,000
13C-3755-3641	Machine Harvesting	Moore	$ 4,056
	RR Cultivar Development	Kempler	$ 9,000
13C-3455-4635	Efficacy of a Phosphite	Walters	$ 4,745
	Coop Raspberry Cultivar	Finn	$ 4,500
	Indentifying Root Traits	Bryla	$12,584
	Eval of Novel Nematicides	Zasada	$11,854

New Projects, 2010:

Short Title	Lead Scientist	Requested
Postemergence Perrenial Weed Control	Miller	$ 3,938

2010 Production Research Priorities

Primary Priorities

- Develop Cultivars that are summer bearing, high yielding, winter hardy, machine harvestable, disease resistant, virus resistant and have superior processed fruit quality.
- Understanding soil ecology and soil-borne pathogens, and their effects on plant health and crop yields.
- Fruit rot including pre-harvest, post-harvest and/or shelf life.
- Soil fumigation techniques and alternatives.
- Harvest contaminants and problems stemming from the loss of long-standing insecticides and namatacides.
- Evaluation of the lifecycle, economic impact and management tactics of the Spotted Wing Drosophila.

Secondary Priorities

- Product/production certification systems: Food safety and security, standards, traceability.
- Weed management.
- Nutrient/irrigation management.
- Viruses/crumbly fruit.
- Mite management.

Tertiary Priorities

- Nutraceutical/nutrition benefits for product development.
- Season extension: improve viability of fresh marketing.
- Labor saving cultural practices including mechanical pruning and tying techniques.
- Foliar and cane diseases (i.e. spur blight, yellow rust, cane blight, etc.)

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2009 PROGRESS REPORT

Title: Red Raspberry Cultivar Development for the Pacific Northwest

Personnel: Chaim Kempler, Research Scientist
Brian Harding and Andrea Muehlchen, Technicians

Agriculture and Agri-Food Canada, Pacific Agri-Food Research Centre
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Summary:

In 2009, PARC selections that were planted on two WARRC sites for machine harvest evaluation were evaluated. Yield data from more than one hundred plots was collected from trials planted in 2005 and 2006. Soon the two recently released cultivars Ukee and Rudyberry will be released to PNW propagators and available for grower trials. The Saanich and Chemainus cultivars released from the PARC have performed very well on growers' fields producing high yields of excellent quality fruit. They are planted extensively by growers and are becoming important cultivars for the industry.

Accomplishments:

The latest releases from the PARC program performed very well; Chemainus (tested as BC89-33-84) machine harvests very well, producing high quality fruit that is suited for both the fresh and the IQF processing markets. Saanich (tested as BC89-34-41) has gained wide acceptance by commercial producers because of its large yields of high quality fruit that machine harvest very well and produce a top quality IQF product. Ukee (tested as BC92-6-41) is highly resistant to rot root induced by Phytophthora fragariae Var rubi and is suitable for machine harvesting, IQF and fresh market sales. Rudyberry (tested as BC90-4-24) produces very high yields of excellent quality fruit that ripen a few days earlier than Meeker.

This year three machine harvest trials were harvested and evaluated. Two were planted at Randy Hancoop's (Lynden) in 2005 and 2006 and one at Sakuma (Mt. Vernon) in 2007. The results identify several selections that appear to harvest very well (table 1). Some of the selections are already in advanced propagation stages and will be released for growers' trials.

During the 2009 harvest season, the 2005 and 2006 plantings were evaluated for yield, fruit traits and harvest season. Harvest data is presented in Tables 2-4. Twenty-nine selections tested RBDV positive for the first time, and most of them were discarded. One hundred and forty-nine new selections, mostly from parents combining resistance to RBDV and root rot, were identified from the 2006 crosses. They are all propagated by tissue culture and will then go through root rot screening before being field planted in the spring for yield and machine harvesting evaluation. Seventy-six new crosses were made; most with one or two parents that are resistant to root rot and RBDV, crosses were also made with germplasm to improve Vitamin C and antioxidants content of the fruit. The seed are being propagated and will be planted in the spring of 2010 after a screening for resistance to aphids.

Notes on cultivars and potential new cultivars:

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

Saanich [(Algonquin x Chilliwack) x (Nootka x Glen Prosen)]: Tested as BC89-34-41, the Saanich cultivar is a promising release from the PARC breeding program. It is very productive, producing very high yields with a fruit size that is slightly larger than Meeker and is suited for the fresh or processing markets. The excellent quality fruit are firm with medium gloss, very fine drupelets and a very pleasant sweet flavor associated with low acidity that is comparable to Tulameen. Because of its small drupelets size the fruit IQF extremely well holding its shape with no breakage. The canes are spineless with laterals that are short and bend easily without breaking and so are able to carry the high yield. In large growers' trials, the fruit released well from the receptacle and harvested very well mechanically. This selection, although exposed to high pressure of RBDV for many years, has been very slow to show RBDV infection and to date has not tested positive on any of the commercially planted fields. It was released because of its productivity, suitability for machine harvesting and exceptionally high fruit quality that is suited for IQF. It produces medium-sized, medium-light-red firm fruit. Its very sweet flavor might also make it suited for specialty fresh fruit markets (yield data presented in the tables).

Ukee (Chilliwack x BC86-41-15): Ukee is a new floricane-fruiting red raspberry cultivar from the PARC breeding program Ukee produces a high yield of firm large-sized fruit suited for both the fresh and processing markets. It machine harvested very well suited for individually quick frozen (IQF). Ukee exhibits an excellent degree of field and greenhouse resistance to root rot caused by P. rubi. It is also resistant to the large raspberry aphid, Amphorophora agathonica, a vector of the raspberry mosaic virus (RMV) complex. Ukee, tested as BC92-6-41, was selected from a 1992 cross Chilliwack, and selection BC86-41-15. Chilliwack was selected from a cross between BC64-10-198 and Skeena. The other parent, BC 86-41-15, comes from a 2nd back cross from the North American wild raspberry R. strigosus (the Dalhousie Lake 4 clone). This clone was collected from Quebec and has a high level of resistance to root rot caused by P. rubi. Ukee floricanes are straight and strong. They are thinner than those of Tulameen, Malahat and Chemainus but similar to those of Saanich and Meeker. The canes are noticeably shorter than most other varieties but long enough for use in a 'looped' trellis system. Ukee laterals are long and strong and carry the yield very well; fruit is spread on the laterals and is well presented. The bark is colored cinnamon brown with minimal basal cracking. Spines are also cinnamon brown, 2 mm long, downward pointing and with no basal spot. The spines are plentiful on the lower 40 cm of the cane but reduced in number and length acropetally. Ukee primocanes turn brown to the tip and shed their leaves earlier in the fall than most other varieties.

Ukee fruit have an excellent appearance; fruit are medium to large in size and conical with small drupelets. Fruit colour is medium to light red with low gloss and some dusty appearance. Ukee is productive and keeps good fruit size over its long harvesting season. The fruit colour is lighter than that of Meeker; it is acceptable for IQF and possibly for other types of processing where dark pigment is not required. In machine harvest trials Ukee rated as suitable for machine harvesting, giving good fruit quality that is suited for IQF. In IQF trials it appears acceptable, but more testing is needed. The ripening season for Ukee is similar to that of Meeker. Because of its long laterals, Ukee fruit is exposed and therefore easy to hand harvest; the flavour is very good and the fruit size is larger than that of Meeker which makes Ukee very suited for the fresh market. Ukee was selected for resistance conferred by the Ag_1 gene to the common biotype of A. agathonica, the N. American large raspberry aphid vector of the RMV complex, and it has tested negative to RMV ever since the genotype was selected. Ukee first tested positive for RBDV in 2003, five years after it was planted in the field. This delay in getting infected with RBDV suggests that it is moderately tolerant. It has exhibited a high degree of field resistance to root rot caused by P. rubi and under extreme root rot pressure at WSU Puyallup it did not show symptoms. While not resistant to spur blight, (Didymella applanata), Ukee has been rated as less susceptible than Meeker, Malahat, Chemainus or Tulameen. Ukee, Meeker, Saanich and Malahat have similar (low) susceptibility to cane Botrytis (B. cinerea) and show more resistance than Tulameen or Chemainus. Ukee is moderately susceptible to anthracnose (Elsinoe veneta), having a response similar to Meeker.

Rudyberry (BC86-41-16 x Qualicum): Rudyberry is a new floricane-fruiting red raspberry cultivar from the PARC breeding program. Rudyberry produces a high yield of firm large-sized fruit that mature early and machine harvest very well and are suited for processing and also for the fresh market. The Rudyberry cultivar exhibits some degree of resistance to root rot caused by P. rubi. It is also resistant to the large raspberry aphid, Amphorophora agathonica, a vector of the raspberry mosaic virus (RMV) complex. It was named after Mr. Rudy Janzen on whose field this cultivar was tested. Mr. Janzen played an important part in the testing and evaluation processes of the cultivar. Rudyberry tested as BC90-4-23, was selected from a 1990 cross of the PARC released cultivar, Qualicum, and selection BC86-41-15. Qualicum was selected from a cross between the SCRI cultivar Glen Moy and Chilliwack. The other parent, BC 86-41-15, comes from a 2nd back cross from the North American wild raspberry R. strigosus (the Dalhousie Lake 4 clone). This clone was collected from Quebec and has a high level of resistance to root rot caused by P. rubi.

Rudyberry floricanes are straight and strong and thinner than those of Tulameen, Malahat and Chemainus but similar to those of Saanich and Meeker. When selected in 1994 from a single plant it was noted as early ripening with long laterals, attractive appearance, nice flavor, firm fruit just over 4 g, only a few spines, easy to harvest, medium vigor and potentially resistant to the resistance-breaking biotype of the large raspberry aphid. Rudyberry laterals are long and strong and carry the yield very well; fruit is spread on the laterals and is well presented. The bark is colored light red-brown with no basal cracking. Spines are 3 mm long, downward pointing and with no basal spot. They are a bit longer and thicker than those of Meeker but less abundant on the basal 60 cm, they become reduced in number and length acropetally. Rudyberry fruit have an excellent appearance; fruit are medium to large in size and conical with medium size drupelets. Fruit colour is medium to dark red with high gloss. Rudyberry is productive and maintains a good fruit size over its harvesting season. The fruit colour is similar to that of Meeker; it is acceptable for processing where dark pigment is required. It machine harvests very well with harvest starting a few days before Meeker and ending almost a week before Meeker. Rudyberry was selected for resistance conferred by the Ag_1 gene to the common biotype of A. agathonica, the North American large raspberry aphid vector of the RMV complex, and it has tested negative to RMV ever since the genotype was selected. Rudyberry first tested positive for RBDV in 2000, six years after it was planted in the field. It has exhibited some degree of field resistance to root rot caused by P. rubi. While not resistant to spur blight, (Didymella applanata), Rudyberry has been rated as less susceptible than Meeker, Malahat, Chemainus or Tulameen. Rudyberry, Ukee, Meeker, Saanich and Malahat have similar (low) susceptibility to cane Botrytis (B. cinerea) and show more resistance than Tulameen or Chemainus. Rudyberry is moderately susceptible to anthracnose (Elsinoe veneta), having a response similar to Meeker. Rudyberry is a multi-purpose cultivar that is suited for machine harvesting/processing and the fresh market. Because it shows some resistance to root rot and is early ripening it may be also suited for the early fresh market as replacement to the root rot susceptible cultivar Malahat.

New selections for growers' trials:

BC90-8-11 (BC86-41-15 x Qualicum): This is a 2nd backcross from a R. strigosus Dalhousie Lake 4 clone. It produces a large mid-to-late season crop that is most suited for the fresh market but also might be acceptable for processing. The fruit is large (5.5 g) and meaty, light red in color, glossy, firm, conical in shape and very attractive. The plant has a good vigor with light green foliage an upright habit and producing enough replacement canes. The fruit is well spaced and presented on the laterals.

BC90-8-20 (BC86-41-15 x Qualicum): A productive mid-season selection that produces very large long meaty fruit (5.9 g) that is a dull light red in color and most suitable for the fresh market. This selection is not suited for mechanical harvesting. The large, low-gloss fruit strongly resembles Qualicum. Plant vigor is not excessive with leaves that are large and light green color, laterals are long. It is resistant to aphids and might also be resistant to the resistance-breaking biotype of aphid. It does not appear to be field resistant to root rot.

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

BC92-5-47 (Kitsilano x BC86-40-6): Productive selection producing mid-size fruit. Originates from a 3rd back cross from the R. strigosus the Dalhousie Lake 4 clone. It has performed well in MH trials and has yet to be tested on larger trials. The fruit is medium size (3.8 g) dark, firm and round shaped with fine drupelets but appears to be not suited for IQF processing but likely because of its dark color it may be suited as Willamette replacement. Fruit has excellent flavor that is very aromatic and with good acidity. It is not resistant to RBDV and has above average field resistance to root rot. The plant is productive with strong laterals it producing earlier crop than Meeker (tables1, 2a and 4)

BC96-22R-55 [(Tulameen x R. strigosus) x (Cherokee x Qualicum)]: This selection is from a 1st back cross from R. strigosus, collected from 8th Lake State Park Campground, Adirondack State Park, NY. The parent was selected because of its resistance to root rot. In machine harvesting trials, it harvested very well, producing fruit as dark colored as Meeker. The fruit is attractive and large in sized (4.7g). It is round shaped with large, coarse drupelets and a glossy red color. The plant growth habit is well adapted for machine harvesting, with short, strong, upright laterals and good vigor. The harvest season of this selection starts later than Meeker's season and is short and concentrated. It appears to have very good field resistance to root rot. It tested positive to RBDV in 2009 after more than 10 year of exposure to the virus in the field. It is possible that it is slow in getting infected. (table 2a).

BC97-30-27 (Qualicum x Willamette): In the machine harvesting trial, this selection harvested well. The fruit size is larger and the color is darker than Meeker; the fruit is firm with small, fine drupelets. Because of its dark color it may be a good replacement for Willamette as it is higher yielding and stands better to root rot than Willamette. The fruiting season is earlier to that of Meeker and more similar to Willamette. It is not resistant to RBDV, stand well to root rot and it is resistant to aphids.

BC1-16-8 (Newburgh x Glen Rosa): A very productive selection producing high yields, large fruit that mature a few days earlier than Meeker. Fruit is dark with small drupelets that hold together very well so it may IQF very well. It performed very well in the MH trials (Tables 2c and 4).

BC1-61-38 (BC90-19-34 x Glen Magna) Extremely late, finished flowering in late July, fruit rips into September. Excellent fruit quality that ripe later and appears more attractive than Octavia. Fruit is dusty meaty, firm with average size of 3 g and very high yield. Canes are thorny, this selection may be resistant to root rot.

BC3-14-12 (Cowichan x Esquimlut) Very productive selection suited for the processing and the fresh market that ripen almost a week later than Meeker and produce large fruit with thick meaty walls and is shaped like a barrel. In field trials it stood very well to root rot pressure (tables 1, 2c and 4).

A limited number of plants from this list will be available for trials from PARC Agassiz (604)796-1716; 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.

Table 1. Results summary of the 2009 machine harvesting trial from the Sakuma (S) and Hancoop (H) planted in 2004, 2005 and 2006 respectively.

Clone	Parents	Testing location	Tested RBDV+[1]	Yield (% of Meeker)	Fruit size (g)	Root rot rating (1=low)	Fruit description	Comments (GT=growers trials)
87-3-37	Cherokee x Tulameen	H 05	*	Low	2.8	1	Round, dark	Harvest well, resistant to RR.
Ukee	Chilliwack x 86-41-15	H 06	S	106	3.9	1	Dull light red color, small drupelets	Harvest very well suited for processing IQF and FM.
BC92-5-47	Kitsilano x 86-40-6	S07	S	74	3.2		Very aromatic, good acid	MH well, not for IQF Willamette replacement
93-9-48	86-41-25 x Sumner		-	95	3.9	1.0	IQF type light, FM, firm, light.	Harvest well, stand to RR.
93-15-38	86-41-25 x Qualicum		S	74	4.0	1	Dark, fine drupelets, firm, high quality	GT harvest well suited for processing and fresh market
93-15-40	86-41-25 x Qualicum	H 05	-	117	4.0	1.1	Light red glossy, round shape, large drupelets	GT harvest well suited for processing and fresh market
96-13R-122	90-20-20 X 86-6-15	H 05	-	79	3.1		Round firm dark glossy	Harvest well, IQF, early
96-17R-47	90-20-40 x 86-6-16	H 05	-	-	4.0	1.0	Firm, conical, med-red.	Harvest well, stand well to root rot
1-3-13	Haida x Cowichan	H05	*	high	4~	1.0	Meeker like, productive	Harvest well, vigor plant.
BC1-86-21	Moutere x Tulameen	S 07		127	4.0		Attractive	Harvest well, attractive
2-1-32	Cowichan x 86-6-15	H06	*	94	3.2	1.0	Dark, good quality	Harvest very well, stand well to root rot.
2-2-18	Cowichan x Nanoose	H05	*	-	-	1.0	Dark, attractive	Health plant, harvest well.
2-20-95	Qualicum x Nootka	H 05	*	105	4.7	1.0	Dark round Nootka like easy release	Harvests well, suited for IQF, very early
BC2-35-34	OPI4	S 07		145	4.0	-	Light, IQF, FM, excellent quality.	Harvest well
BC3-31-3	Cowichan x 97-42-21	S 07		105	4.0	1.1	Meeker like strong good acid, aromatic	Harvest well, short laterals, productive.

[1] * may be resistant to RBDV because one of it parents is resistant.

Table 2a. Yield, fruit weight, harvest season and harvest ease of raspberry cultivars and selections harvested in 2009, Abbotsford, BC.

Clone	Total Yield (kg/hill)	Marketable Yield (tons/ac)	Early Yield[1] (%)	Fruit Weight (g)	5% Harvest (Date)	50% Harvest (Date)	95% Harvest (Date)	Harvest Duration (Days)	Ease of Harvest (1=Easy 5=hard)
2005 Planting									
BC90-19-8	3.60	5.76	4.0	4.2	06-Jul	17-Jul	01-Aug	27	2.6
BC91-24-12	2.46	3.94	11.1	4.3	04-Jul	16-Jul	27-Jul	24	3.3
BC92-05-47	2.28	3.66	33.3	3.9	30-Jun	10-Jul	21-Jul	21	2.8
BC93-15-38	2.17	3.47	0.0	3.2	15-Jul	26-Jul	07-Aug	24	2.8
BC93-15-40	3.45	5.52	14.8	4.3	03-Jul	14-Jul	30-Jul	28	3.0
BC93-18-20	3.63	5.82	1.7	3.4	10-Jul	20-Jul	03-Aug	25	3.1
BC96-22R-55	2.34	3.74	0.0	3.9	12-Jul	21-Jul	06-Aug	27	2.9
BC97-27-2	2.64	4.23	26.8	3.3	30-Jun	12-Jul	03-Aug	35	3.2
BC97-27-31	2.91	4.67	42.4	4.8	29-Jun	08-Jul	19-Jul	21	3.3
BC97-33-33	3.10	4.97	0.0	3.0	10-Jul	21-Jul	05-Aug	27	3.0
BC1-17-6	2.22	3.56	21.1	3.6	02-Jul	13-Jul	26-Jul	25	3.0
BC1-19-11	3.67	5.87	32.9	3.7	29-Jun	10-Jul	25-Jul	27	2.8
BC1-87-19	2.99	4.80	12.6	5.0	03-Jul	14-Jul	27-Jul	26	3.8
BC1-87-2	2.36	3.78	43.5	5.2	30-Jun	07-Jul	19-Jul	20	2.5
BC1-87-9	2.54	4.07	4.2	4.0	06-Jul	16-Jul	30-Jul	25	2.4
BC2-01-32	2.77	4.44	38.7	4.7	29-Jun	08-Jul	19-Jul	21	3.0
BC2-01-57	3.27	5.24	15.4	4.1	02-Jul	15-Jul	26-Jul	25	3.3
BC2-02-18	2.18	3.49	10.9	4.1	03-Jul	14-Jul	31-Jul	29	2.5
BC2-11-59	3.19	5.11	1.3	3.6	08-Jul	19-Jul	04-Aug	28	2.3
BC2-20-23	2.81	4.50	32.8	3.6	02-Jul	09-Jul	19-Jul	18	2.5
BC2-20-95	3.08	4.93	50.9	4.7	29-Jun	06-Jul	19-Jul	21	2.6
BC2-27-20	3.85	6.16	43.3	3.7	29-Jun	09-Jul	31-Jul	33	2.8
C. Delight	3.72	5.95	1.9	3.8	08-Jul	20-Jul	04-Aug	28	3.3
Chemainus	3.37	5.40	5.9	3.5	05-Jul	17-Jul	05-Aug	32	2.1
Cherokee	2.03	3.26	17.1	3.9	03-Jul	13-Jul	24-Jul	22	2.8
Cowichan	2.82	4.52	7.0	4.2	05-Jul	15-Jul	31-Jul	27	2.7
Malahat	2.59	4.15	31.9	4.9	29-Jun	11-Jul	26-Jul	27	2.3
Meeker	2.95	4.73	4.2	3.2	06-Jul	18-Jul	29-Jul	24	3.0
Moutere	3.36	5.38	22.8	4.6	01-Jul	13-Jul	27-Jul	28	2.8
Octavia	3.81	6.10	0.2	3.6	16-Jul	31-Jul	10-Aug	26	3.4
Qualicum	3.71	5.95	3.6	5.1	07-Jul	16-Jul	01-Aug	26	2.9
Saanich	5.50	8.81	5.0	3.0	06-Jul	18-Jul	03-Aug	29	3.0
Tulameen	3.49	5.58	2.3	4.2	07-Jul	18-Jul	05-Aug	30	2.9
Ukee	3.11	4.98	13.4	3.9	04-Jul	15-Jul	30-Jul	27	2.5
LSD[4]	1.35	2.17	17.5	0.9	4	5	7	6	0.9

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

[1]Early Yield harvested before July 16, 2008

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

Table 2b. Yield, fruit weight, harvest season and harvest ease of raspberry cultivars harvested in 2008, Abbotsford, BC.

Clone	Total Yield (kg/ hill)	Marketable Yield (tons/ac)	Early Yield[1] (%)	Fruit Weight (g)	5% Harvest (Date)	50% Harvest (Date)	95% Harvest (Date)	Harvest Duration (Days)	Ease of Harvest (1=Easy 5=hard)
2006 Planting									
BC1-50-14	3.20	5.13	8.8	2.8	04-Jul	18-Jul	01-Aug	30	2.7
BC1-86-21	3.19	5.10	2.1	4.0	07-Jul	17-Jul	04-Aug	29	3.1
BC2-06-16	3.13	5.01	21.6	4.2	01-Jul	12-Jul	28-Jul	28	2.9
BC2-18-49	2.82	4.51	53.7	3.2	29-Jun	06-Jul	20-Jul	22	3.0
BC3-10-15	3.21	5.14	1.3	3.0	08-Jul	20-Jul	05-Aug	29	2.8
BC3-12-2	2.64	4.23	56.9	3.8	30-Jun	05-Jul	18-Jul	20	2.9
BC90-05-30	3.05	4.88	55.7	3.8	29-Jun	06-Jul	16-Jul	18	2.5
BC90-12-50	3.18	5.10	1.8	3.6	07-Jul	18-Jul	03-Aug	28	3.0
BC96-13R-122	2.01	3.21	32.5	3.1	01-Jul	09-Jul	19-Jul	20	2.3
BC96-37-1	3.32	5.31	10.0	3.1	04-Jul	19-Jul	04-Aug	32	3.0
BC97-25-58	2.81	4.49	16.0	3.5	04-Jul	13-Jul	29-Jul	26	2.9
BC97-29-23	3.22	5.15	1.5	4.1	08-Jul	19-Jul	04-Aug	28	3.8
BC97-29-35	3.03	4.86	23.8	4.3	02-Jul	12-Jul	02-Aug	32	3.2
BC97-29-71	2.60	4.16	12.4	3.1	03-Jul	17-Jul	04-Aug	33	3.4
BC97-30-27	2.28	3.66	10.5	4.0	04-Jul	15-Jul	29-Jul	26	2.9
BC97-30-3	2.60	4.17	29.2	3.3	02-Jul	11-Jul	23-Jul	23	3.0
C. Delight	3.32	5.32	2.2	3.9	07-Jul	19-Jul	03-Aug	28	3.7
Chemainus	3.30	5.29	6.1	3.7	05-Jul	17-Jul	03-Aug	30	2.6
Cowichan	3.47	5.55	8.5	4.6	04-Jul	14-Jul	30-Jul	27	2.9
Malahat	2.03	3.25	44.5	4.3	29-Jun	07-Jul	24-Jul	26	2.6
Meeker	2.52	4.04	4.1	3.0	06-Jul	17-Jul	31-Jul	26	3.2
Saanich	5.08	8.14	8.8	3.1	05-Jul	16-Jul	02-Aug	29	3.0
Tulameen	3.68	5.90	4.5	4.1	06-Jul	17-Jul	03-Aug	29	2.7
Ukee	2.23	3.57	21.4	3.3	02-Jul	12-Jul	25-Jul	24	2.8
Waimea	2.83	4.54	23.8	4.0	30-Jun	11-Jul	19-Jul	20	2.8
LSD[4]	1.35	2.17	17.5	0.9	4	5	7	6	0.9

See foot notes on Table 2a.

Table 2c. Yield, fruit weight, harvest season and harvest ease of raspberry cultivars harvested in 2008, Abbotsford, BC (un-replicated).

Clone	Total Yield (kg/hill)	Marketable Yield (tons/ac)	Early Yield[1] (%)	Fruit Weight (g)	5% Harvest (Date)	50% Harvest (Date)	95% Harvest (Date)	Harvest Duration (Days)	Ease of Harvest (1=Easy 5=hard)
2006 Planting									
BC1-16-8	3.29	5.26	59.7	3.7	29-Jun	05-Jul	17-Jul	19	2.5
BC1-20-1	3.10	4.97	22.6	3.8	02-Jul	13-Jul	30-Jul	29	2.8
BC1-37-32	2.89	4.64	0.0	5.0	08-Jul	29-Jul	04-Aug	28	3.5
BC1-50-2	3.43	5.49	15.5	2.8	03-Jul	21-Jul	03-Aug	33	3.2
BC1-61-38	3.46	5.55	0.0	3.0	24-Jul	06-Aug	18-Aug	27	3.5
BC1-88-14	3.36	5.38	18.4	3.5	03-Jul	15-Jul	02-Aug	31	2.3
BC2-01-74	4.49	7.18	20.2	4.6	02-Jul	11-Jul	27-Jul	26	3.0
BC2-02-76	2.92	4.68	5.5	5.8	06-Jul	17-Jul	02-Aug	28	3.0
BC2-02-89	2.69	4.31	18.5	6.0	02-Jul	10-Jul	20-Jul	19	2.5
BC2-06-52	3.30	5.28	11.8	3.9	03-Jul	13-Jul	01-Aug	30	3.2
BC2-21-76	3.32	5.32	62.3	4.6	29-Jun	04-Jul	23-Jul	25	2.7
BC2-25-23	2.75	4.41	19.3	4.0	01-Jul	12-Jul	27-Jul	28	2.6
BC2-30-22	2.95	4.73	24.5	6.0	02-Jul	10-Jul	27-Jul	26	3.4
BC2-35-34	3.66	5.87	10.4	3.5	03-Jul	13-Jul	02-Aug	32	2.7
BC3-12-6	2.90	4.64	7.4	3.0	04-Jul	23-Jul	05-Aug	33	3.0
BC3-12-8	3.08	4.93	19.3	4.5	01-Jul	12-Jul	28-Jul	28	2.7
BC3-14-12	2.58	4.14	7.0	5.9	05-Jul	13-Jul	02-Aug	29	3.0
BC3-16-16	2.80	4.48	14.2	4.0	03-Jul	11-Jul	01-Aug	30	3.3
BC3-19-17	3.92	6.28	34.0	3.7	30-Jun	10-Jul	05-Aug	37	2.3
BC3-20-14	2.92	4.68	0.9	4.9	07-Jul	19-Jul	02-Aug	27	2.6
BC3-29-10	2.71	4.34	15.4	3.9	02-Jul	13-Jul	03-Aug	33	3.0
BC3-31-13	2.88	4.62	18.1	4.5	02-Jul	14-Jul	31-Jul	30	2.7
BC3-31-3	2.65	4.24	1.8	4.0	07-Jul	21-Jul	04-Aug	29	3.3
BC3-31-39	3.51	5.62	0.0	4.0	09-Jul	22-Jul	04-Aug	28	3.3
BC3-31-43	3.72	5.95	8.5	4.3	04-Jul	14-Jul	01-Aug	29	3.3
BC3-31-8	3.22	5.16	14.9	5.3	03-Jul	12-Jul	04-Aug	33	3.2
BC3-31-9	2.82	4.52	10.5	4.1	03-Jul	13-Jul	30-Jul	28	3.2
BC3-37-5	1.91	3.06	0.0	4.9	10-Jul	19-Jul	26-Jul	18	3.3
BC86-42-18	3.44	5.51	20.5	3.5	01-Jul	13-Jul	31-Jul	31	2.7
Rudyberry	3.02	4.83	54.5	4.5	29-Jun	06-Jul	18-Jul	20	2.0
BC93-09-48	3.38	5.42	0.0	3.7	08-Jul	18-Jul	01-Aug	25	3.7
BC97-29-29	3.44	5.52	28.7	3.6	01-Jul	14-Jul	04-Aug	35	2.5
C. Bounty	3.19	5.11	7.2	2.9	05-Jul	17-Jul	04-Aug	31	2.5
C. Dawn	2.15	3.45	35.8	3.7	29-Jun	09-Jul	27-Jul	29	3.7
K-81-6	2.92	4.68	3.3	5.1	06-Jul	16-Jul	01-Aug	27	2.6
Moutere	2.97	4.75	33.0	4.2	30-Jun	10-Jul	24-Jul	25	3.7
ORUS 1142-1	2.15	3.45	36.9	2.9	29-Jun	09-Jul	27-Jul	29	3.4
OSC 1658	2.14	3.42	54.3	3.3	29-Jun	05-Jul	24-Jul	26	3.5
WSU 1447	2.27	3.64	18.6	3.0	02-Jul	11-Jul	01-Aug	31	3.0
WSU 1502	1.72	2.76	42.8	2.4	30-Jun	07-Jul	24-Jul	25	2.3
WSU 1582	2.35	3.76	3.1	3.1	07-Jul	24-Jul	08-Aug	33	3.7

See foot notes on Table 2a.

Table 3. Yield and fruit weight of raspberry cultivars and selections from the 2005 and 2006 planting field, Abbotsford, BC.

Clone	Total Yield (kg/hill)		Fruit Weight (g)		
	2008	2009	2008	2009	Ave.
2006 Planting					
BC90-05-30	3.68	3.05	2.7	3.8	3.2
BC93-09-48	3.88	3.38	3.9	3.7	3.8
BC96-37-1	5.40	3.32	3.1	3.1	3.1
BC97-25-58	2.44	2.81	3.8	3.5	3.6
BC97-29-29	3.09	3.44	3.6	3.6	3.6
BC97-29-35	3.45	3.03	4.0	4.3	4.2
BC97-29-71	2.39	2.60	3.8	3.1	3.4
BC97-30-27	1.99	2.28	4.4	4.0	4.2
BC97-30-3	2.83	2.60	3.4	3.3	3.4
BC1-37-32	5.20	2.89	4.9	5.0	5.0
BC1-61-38	4.22	3.46	4.3	3.0	3.7
BC1-86-21	3.25	3.19	4.2	4.0	4.1
BC1-86-7	3.11	1.43	4.0	4.1	4.0
BC2-01-74	4.54	4.49	3.7	4.6	4.1
BC2-02-76	4.31	2.92	6.3	5.8	6.1
BC2-02-89	2.19	2.69	5.1	6.0	5.6
BC2-06-16	3.64	3.13	3.9	4.2	4.1
BC3-12-8	3.28	3.08	3.9	4.5	4.2
BC3-14-12	4.50	2.58	4.5	5.9	5.2
BC3-31-39	3.68	3.51	4.7	4.0	4.3
K-81-6	3.85	2.92	4.0	5.1	4.6
C. Bounty	4.12	3.19	3.5	2.9	3.2
C. Dawn	2.76	2.15	3.3	3.7	3.5
C. Delight	4.32	3.32	4.4	3.9	4.1
Chemainus	3.69	3.30	3.9	3.7	3.8
Cowichan	3.24	3.47	4.4	4.6	4.5
Malahat	3.50	2.03	4.2	4.3	4.2
Meeker	4.10	2.52	3.0	3.0	3.0
Saanich	5.13	5.08	3.4	3.1	3.2
Tulameen	3.38	3.68	4.6	4.1	4.4
Ukee	2.64	2.23	3.4	3.3	3.4
Waimea	3.99	2.83	3.5	4.0	3.7
LSD[1]	1.66	1.35	0.8	0.9	0.8
Year Ave.	3.62	3.02	4.0	4.0	4.0

Clone	Total Yield (kg/hill)			Fruit Weight (g)	
	2007	2008	2009	2007	2008
2005 Planting					
BC1-21-3	5.46	2.87	2.18	4.9	4.0
BC2-1-57	3.43	3.36	3.27	4.2	3.8
BC2-20-95	4.37	2.30	3.08	4.5	4.1
BC93-15-38	3.82	2.59	2.17	4.4	4.1
BC93-15-40	5.47	4.03	3.45	4.7	4.2
BC96-22R-55	3.91	2.74	2.34	4.8	4.7
BC97-27-31	5.39	3.95	2.91	4.7	4.1
BC97-27-6	3.47	3.06	2.85	3.6	3.6
BC97-33-33	5.97	3.97	3.10	4.0	3.6
C. Delight	5.11	3.54	3.72	5.1	4.2
Chemainus	5.97	3.11	3.37	4.5	4.3
Coho	3.90	1.70		3.9	3.8
Cowichan	4.64	2.39	2.82	4.9	4.2
Esquimalt	4.16	2.55		3.5	2.2
Malahat	6.19	3.48	2.59	4.9	4.5
Meeker	4.48	3.83	2.95	3.4	3.1
Moutere	5.01	4.01	3.36	4.6	4.6
Nanoose	5.77	4.31		5.3	4.7
Octavia	4.14	5.51	3.81	4.6	4.3
Qualicum	6.93	3.99	3.71	4.6	4.9
Saanich	7.04	5.61	5.50	3.6	3.2
Tulameen	5.92	3.42	3.49	5.5	4.7
Ukee	5.27	3.44	3.11	4.1	3.8
LSD[1]	1.95	1.66	1.35	0.9	0.8
Year Ave.	5.04	3.47	3.19	4.45	4.03

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

Table 4. Fruit traits of raspberry cultivars and selections harvested in 2009, Abbotsford, BC.

Clone	Soluble Solids Concentration (%)	Firmness (g/cm^2)	Diameter (mm)	Length (mm)	Ratio L/D	Fruit Size (g)	Postharvest Fruit Rot After 24 hours (%)
BC1-16-8	12.8	49.5	19.0	26.7	1.40	3.8	0.0
BC1-37-32	9.8	48.2	23.7	32.3	1.36	7.2	12.5
BC1-87-2	12.4	34.4	20.3	27.5	1.35	4.8	3.3
BC1-87-9	11.4	47.1	20.3	26.9	1.33	4.0	8.3
BC2-1-32	12.3	39.8	21.2	25.9	1.22	4.1	9.3
BC2-1-74	11.1	43.2	18.7	23.5	1.27	4.7	11.4
BC2-17-21	11.9	41.7	20.2	26.3	1.31	4.3	3.3
BC2-18-21	11.6	49.6	20.7	26.4	1.28	3.8	5.6
BC2-2-18	10.8	46.2	21.4	24.8	1.15	4.4	2.9
BC2-2-89	10.9	38.0	22.7	29.0	1.28	5.7	2.2
BC2-20-23	12.1	25.9	21.6	22.0	1.02	3.6	2.2
BC2-20-66	11.1	20.8	24.9	32.7	1.31	6.7	
BC2-20-95	13.0	31.1	21.2	22.8	1.07	5.0	11.0
BC2-25-19	11.4	37.5	20.2	25.9	1.27	4.4	3.3
BC3-12-2	11.9	37.7	18.8	24.9	1.32	3.7	12.7
BC3-14-12	10.3	37.8	22.9	26.4	1.15	5.6	23.3
BC3-16-16	10.9	44.5	20.6	25.5	1.23	3.9	10.0
BC3-31-10	11.0	25.8	22.7	33.6	1.48	7.4	
BC3-31-39	10.8	43.6	21.0	27.8	1.32	4.7	5.0
BC3-31-9							6.7
BC90-12-50	12.3	47.1	20.4	24.5	1.16	3.9	5.8
BC92-5-47	11.3	33.2	22.2	27.6	1.25	5.3	8.0
BC93-15-40	11.7	38.8	22.0	26.8	1.21	4.8	3.3
BC97-27-6	10.3					4.1	
BC97-29-23	10.4	43.8	18.1	25.4	1.41	3.6	6.7
BC97-29-35	11.9	41.8	21.1	28.1	1.33	4.8	0.0
BC97-30-27	11.0	55.5	17.8	23.4	1.31	3.2	0.0
BC97-30-3	10.9	52.6	17.7	23.2	1.31	2.9	0.0
Chemainus	10.7	46.0	21.8	28.1	1.29	5.2	7.5
Cowichan	11.7	41.9	20.8	27.0	1.29	5.0	11.1
Malahat	11.1	43.1	21.7	27.1	1.25	5.4	9.2
Meeker	11.7	40.4	20.8	23.6	1.14	4.2	15.0
Nanoose	9.5	36.6	22.0	24.2	1.10	5.9	4.4
Qualicum	10.6	38.0	22.9	29.3	1.28	5.9	23.0
Rudyberry	12.7	44.7	20.3	23.1	1.13	4.1	3.3
Saanich	11.1	40.3	20.6	26.0	1.26	4.2	14.2
Tulameen	11.6	40.4	22.3	29.5	1.32	6.0	10.8
Ukee	11.3	35.0	21.9	26.4	1.20	5.0	13.3
Waimea	11.3	39.2	15.4	21.1	1.45	4.2	2.5
LSD	1.6	15.3	2.7	4.0	0.18	0.9	10.3

2010 PROPOSAL

Title: Red Raspberry Cultivar Development

Year Initiated: 2010 **Current Year:** 2010-2011 **Terminating Year:** 2014

Amount requested from the WRRC: $ 9,000

Personnel: Chaim Kempler (Research Scientist)

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Andrew Jamieson Berry Breeder AAFC Kentville NS

Project Description:

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

Project Summary:

The PARC AAFC breeding program is developing varieties adapted to the PNW region. Chemical pest control measures are becoming increasingly unavailable, making genetic resistance and tolerance more important. Breeding for resistance is the most sustainable and preferable way to address industry concerns and needs. The scientific approach for development of improved berry cultivars employs recurrent mass selection. This consists of hybridization among the best selections, followed by selection. This method exploits additive polygenes, providing minor gene resistance, which is not as vulnerable to being overcome by changes in pathogen population genetics, but gives lower levels of resistance. Exploring a diverse gene pool by including various species allows us to broaden the genetic base and introduce new sources of resistance that are more effective and slower to be overcome by evolving pathogen populations.

The objective of the project is to fasten the process of releasing potential cultivars to the propagators for multiplication and fast testing on growers' fields. We believe that the fastest way to introduce new cultivars to the industry is planting them on growers' fields' trials. We propose a project to develop raspberry cultivars and to soon test them on growers' field.

Justification:

The Agriculture and Agri-Food Canada (AAFC) breeding program supports the berry industry throughout the Pacific Northwest (PNW) and produces new berry varieties that enhance production. Of particular importance to the industry is the development of cultivars displaying disease and pest resistance, such as resistance to raspberry bushy dwarf virus (RBDV), root rot caused by *Phytophthora fragariae*, fruit rot and raspberry mosaic virus (RMV). The RMV complex can be a limiting factor in raspberry production but can be simply controlled by introducing resistance to its aphid vector. Reaction to the aphid vector *(Amphorophora agathonica)* of the RMV is used by the Pacific Agri-Food Research Centre (PARC) program as a primary screen in the seedling stage. All the cultivars that are released from this program are resistant to the common biotype of *A. agathonica.* A resistance-breaking biotype of *A. agathonica* has been already found in North America but is not causing problems, as it does not colonize very well on resistant cultivars and is not yet a vector of RMV. Raspberry bushy dwarf virus (RBDV) causes symptoms that adversely affect fruiting and growth in susceptible raspberry cultivars and selections. The combination of RBDV with raspberry mosaic virus (RMV) has been shown to be particularly detrimental to growth and fruiting. The most common strain of the RBDV virus has been controlled by breeding for resistance. Of cultivars released in the past, Haida and Nootka, and Chilcotin are resistant to RBDV. Cowichan, released in 2001, has given some hope to the industry because it is suitable for mechanical harvesting and that escapes RBDV. However it is not adapted by the industry because it lacks root rot resistance that is needed when grown in infected soils, or heavy and poorly drained soils. More than one million plants of Chemainus (BC89-33-84) have been already planted throughout the PNW. This cultivar produces large, glossy, dark, firm fruit that is suited both for processing and the fresh market and machine harvests very well. Its fruit is very suited for the IQF processing market. Saanich (BC89-34-41) also recently released from the PARC program and has been extensively planted throughout Washington State and the British Columbia with over half million plans. Saanich attracts attention mainly for its high yield, its exceptionally good fruit quality which is very suited for IQF, and its suitability for mechanical harvesting. It is also very slow to become infected with RBDV and is moderately resistant to root rot. The simplest test of value is 'what the industry plant', between 2001 to 2008 the increase for PARC Agassiz cultivars plant sale amount from 9% in 2001 to more than 31% in 2008.

The PARC breeding program is using selections of *R. strigosus* as new sources of resistance to the root rot caused by *Phytophthora fragariae*. Hybrids and back-crosses are screened in greenhouse trials for resistant to different strains of *Phytophthora* they are than tested again in field conditions to insure that there are no escapes. The goal off cause is to combine root rot and RBDV resistant in single cultivar.

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

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

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

Objectives:

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

- The fast release of potential cultivars to propagators to multiply for testing on growers' fields.
- Cultivars that combine resistance to pollen infection from RBDV and to root rot.
- Manageable plant habit that is suitable for machine harvesting and produces high yields, superior fruit quality, good flavour, size, firmness, small drupelets, ease of harvest, and fruit rot resistance.
- Hardy plants that withstand low temperatures, desiccating winds and late breaking dormancy.
- Dark color fruit for processing that exhibits small drupelets that are suited for IQF.
- Large, firm, light color fruit that is suited for the fresh market.
- Aphid resistance, which controls the Raspberry Mosaic Virus Complex (RMVC).
- Resistance or tolerance to cane diseases (such as spur blight, cane *botrytis* and cane spot), spider mites, lesion nematodes, bacterial blight, crown gall and to leaf diseases such as rust and powdery mildew.
- Adequate replacement cane production.
- Cultivars with enhanced and higher nutraceutical/nutritional benefits

Procedures:

*Experimental Details:*This will involve the harvest of the fruit, ease of harvest assessment, 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 includes 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*) and winter damage. Advanced selections will also be used in further breeding to develop a broad base of resistance.

Activities:

- Crossing blocks BC10 – use parents that are resistant to root rot, RBDV, MH well, and superior fruit quality.
- Evaluate the seedling populations planted in 2007.

- Continue propagation of advanced selections for WRRC and RIDC machine harvest evaluation.
- Establish replicated trials at the Abbotsford substation to assess advanced selections suitable for processing and machine harvest.
- Evaluate advanced selections in growers' fields throughout the PNW to assess productivity, machine harvesting, and resistance to root rot and RBDV.
- Release potential cultivars to the propagators.
- Supervise distribution of advanced selections to North American propagators and growers and subsequently monitor their performance.
- Release Ukee and Rudyberry to propagators for plant sale and large growers' trials.
- Conduct collaborative research with researchers at USDA-ARS, Corvallis, WSU and UBC.

Anticipated Benefits and Information Transfer:

It is well established that breeding for resistance is the most sustainable and preferable way to address industry concerns and needs. The program emphases on developing and releasing RBDV resistant cultivars and Phytophthora root rot tolerant cultivars. All PARC releases are resistant to aphids, which transmit viruses and cause insect contamination at harvest. Many of the PARC releases extend the harvest season are suited for the fresh market and have some fruit rot resistance. The results of the evaluations will be directly available to the PNW red raspberry industry. In the coming years, the evaluations will help determine the commercial suitability of advance selections. It will also allow the PARC breeding program to continue its breeding activities, identifying new potential cultivars to be released for propagation and further testing.

2009/2010 BUDGET

Amount requested from the	$US 8,000
Washington Red Raspberry Commission (WRRC)	$CD 9,000
Raspberry Industry Development Council (RIDC)	$CD 15,000
Lower Mainland Horticultural Improvement Association (LMHIA)	$CD 6,000
Growing Forward- Developing Innovative Agri-Products (DIAP)[1]	$CD 60,000

Resource commitments by	*DIAP*	*Industry(Cash)*	*Industry(in-kind)*
Salary	30,000	-	-
Salary (post)	25,000	10,000	
Student salary	9,500	12,000	-
Travel	-	4,000	-
Operating	12,000	4,000	-
RIDC technical coordinator			4,500
RIDC use of growers land			10,000
RIDC plant propagation for growers trials			3,600
WRRC plant propagation for the Abbot. Site (by Sakuma)			1,000
RIDC Virus testing			5,000
RIDC soil testing			500
WRRC trials 07 planting			2,200
WRRC trials 08/09/10 planting			1,700
WRRC technical coordinator			1,500
Admin cost (15%)			13,500
Total	**$ 90,000**	**$ 30,000**	**$ 30,000**

Budget Summary

Contribution	
RIDC	15,000
WRRC	9,000
LMHIA	6,000
Industry in-kind	30,000
Total industry (Cash + in-kind)	***60,000***
AAFC-DIAP	90,000
Total for project	**150,000**
Administration cost (AAFC-PARC)	13,500
Total cash funds available to the program	**106,500**

[1]DIAP proposal will be submitted by the BC industry for approval for 4 years (2010-2013).

Project Number: 13C-3419-7297

Title: Postemergence Canada Thistle and Bindweed Control in Red Raspberries

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

Reporting Period: 2009-10

Accomplishments:

Two trials were conducted during 2009. The first (Randy Honcoop, cooperator, Lynden) tested the effects of several herbicides on wild buckwheat (locally called bindweed). The second (Sakuma Brothers Farm, cooperator, Burlington) tested several combinations of Casoron, Matrix, Sandea, and Stinger for crop safety on Canada thistle and other problem perennial weeds. A third trial testing potential primocane burning products (Gowan Co., sponsor) was also conducted at WSU Mount Vernon this year. Data for the first two trials will be presented at the red raspberry commission meeting for project review and at winter grower meetings during 2009-10.

Results:

Wild buckwheat trial: Treatments were applied April 7, April 17, and May 27 for preemergence, for caneburning, and for postemergence timings. Weed control was evaluated June 17 and then plots were weeded by the cooperator. Berries were sampled July 10, and primocane growth will be measured later this fall. The design was a randomized complete block with four replicates.

Due to variability in the amount of seedlings found in each plot, there was not a significant affect of herbicide treatment on wild buckwheat control (Table 1). Still, the raw numbers indicate that several of these herbicides likely showed activity on wild buckwheat. Labels of all products mention annual *Polygonum* spp. weeds, although only Karmex and Aim labels specifically mention wild buckwheat (Karmex for control, Aim for suppression). No herbicide caused a reduction in berry yield, so it appears all these products are safe in raspberry. A second year of testing is warranted, particularly using combination treatments of these products, provided a suitable field can be located.

Herbicide trial: Treatments were applied April 8, April 20, and May 29-30 for preemergence, for caneburning, and for postemergence timings. Weed control was evaluated April 28. Berries were sampled July 8 and 9. The design was a randomized complete block with three replicates.

Raspberry plant density in this section of the field was extremely variable due to root rot. Consequently, the effect of these products on raspberries was not easy to gauge. Similarly, as raspberry plants died due to root rot during the summer, weed control became increasingly difficult to estimate as no crop was there to compete with the various weed species. Therefore, only initial control ratings are provided here (prior to the POST application timing). Casoron applied PRE slowed primocane emergence by 14 to 22% in late April, while the other PRE products did not slow primocane growth significantly (Table 2). Weed control with Casoron, however, was superior to other PRE products. Potential cane burning products (Chateau, Spartan, and Kixor) gave excellent control of primocanes and comparably good control of emerged weeds. Raspberry yield was too variable for a significant response due to herbicide.

Table 1. Wild buckwheat density and control and raspberry yield following application of several herbicides in red raspberry.

Treatment[a]	Timing	Rate	Wild buckwheat[b]	Berry yield[c]
		product/a	no./25 ft row (% control)	lb/a
Surflan	Cane burn 1	4 qt	31 (70)	1498
Karmex	Cane burn 1	3 lb	10 (90)	1383
Simazine	Cane burn 1	3 qt	2 (98)	1608
Devrinol	Cane burn 1	8 lb	33 (68)	1685
Aim + mso	Cane burn 2	6.4 fl.oz + 1%	51 (50)	1388
Goal + mso	Cane burn 2	2 pt + 1%	9 (91)	1559
Matrix + nis	POST	4 oz + 0.25%	30 (71)	1743
Sandea + nis	POST	2 oz + 0.25%	8 (92)	1785
Non-treated	---	---	103 (0)	1706
$LSD_{0.05}$	---	---	NS	NS

Means followed by the same letter are not significantly different ($P < 0.05$).
[a]Herbicides were applied April 7 (Caneburn1), April 17 (Caneburn2), and May 27 (POST).
[b]Weed control estimated June 17.
[c]Berries sampled by hand July 10.

Table 2. Primocane burn, weed control, and raspberry yield following application of several herbicides in red raspberry.

Treatment[a]	Timing	Rate	Primocane injury[b]	Weed control[b]	Berry yield[c]
		product/a	%	%	lb/a
Prowl H2O	PRE	2 qt	7 cd	75 cd	2064
Outlook	PRE	1 qt	0 d	68 d	775
Dual Magnum	PRE	1 qt	0 d	70 d	1809
Casoron	PRE	75 lb	14 bc	91 abc	2723
Sinbar	PRE	1.5 lb	0 d	97 a	2087
Sinbar fb Matrix	PRE fb POST	1 lb fb 4 oz	0 d	95 ab	1738
Sinbar fb Sandea	PRE fb POST	1 lb fb 2 oz	8 cd	78 bcd	1482
Casoron fb Matrix	PRE fb POST	75 lb fb 4 oz	18 b	98 a	2127
Casoron fb Sandea	PRE fb POST	75 fb 2 oz	22 b	98 a	2566
Casoron fb Stinger	PRE fb POST	75 lb fb 5.3 fl.oz	18 b	98 a	3392
Chateau	Caneburn	7 oz	95 a	95 ab	329
Spartan	Caneburn	8 fl.oz	93 a	95 ab	280
Kixor	Caneburn	1 oz	93 a	98 a	1904
Kixor	Caneburn	2 oz	95 a	98 a	1499
Matrix	POST	4 oz	---	---	833
Sandea	POST	2 oz	---	---	347
Stinger	POST	5.3 fl.oz	---	---	1630
Stinger + Matrix	POST	5.3 fl.oz + 4 oz	---	---	760
Stinger + Sandea	POST	5.3 fl.oz + 2 oz	---	---	1706
Non-treated	---	---	---	---	387
$LSD_{0.05}$	---	---	8	18	NS

Means followed by the same letter are not significantly different ($P < 0.05$).
[a]Herbicides were applied April 8 (PRE), April 20 (Caneburn), and May 29-30 (POST).
[b]Weed control and primocane injury estimated April 28.
[c]Berries sampled by hand July 8-9.

Project No: new

Title: Postemergence Perennial Weed Control in Red Raspberries

Year Initiated: 2010-11 **Current Year:** 2010-11 **Terminating Year:** 2010-11

Personnel: Timothy W. Miller, Extension Weed Scientist, WSU Mount Vernon NWREC
Carl R. Libbey, A/P Assistant Scientist, WSU Mount Vernon NWREC

Justification:

Perennial weed species generally become more important the longer raspberry blocks are left in production. Horsetail (*Equisetum* spp.), quackgrass (*Elymus repens*), broadleaf dock (*Rumex obtusifolius*), Canada thistle (*Cirsium arvense*), dandelion (*Taraxacum officinale*), white clover (*Trifolium repens*) and hedge bindweed (*Calystegia sepium*) have long been weedy in western Washington. These weeds often will outlive the raspberry crop and are also difficult to control in the break crop between raspberry plantings, so they generally remain a problem in the subsequent raspberry planting. Yet another difficulty with perennial weeds in raspberry is the physical interference to berry drop using machine harvesters, which may result in berry loss. They also impact harvest of hand-picked fruit, reducing the efficiency of hand harvest by making berries harder to find and pick.

Perennial weeds frequently become established the first couple of seasons on a new raspberry block, when raspberry plants are small and not as competitive. Often, these weeds are present in the field prior to transplanting baby raspberries. If not controlled when the infestation is relatively small, 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 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).

It is important to gain new tools for controlling established Canada thistle in established raspberries. Trials with postemergence (POST) Stinger (clopyralid) and Casoron (dichlobenil, both granular and liquid formulations) in healthy raspberries over the last few years have been encouraging. Primocane injury was generally low from directed-sprays of Stinger to the base of the floricanes; primocane injury from Casoron applied after emergence was moderate, but transitory. Importantly, floricane injury and berry harvest have not been significantly impacted by these applications. Since POST treatments can be made when weeds are visible and thus to areas known to be infested with perennial weeds, cost of these treatments may be significantly lower than broadcast applications to the full block. Additionally, if good to excellent weed control results from these applications, slight crop injury due to the herbicide is more acceptable if it occurs only on selected areas of the field. More reliable crop injury data resulting from applications of these products is needed to document that they are safe for use in raspberry if registrations are to result, however.

Two additional POST herbicides with potential for registration in raspberry have advanced through IR-4 testing during 2007 and 2008. These are Matrix (rimsulfuron) and Sandea (halosulfuron), which offer improved control of quackgrass and yellow nutsedge, respectively. I have some crop data dating back to the early 2000's with these products, but combination treatments at with either Stinger or Casoron at lower rates than when applied alone may prove helpful to improve weed control and lessen potential for injury to raspberry crowns.

Objective:

To test Stinger, Casoron, Matrix, and Sandea in various mixtures applied POST for control of several perennial weeds in established red raspberries.

Procedures:

Plots will be established in 2010 in perennial weed-infested raspberries near Mount Vernon or Lynden. Herbicide applications will be made for several combinations of these herbicides in early spring (Casoron, granular and liquid formulations) and early summer (Stinger, Matrix, and Sandea). A typical application sequence could be Casoron (4G) in March followed by Stinger + Matrix in late June. Most sequences/combinations of these four herbicides will be included in this trial. Additional perennial weed control will be evaluated, as will herbicide effects on raspberry yield, berry size, and primocane growth.

Anticipated Benefits and Information Transfer:

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

Budget:

Amount allocated to PI by Red Raspberry Commission for FY 2009-10: $ 3,932

Requested 2010/2011	
Salaries[1]	$ 1,500
Time-slip wages	1,000
Operations (Goods & Services)	500
Travel	
Projected Needs[2]	250
Meetings	0
Other	0
Equipment	0
Employee Benefits	
A/P Ass't Scientist (36.0%)	540
Time-slip (14.8%)	148
Total Request	$ 3,938

[1]Salary for A/P scientific assistant Carl Libbey (0.59 FTE funded by WSU, 0.41 FTE funded by my program; benefits (36.0%) included in employee benefit line.
[2]Travel is for plot establishment, maintenance, and harvest.

Other Support of Projct:

Herbicides are typically provided by herbicide manufacturers.

Project: 13C-3755-3641

Title: Machine Harvesting Evaluation of Raspberry Seedlings

Current Year: 2010

Personnel: Patrick P. Moore, Professor, WSU Puyallup
Wendy Hoashi-Erhardt, Scientific Assistant, WSU Puyallup

Reporting Period: 2009

Accomplishments:

2,150 seedlings from 30 crosses were planted at Sakuma Bros. on April 25, 2008. Seedlings from the same crosses were planted at WSU Puyallup in May. With the cool weather in May and June, the machine harvesting seedlings did not put on much growth. By September, few of the seedlings had sufficient growth to justify machine harvesting in 2009. The planting was maintained in 2009 and most seedlings made sufficient growth to machine harvest in 2010. The seedling planting will machine harvested in 2010 and 2011.

Project: 13C-2755-3641

Title: Machine Harvesting Evaluation of Raspberry Seedlings

Current Year: 2010 **Terminating Year: 2011**

Personnel: Patrick P. Moore, Professor, WSU Puyallup
Wendy Hoashi-Erhardt, Scientific Assistant, WSU Puyallup

Justification:

Over 98% of the raspberries grown commercially in Washington have been harvested for processing use. Virtually all of this production is machine harvested. For a new raspberry cultivar to be successful for the majority of Washington raspberry growers, it must be adapted to machine harvesting. Prior to 2002, selections were made at WSU Puyallup and then evaluated in hand harvested plots at WSU Puyallup. When promising selections were distributed to growers for testing, virtually none of them were adapted to machine harvesting. Beginning in 2002, selections were made at WSU Puyallup and the next evaluation was for machine harvestability with a cooperating grower. The first five plantings included 299 WSU selections. The 2002-06 plantings have been evaluated two times and the 2007 planting for only one season. There have been 40 WSU selections (13%) that have had enough potential for further evaluation.

Machine harvesting seedlings should improve the efficiency of selection for machine harvestability. Seedlings would be selected based on their machine harvesting characteristics as well as fruit characteristics (size, color, firmness, and flavor). Other raspberry breeding programs have used this method of evaluating seedlings.

Objective:

Machine harvest seedling populations and make selections based on machine harvesting characteristics.

Work Plan:

Year 1 – 2008
Crosses will be made by the WSU Puyallup Raspberry Breeding Program. Seed will be germinated in the greenhouse. . Approximately 2,000 seedlings will be planted with a cooperating grower. The remaining portion of the seedling population will be planted at WSU Puyallup and the normal evaluation procedure followed.

The seedlings will be planted as early in the spring as possible. The cooperator will prepare the site for planting and maintain the planting. The breeding program will supply the plants and assist in the planting. The seedlings will be planted at 4 foot spacing within the row and 10 feet between the rows (1,089 plants per acre). Seedlings will be tied up at the end of the growing season.

Year 2 – 2009
It was proposed to machine harvest the seedlings in 2009. However, in mid-September most of the seedlings were not large enough to harvest. The first harvest season will

be postponed to 2010. The budget was changed to reflect maintenance of the planting without any harvests.

Year 3 – 2010
Seedlings will be machine harvested. One person from the breeding program will ride the machine and one or two people will walk the row behind the machine. When a seedling is identified that appears to machine harvest well, the person on the machine will signal the people on the ground to flag the seedling. Seedlings will be machine harvested on a commercial harvest schedule and seedlings evaluated weekly.

Prior to machine harvesting the seedlings, the seedlings will be evaluated from the ground and selections made. Selections will also be made based on the machine harvesting evaluation. The seedlings that were selected by each method will be compared. This information will be used to determine the value of the machine harvesting of seedlings. This information will also be used to improve the ground based selection process.

At the end of the harvest season the most promising seedlings will be propagated for inclusion in a machine harvesting planting.

Year 3 – 2010
The same procedures that were followed in year 2 will be repeated in year 3.

Anticipated Benefits and Information Transfer:

Evaluation of seedlings for machine harvestability should result in an increased proportion of selections that are adapted to machine harvesting. This should result in new cultivars that are of more value to commercial growers.

Proposed Budget:

Sakuma Bros will be the cooperating grower for the 2008 seedling planting. The proposed budget is to reimburse them for their expense in establishing and maintaining the seedling field (2 acres) for the breeding program. Expenses for the breeding program are not included in this proposal.

After discussions with Sakuma Bros the amount requested for 2010-11 is reduced from the original proposal ($9,622) to $4,056.

Budget

Year 1 - 2008-09	
Establishment and maintenance	$12,846
Year 2 - 2009-10	
Plot maintenance	$ 2,428
Year 3 – 2010-11	
Plot maintenance and harvest	$ 4,056
Year 4 – 2011-2012	
Plot maintenance, harvest and removal	$11,064

Project: 13C-3755-5641

Title: Red Raspberry Breeding, Genetics and Clone Evaluation

Personnel: Patrick P. Moore, Professor, WSU Puyallup
Wendy Hoashi-Erhardt, Scientific Assistant, WSU Puyallup

Reporting Period: 2009

Accomplishments:

In 2009, 92 crosses were made for cultivar development and 3 were made for germplasm purposes, totaling 95 crosses. Parents with probable root rot tolerance were used in 87 of the crosses, and parents with probable RBDV resistance were used in 89 crosses, so that all crosses had at least one parent that was root rot or RBDV resistant. Approximately 4,500 seedlings were planted at WSU Puyallup in 2009. These will be evaluated in 2011 and 2012.

The planting of 9,500 seedlings established in 2006 was evaluated in 2009, resulting in 59 selections (0.62%). This is in addition to the 81 selections (0.85%) made in this field in 2008. These selections are the first progeny of crosses using demonstrably machine-harvestable parents. **WSU 1499**, **WSU 1471** and **WSU 1507** were the parents most represented among the seedlings selected. These parents have been evaluated as being machine harvestable in the 2002 machine harvesting trial. The planting of 7,100 seedlings planted in 2007 was evaluated for the first time in 2009, resulting in 42 selections (0.59%).

A new machine harvesting trial was planted at Lynden, WA with '**Meeker**,' '**Willamette**,' and 102 WSU selections, 63 of which were selected in 2008. A new replicated planting at Puyallup was established with four cultivars (**Meeker**, **Willamette**, **Cascade Bounty** and **Ukee**) and 21 WSU selections, 11 of which were made in 2008. A new root rot evaluation planting was established at Puyallup with '**Cascade Bounty**' and 17 WSU selections, 11 of which were made in 2008.

The replicated planting established in 2005 at Puyallup was harvested in 2009 (Table 1). '**Meeker**' had the highest yield, though **WSU 1539** and **WSU 1507** also had good yields, with fruit weights equal to or larger than '**Meeker**' and firmness similar to '**Meeker**'. The replicated planting established in 2007 was harvested for the first time in 2009 (Table 2). All of the WSU selections except **WSU 991** have been previously evaluated in machine harvesting trials. Due to plot variability, numerical differences between the clones were not always statistically significant. **WSU1503** had the highest yield, followed by '**Meeker**,' **WSU 1480**, **ORUS 1142-1** and **WSU 1582**. The yield of **WSU 1499** was better than in the previous planting, although fruit was still small and soft. **WSU 991** is a yellow-fruited raspberry that had been evaluated in the early 1990s, but not tested further because virus-free plants were not available. Virus-free plants of **WSU 991**were evaluated in this planting and found to be productive with large, firm fruit.

The machine harvesting trial established in 2006 in Lynden was harvested for the second time. Some of the clones suffered apparent winter damage and possible root rot damage. Some selections that harvested well despite long fruiting laterals in 2008 were found to have lateral breakage or higher levels of green fruit harvested when evaluated in 2009. While **WSU**

1511 and **WSU 1750** had good harvest ratings in 2008, they showed excellent performance in 2009 and were identified as suitable for advanced testing. The machine harvesting trial established in 2007 in Burlington was harvested for the first time. Eighteen selections, including an ORUS selection, 5 BC selections, and 12 WSU selections, showed potential for IQF processing or as a Willamette replacement. Although samples were collected for IQF, it was not possible to complete an IQF evaluation on these selections.

Fruit samples were collected from the machine harvests and will be analyzed for total anthocyanins, soluble solids, pH and titratable acidity. The laboratory work has not yet been completed for these samples.

Several raspberry clones were tested for RBDV resistance by grafting. In these tests, **'Cascade Dawn'**, **WSU 1507** and **WSU 1539** appear to be resistant to RBDV. Since **WSU 1507** and **WSU 1539** have also had tolerant reactions to root rot at WSU Puyallup, they represent excellent progress toward a machine harvestable cultivar combining RBDV resistance, root rot tolerance, and good fruit quality. Fruit of **'Meeker'**, **WSU 1499**, **WSU 1507** and **WSU 1539** was harvested from the IQF planting in Burlington and puree samples will be prepared and evaluated.

Publications/Presentations:

Carew, R., Kempler, C., Moore, P.P., & Walters, T.W. 2009. Developments in Raspberry Production, Cultivar Releases, and Intellectual Property Rights: A Comparative Study of British Columbia and Washington State. International Journal of Fruit Science 9:54-77.

February 2009 Strawberry and Raspberry Cultivar Development. Lower Mainland Horticulture Improvement Association Meeting, Abbotsford, BC

July 2009. Machine Harvesting Open House. Burlington, WA

July 2009. Machine Harvesting Open House. Lynden, WA.

Table 1. 2009 harvest of 2005 planted raspberries, Puyallup, WA.

Cultivar	Yield (t/a)	Rot (%)	Fruit wt (g)	Firmness (g)	Harvest Season 5%	50%	95%	Length of season
Meeker	12.30 a	6.6 bc	3.63 b	189 a	7/5/09 a	7/16/09 a	7/29/09 a	24 a
WSU 1539	9.22 b	9.2 ab	4.09 a	186 a	7/3/09 a	7/13/09 ab	7/26/09 b	22 a
WSU 1507	9.05 b	11.0 a	3.99 ab	196 a	6/30/09 ab	7/10/09 bc	7/25/09 b	25 a
Willamette	8.41 b	4.6 c	3.68 b	184 a	6/27/09 b	7/7/09 c	7/21/09 c	23 a
WSU 1499	7.29 b	8.7 ab	2.25 c	130 b	7/2/09 ab	7/13/09 ab	7/25/09 b	24 a

Table 2. 2009 harvest of 2007 planted raspberries, Puyallup, WA.

Cultivar	Yield (t/a)	Rot (%)	Fruit wt (g)	Firmness (g)	Harvest Season 5%	50%	95%	Length of season
WSU 1503	11.41 a	4.4 b-d	2.78 fg	167 fg	6/25/09 ef	7/6/09 f	7/20/09 d	25 bc
Meeker	10.72 ab	3.1 d	3.52 de	177 ef	7/3/09 ab	7/14/09 bc	7/26/09 bc	23 c
WSU 1480	9.43 ab	2.9 d	3.50 de	238 b	7/1/09 b-d	7/17/09 b	8/4/09 a	35 a
ORUS 1142-1	8.52 ab	7.3 a-c	3.85 b-d	204 c-e	6/27/09 c-f	7/11/09 c-e	7/22/09 b-d	25 bc
WSU 1582	8.46 ab	9.1 a	4.36 b	291 a	7/7/09 a	7/21/09 a	8/7/09 a	30 ab
C. Bounty	8.26 ab	5.3 b-d	3.22 ef	158 fg	7/2/09 bc	7/14/09 bc	7/26/09 bc	24 c
WSU 991	8.21 ab	7.5 ab	5.44 a	214 b-d	6/28/09 b-f	7/8/09 d-f	7/20/09 cd	22 c
WSU 1499	7.89 ab	3.2 d	2.26 g	135 g	6/25/09 ef	7/7/09 ef	7/20/09 d	24 c
WSU 1455	7.87 ab	4.4 b-d	4.12 bc	180 ef	6/26/09 d-f	7/9/09 d-f	7/28/09 b	31 a
Willamette	7.79 ab	2.4 d	3.21 ef	173 ef	6/23/09 f	7/6/09 f	7/17/09 d	24 c
WSU 1558 **	7.43	2.6	3.57	170	6/25/09	7/8/09	7/22/09	28
WSU 1530	7.10 ab	2.9 d	3.19 ef	157 fg	6/30/09 b-e	7/8/09 d-f	7/22/09 b-d	22 c
WSU 1447	4.48 ab	4.4 b-d	3.62 c-e	235 bc	6/30/09 b-e	7/10/09 c-f	7/23/09 b-d	23 c
WSU 1452	3.85 b	3.6 cd	4.01 b-d	200 de	7/2/09 a-c	7/12/09 cd	7/22/09 b-d	20 c

Means within a column followed by the same letter are not significantly different at $P \leq 0.05$,by Tukey's Studentized Range Test (HSD)

** only two replications harvested. Data not included in statistical analysis.

PROJECT: 13C-3755-5641

TITLE: Red Raspberry Breeding, Genetics and Clone Evaluation

Current Year: 2010 **Terminating Year:** continuing

Personnel: Patrick P. Moore, Professor, WSU Puyallup
Wendy Hoashi-Erhardt, Scientific Assistant, WSU Puyallup

Justification:

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

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

Objective:

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

Work Plan:

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

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

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

3. Seed from the 95 crosses made in 2009 will be sown in 2009-2010. The goal will be to plant 108 plants for each cross, but will depend on the number of seeds, germination rate and field space.

4. Selections will be made among the seedlings planted in 2007 (7,100 seedlings) and in 2008 (5,000 seedlings). Seedlings will be subjectively evaluated for yield, flavor, color, ease of harvest, freedom from pests, appearance, harvest season and growth form. Based on these observations, seedlings will be selected for propagation and further evaluation. Typically, the best 1% or less of a seedling population will be selected.

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

6. The replicated plantings established in 2007 and 2008 at WSU Puyallup will be hand harvested for yield, fruit weight, fruit rot and fruit firmness.

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

Machine Harvesting Evaluation

1. Eight plants of selections propagated as in #5 above will be planted in a grower planting for machine harvesting evaluation.

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

3. The machine harvesting trial established in 2008 will be harvested for the first time in 2010. The machine harvesting trial established in 2007 will be evaluated for the second time in 2010. Evaluations will be made multiple times through the harvest season.

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

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

6. Selections that appear to machine harvest well will be planted in a second machine harvesting trial, in replicated plantings at WSU Puyallup for collection of hand harvest data and screened for root rot tolerance and RBDV resistance (if potentially resistant based on parentage).

Anticipated Benefits and Information Transfer:

This program will develop new raspberry cultivars that are more productive or more pest resistant. The emphasis of the program is on developing machine harvestable cultivars. Such cultivars may result from crosses made this year or may already be under evaluation. When a superior selection is identified and adequately tested, it may be released as a new cultivar and be available for commercial plantings. Promising selections and new cultivars will be displayed at field days.

Proposed Budget:

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

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

The proposed budget represents a significant increase over last year. Additional support that has been used to subsidize the breeding efforts are no longer available. The WRRC budget request needed to be increased to maintain the current levels of effort.

Budget:	2008-2009	2009-2010
00 Salaries		
Ag Res Tech 2 (0.05) FTE	2,096	2,096
01 Timeslip Labor	19,500	33,000
03 Service and Supplies[1]	19,067	16,944
04 Travel	1,500	4,000
07 Benefits		
Timeslip	2,145	3,135
Ag Res Tech 2	692	825
Total	$45,000	$60,000

[1] Includes $13,000 for expenses for the following test plantings for evaluation of raspberry selections.

Maintenance of test plantings

Machine harvesting trial established in 2007 – Sakuma Bros	$3,000
Machine harvesting trial established in 2008 – Sakuma Bros	$3,000
Machine harvesting trial established in 2009 – Honcoop Farms	$3,000

Establishment and maintenance of new test planting

Machine harvesting trial to be established in 2010 – Honcoop Farms	$4,000

Current Support

Name (List PI #1 first)	Supporting Agency and Project #	Total $ Amount	Effective and Expiration Dates	Title of Project
Moore, P.P. and Hoashi-Erhardt	Northwest Center for Small Fruit Research	$75,000	2009 - 2010	Small Fruit Breeding in the Pacific Northwest
Moore, P.P. and Hoashi-Erhardt	Washington Red Raspberry Commission	$45,000	2009 - 2010	Red Raspberry Breeding, Genetics and Clone Evaluation
Moore, P.P. and Hoashi-Erhardt	Washington Red Raspberry Commission	$2,428	2009 - 2010	Machine Harvesting Evaluation of Raspberry Seedlings
Moore, P.P. and Hoashi-Erhardt	Washington Strawberry Commission	$25,200	2009 - 2010	Genetic Improvement of Strawberry
Moore, Hoashi-Erhardt, Cogger, Bary, Collins	Organic Farm Research Foundation	$38,640	11/08 - 12/11	Evaluation of Day-Neutral Strawberries in Organic Systems in Washington
Moore, P.P. and Hoashi-Erhardt	Oregon Strawberry Commission	$3,750	7/09 - 6/10	Development of New Strawberry Cultivars for the Pacific Northwest

Pending Support

Name (List PI #1 first)	Supporting Agency and Project #	Total $ Amount	Effective and Expiration Dates	Title of Project
Zasada, I.A. and Moore, P.P.	Northwest Center for Small Fruit Research	$13,500	2010 - 2012	Evaluation of *Rubus* spp. Hybrids for *Pratylenchus penentrans* Resistance
Moore, P.P. and Hoashi-Erhardt	Washington Red Raspberry Commission	$60,000	2010 - 2011	Red Raspberry Breeding, Genetics and Clone Evaluation
Moore, P.P. and Hoashi-Erhardt	Washington Red Raspberry Commission	$9,622	2010 - 2011	Machine Harvesting Evaluation of Raspberry Seedlings
Moore, P.P. and Hoashi-Erhardt	Washington Strawberry Commission	$37,000	2010 - 2011	Genetic Improvement of Strawberry

Project No.: 13C-3543-4370

Title: Integrating Insect and Mite Management in Red Raspberry

Year Initiated: 2004 **Current Year:** 2008 **Terminating Year:** 2009

Personnel: Lynell K. Tanigoshi, Entomologist
Beverly S. Gerdeman, Research Associate
G. Hollis Spitler, Agricultural Research Technician

Washington State University, Mount Vernon Northwestern Research and Extension Center

Terminal report: 2009

Accomplishments:

Western raspberry fruitworm (WRFW).

Laboratory bioassays. Western raspberry fruitworm adults were collected on 5, 10 and 15 June from mature 'Meeker' grown in high tunnels in Nooksack, WA. Two experimental MOA Group 22, semicarbazone class insecticides, Avaunt™WG (indoxacarb) and Alverde ™ (metaflumizone), experimental Group 4A/28 Voliam flexi™ (thiamethoxam + chlorantraniliprole) were compared with Brigade™ (bifenthrin) and UTC. Individual red raspberry leaflets whose stems were inserted in water-filled vials plugged with cotton, were dipped for 5 sec in aqueous solutions of these insecticides at recommended field rates. Four (Trial 1) and five adults (Trial 2) per Petri dish were release on these air-dried leaflets and maintained at lab temperature in Trials 1 (n=12) and 3 (n=16) and Trial 2 (n=22), respectively. Adult mortality was assessed at 24 hours intervals. However, after 1 DAT, the combined average mortality was 94% Alverde, 88% Auvant, 100% Brigade, 98% Voliam flexi and 64% UTC. All of the adults exposed to Alverde and Auvant were in a moribund state. These adults were scored in the mortality category because they no longer fed and never recovered. This morbidity was reported last year from beetle trials (root weevils, WRFW) testing both of these sodium channel blockers. The dual MOAs of Voliam flexi also showed rapid mortality and excellent potential as a broadspectrum, contact and translaminar insecticide that will be considered for the IR-4 docket. Despite the high mortality for perhaps these late season adult WRFW in the UTC, we feel the data are valid and concur with the past two seasons of like bioassays. Field populations of the WRFW never developed to economic levels in northcentral Whatcom County for planned drench applications to the crown and basal canes for control of overwintering adults.

Clay colored root weevil (CCW).

Laboratory bioassay. Clay colored weevils were collected from 'Meeker' red raspberry near Everson, WA on 28 May and 3 June. Leaf dips in aqueous insecticide solutions at field rates for 5 sec and air-dried included the pyrethroids Brigade and Mustang, neonicotinoids Actara and Provado 1.6F, experimentals Alverde, Avaunt and Voliam flexi, plus untreated check. Each treatment consisted of 20 individual CCW placed on 5 different leaf arenas as described above and held in 5 inch diameter Petri dishes at lab temperature. Percent mortality was 100% at 1 DAT for Brigade and Mustang and 93% Voliam flexi, 88% Alverde, 80% Actara, 76% Avaunt, 60% Provado and 0 for the UTC at 7 DAT. These data again indicate continued excellent efficacy for pyrethroid chemistry for root weevil control and good potential to root weevils from the 3 new MOA insecticides tested. As before, the neonicotinids are slower acting than other weevilcide compounds, but their systemic activity results in extended residual control, as growers have experienced in the field. The prolonged morbidity and post-exposure responses by CCW are similar to root weevil species when exposed to neonicotinoids, too (e.g., Actara, Provado, Voliam flexi).

Spider mites.
Field trials. On 28 July 2009, a pretreatment sample of 20 leaflets/plot were taken from a 'Willamette' field scheduled to be removed after harvest in the Northwood area of Lynden, WA. The population of twospotted spider mites had exceeded our provisional economic threshold of 25 motile mites/leaflet soon after harvest. Treatments were replicated five times and plots measured 30 feet long by 10 feet wide. Applications were applied with a Rear's hydraulic plot sprayer equipped to deliver 122 gpa at 1.8 mph with 2 8004 nozzles on top of the boom, with both vertical arms each equipped with 5 D3-45 TeeJet™ nozzles. Acaricides field-tested, included Acramite 4SC (bifenazate), Savey 50DF (hexythiazox), Vendex 50WP (fenbutatin oxide) experimental Envidor 2SC (spirodiclofen) and UTC. Bayer CropScience suggested Envidor should not be sampled until ca. 7 days posttreatment due to its mode of action. It is active by contact on mite eggs, immatures and adult females. As we reported last year, Envidor provided quick knockdown of those motile life stages of YSM/TSSM after 3 DAT. Envidor is in the IR-4 pipline for blueberry registration and we will support it for an IR-4 residue project for red raspberry. Given an average pretreatment count of 30 motile TSSM/leaflet, after 3 DAT each miticide provided 3-fold suppression of the high late season populations that were significantly less than the UTC densities. At 7 and 17 DAT, Acramite levels were significantly different from the other treatments. Though TSSM was increasing again by 7 DAT, the other acaricides were nearly 4-fold less than the untreated check. Envidor suppression of TSSM is not significantly different from Vendex and Savey at 17 DAT.

On 29 July 2009, a similar study with identical experimental design was conducted at the WSU NWREC, Mount Vernon, WA on 'Meeker" infested with a mixed population of dominant TSSM and subordinate but increasing late season yellow spider mite (YSM). Pretreatment densities for all plots averaged about 30 motiles/leaflet. At 3 DAT, densities for Envidor and Acramite were identical and significantly different from the UTC. This trend remained at 8 DAT with all four acaricides averaging about 3.5-fold less than the UTC, though above the economic threshold for red raspberries of 25 motiles per leaflet. The study had to be terminated as we decided to cover the 3 acre block with Acramite after these counts to contain a rapidly increasing spider mite population that was at 92 motiles per leaflet in the untreated check.

Laboratory bioassay. A laboratory leaf disc bioassay was conducted with twospotted spider mite females to compare the efficacy of the above acaricides and two rates of the insecticide/acaricide Brigade, under controlled environmental conditions. A Potter Precision Laboratory Spray Tower, calibrated to deliver 2 ml aliquots of acaricide at 50 pKa pressue on the topside of red raspberry discs 25 mm in diameter. Leaf discs were then placed topside down on water saturated cotton, absorbent pads, in 88 mm diameter Petri dishes. Five adult TSSM females were transferred from infested leaves to each leaf disc. A total of 90 TSSM females were used for each treatment. They were held at room temperature and examined for percent mortality at 1, 2 and 5 DAT. At 1 DAT, 100% of the TSSM were dead when treated with the field rate of 16 fl. oz/acre of Acramite. TSSM female mortality at 5 DAT was: Vendex (98%), Envidor (90%), Brigade, 0.1 lb(AI)/acre (81%), Brigade, 0.5 lb(AI)/acre (56%), Mustang (55%) and UTC (6%). The miticidal activity of our registered acaricides is excellent, with acceptable control from our field rate of Brigade. The marginal performance of the lower rate of Brigade and Mustang was expected for these pyrethroids.

Project No:

Title: Identifying Root Traits Associated with Root Rot Resistance in Red Raspberry

Personnel: David Bryla, USDA-ARS Horticultural Crops Research Unit, Corvallis, OR
Luis Valenzuela-Estrada, Dept. of Horticulture, Oregon State Univ., Corvallis, OR

Collaborators: Pat Moore and Wendy Hoashi-Erhardt, Dept. of Horticulture and Landscape Architecture, Washington State Univ., Puyallup, WA
Tom Forge, Agriculture and Agri-Food Canada, Agassiz, British Columbia, Canada

Reporting Period: January 1, 2009 – September 30, 2009

Accomplishments:

1. This past winter, we conducted a preliminary trial in the greenhouse to examine root morphology and anatomy in seven cultivars of red raspberry with a wide range of resistance to *Phytophthora* root rot. The cultivars included 'Summit', 'Cascade Bounty', 'Tulameen', 'Meeker', 'Saanich', 'Malahat', and 'Cowichan'. We hypothesized that cultivars producing small, thin roots with low tissue density would be more tolerant to root rot because plants would require less carbon to replace any roots lost to infection. Alternatively, cultivars producing thicker roots with high tissue density (i.e., high specific root length) may invest more carbon in root defense and therefore may be more resistant to root rot. Either mechanism may play a major role in plant defense against soil pathogens and thus might be useful strategy for breeding increased tolerance or resistance to root rot.

2. This past spring, we planted as planned a field trial of seven cultivars with varying degrees of resistance to root rot. The cultivars included 'Summit', 'Cascade Bounty', 'Cascade Delight', 'Tulameen', 'Meeker', 'Saanich', and 'Malahat'. The trial is located at the Washington State University Payallup Research Center at a site with a long history of problems with root rot.

Results:

Preliminary greenhouse trial. Root morphological characteristics, including average root diameter, specific root length (i.e., amount of root length per unit of root biomass), and root tissue density, varied considerably among the cultivars but revealed no general relationship between the root traits and resistance to root rot (Fig. 1). 'Meeker', which is moderately resistant to root rot, produced the thickest and the second densest roots among the cultivars, suggesting any resistance is due to biochemical and/or structural defense mechanisms. 'Saanich', on the other hand, which is considered most resistant, produced the finest roots with intermediate root density, indicating it would require a moderate amount of carbon to generate new roots. Note that plants were grown in pots without *Phytophthora*, which may certainly affect how roots develop. Thus, we will repeat the measurements in the field and reexamine the results for any relationships.

So far, we found no visible differences in root anatomy among the cultivars, but we still need to stain the cross-sections and examine them for suberin and other phenolic defense compounds (Fig. 2).

Field trial. We installed clear plastic minirhizotron (root observation) tubes in the field are now collecting digital images every 2 weeks to monitor root production and distribution in each cultivar (Fig. 3). We will continue to monitor the roots and quantify any incidence of root rot. We will also collect roots and characterize morphology and anatomy of each root system and examine them for colonization by beneficial mycorrhizal fungi and infection by root pathogens.

Publications:

None. This is a new study still early in its progress.

Appendix I – Figures

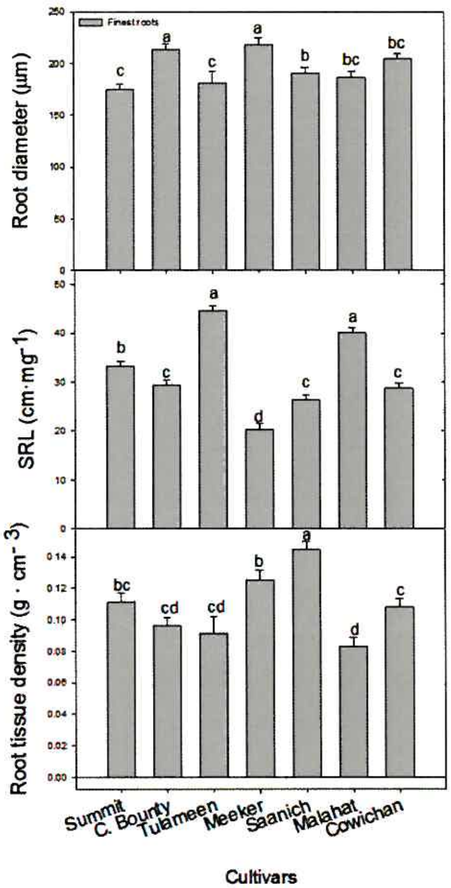

Fig. 1. Fine root diameter, specific root length (SRL), and root tissue density in seven cultivars of red raspberry with varying degrees of resistance to *Phytophthora* root rot. 'Summit' is considered most resistant while 'Cowichan' is considered least resistant. Different letters above the bars indicate a significant difference ($P < 0.05$) among cultivars.

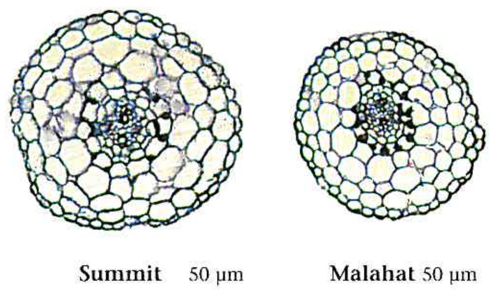

Fig. 2. Cross-sections of very fine roots from two red raspberry cultivars, 'Summit' and 'Malahat'. Note the similar anatomy between the cultivars.

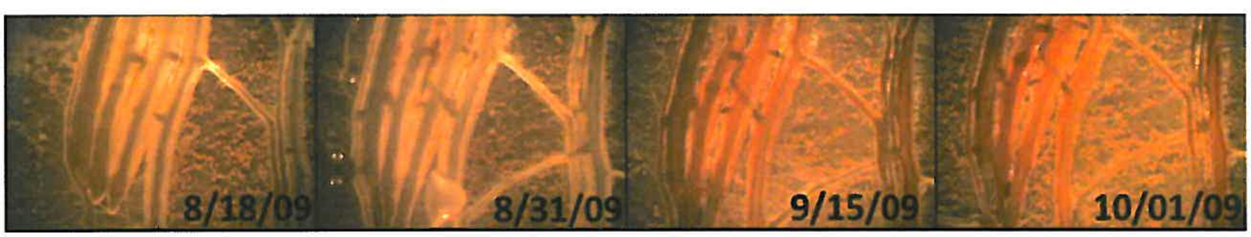

Fig. 3. 'Meeker' red raspberry root images captured with a minirhizotron digital camera system on four consecutive sampling dates. Note the change in root color over time.

Project No:

Title: Identifying Root Traits Associated with Root Rot Resistance in Red Raspberry

Year Initiated: 2009 **Current Year:** 2009-2010 **Terminating Year:** 2011

Personnel: David Bryla, USDA-ARS Horticultural Crops Research Unit, Corvallis, OR; phone: 541-738-4094; email: david.bryla@ars.usda.gov
Luis Valenzuela-Estrada, Dept. of Horticulture, Oregon State Univ., Corvallis, OR

Collaborators: Pat Moore and Wendy Hoashi-Erhardt, Dept. of Horticulture and Landscape Architecture, Washington State Univ., Puyallup, WA
Tom Forge, Agriculture and Agri-Food Canada, Agassiz, British Columbia, Canada

Justification:

Phytophthora root rot is a serious problem for commercial production of red raspberry in the Pacific Northwest. Developing new cultivars with high resistance or tolerance to *Phytophthora* root rot is therefore critical to sustaining profitable production in the region and is a major focus of the WSU raspberry breeding program. Current breeding efforts to identify resistant genotypes screen large numbers of plants in the greenhouse and field and select those demonstrating high tolerance to the disease (Hoashi-Erhardt et al., 2008). Little is known, however, why certain genotypes exhibit a better response than others under the presence of *Phytophthora.*

In citrus and avocado, root rot tolerance has been associated with the capacity of the plant to regenerate roots that have been lost by infection (Graham, 1990; Menge et al., 1992). Other tolerance traits noted in other crops include: 1) increased suberization (cell wall thickening) of both exodermal and endodermal layers in the fine roots (Estone et al., 2003; Thomas et al., 2007), 2) higher production of fungitoxic compounds, such as phenolics and phytoalexins (Nicholson & Hammerschmidt, 1992; Hammerschmidt, 1999), and 3) enhanced associations with beneficial soil microorganisms, such as mycorrhizal fungi (Mark and Cassells, 1996; Resendes et al., 2008) and bioprotective bacteria (Ezziyyani et al., 2007). A combination of these traits may lead to root rot resistance even under the most severe disease conditions. *The goal of this project is to identify prominent root traits associated with little or no Phytophthora infection in raspberry so that the traits can be selected and incorporated into breeding material to produce new cultivars with high resistance to Phytophthora root rot.*

Numerous raspberry cultivars are available with a wide range of resistance to *Phytophthora* root rot, although none so far are completely resistant. The commercial standard, 'Meeker', falls somewhere near the middle of this range with only mild to moderate resistance to root rot. We will examine the roots of 'Meeker' along with six other cultivars, including 'Summit', which is the most resistant cultivar evaluated in Washington, 'Cascade Bounty' and 'Cascade Delight', also found to have high resistance, 'Tulameen', which is similar to 'Meeker' in resistance, and 'Malahat' and 'Saanich', two cultivars highly susceptible to root rot. Detecting differences in root traits among the cultivars may provide unique selection criteria for identifying genetic resistance to *Phytophthora* root rot.

One of the most effective methods to study roots is the use of minirhizotrons. Minirhizotrons are basically clear plastic tubes installed near the plants that enable us to monitor root development over time using a miniature digital camera system. We are currently using minirhizotrons with success on cranberry and blueberry, and now also on red raspberry (see Progress Report). The potential advantages of the technique are many. It is nondestructive and consequently can be used in small plots where disturbance needs to be minimized. Because the same roots are repeatedly examined, it eliminates spatial variation being confounded with temporal variation. Probably the biggest advantage of minirhizotrons is that they provide a great deal of information on root morphology and demographics *in situ*, including root diameter, specific birth rates, age structure, age-specific death rate, and root lifespan. Root browning is also visible in the images, which often indicates the presence of phenolic compounds in the roots (Wells et al., 2002). Shortcomings of the technique include: 1) root production and losses can only be converted to biomass indirectly, 2) the plastic walls of the tube may cause abnormal root behavior, 3) root death may not always be visually apparent, 4) the initial investment of the camera system is fairly high (but is already available for this study) and 5) labor costs are high, since it takes an enormous amount of time to analyze the root images Thus, root samples will also be collected periodically (spring, summer, and fall) by using in-growth cores to estimate standing root biomass (e.g., Basile et al., 2007) and vitality (e.g., Comas et al., 2000), examine microscopic features only visible under high magnification (Valenzuela-Estrada et al., 2008), and extract and quantify phenolics and other fungitoxins accumulated in the roots.

Additional knowledge gained from this study will include basic information on raspberry root distribution and growth. A plant's ability to absorb water and nutrients from the soil environment primarily depends on the root system's absorption capacity (i.e., the amount of nutrients or water absorbed per unit mass of root tissue) and development (e.g., the number of roots occupying the soil, root fineness, root:shoot ratio, the size and number of root xylem vessels, and root hariness). We will examine root characteristics of the cultivars (particularly 'Meeker') in order to predict their inherent effectiveness at acquiring water and nutrients from soil. The information will be used to better predict timing and placement of water and fertilizers during the growing season to optimize growth and production and to make recommendations on the best cultivars for efficient water and nutrient management.

This work will complement raspberry breeding efforts in Washington (P. Moore), Oregon (C. Finn), and British Columbia (C. Kempler) and provide useful information helpful to those studying soil ecology (T. Forge) and irrigation and nutrient management (D. Bryla and T. Walters) of the crop.

Objectives:

This is the second year of a 3-year project funded last year by the Commission. The objectives of the project are to investigate root development and morphological and physiological root traits in red raspberry associated with increased resistance or tolerance to *Phytophthora* root rot. Specifically, this funding year, we will:

1. Continue to monitor root production and distribution in each cultivar and quantify the incidence of root rot.

2. Continue to characterize morphology and anatomy of each root system and examine infection by mycorrhizal fungi and root rot pathogens.

3. Develop relationships, if any, between the root traits and root rot resistance.

Procedures:

The experiment will continue in a field of seven raspberry cultivars planted in June of 2009, at the Washington State University Puyallup Research Center. The cultivars include 'Cascade Bounty', 'Cascade Delight', 'Malahat', 'Meeker', 'Saanich', 'Summit', and 'Tulameen'. All cultivars were planted from bare root except 'Summit', which was only available from tissue culture. As root development may differ between bare root and tissue culture, 'Meeker' and 'Cascade Bounty' were also planted from tissue culture for comparison. The field site has a long history of problems with root rot and is located next to Pat Moore's breeding evaluations. Each cultivar was planted 2.5 × 10 ft. apart and arranged in a completely random block design with six replicates per cultivar; each cultivar plot consists of three plants per cultivar.

Roots will be monitored using 54 minirhizotron tubes that were installed (30° off vertical and 6-ft deep) ≈1 ft. from the base of the middle plant of each plot. Images of roots that grow along the surface of the tubes will be recorded biweekly (Apr.-Oct.) or monthly (Nov.-Mar.) at 0.6-inch depth increments and will be analyzed for root production (number of roots produced since the previous sampling), root longevity (duration of each root from first appearance to disappearance), root diameter, and changes in root color (indicates accumulation of phenolics and other fungitoxic compounds) using an interactive PC-based software program (Roo-Fly, Clemson University).

In-growth cores (1-ft. long x 4-in. diameter) will also be installed near the center of each plot. Two cores will be collected per plot in May, July, and September each year. Roots will be washed from the cores, measured for length using a root scanner, and dried and weighed to determine biomass, root tissue density, and specific root length (Basile et al., 2007). A subsample of fresh roots from each core will also be prepared for histochemical measurements and observation under light and fluorescent microscope and examined for cellular characteristics, such as root epidermal suberization, mycorrhizal colonization, and incidence of infection by root rot pathogens using light and electron microscopes. Identity of the pathogens will be determined using PCRD (Duncan & Cooke, 2002).

All measurements will continue for at least 2 more years, with the third year focusing primarily on the most promising traits found to invoke resistance to root rot. Additional measurements will be made in year 3 to identify chemical or molecular characteristics associated with the traits.

Anticipated Benefits and Information Transfer:

This study will be the first detailed examination of root development under field conditions in red raspberry. We will identify inherent root traits associated with increased resistance to *Phytophthora* root rot, which we will eventually use to develop new cultivars with high resistance to root rot. We will also determine when and where new roots are produced, providing important information for optimizing timing and placement of water and nutrients. Results will be presented at field days and grower meetings in Washington and published in extension bulletins.

Budget:

Amount allocated by Commission for previous year: $12,604

Request for FY 2009-2010	
Salaries[1]	$ 6,000
Time-Slip	0
Operations (goods & services)[2]	800
Travel	
Projected Needs[3]	2,124
Meetings	0
Other	0
Equipment	0
Employee Benefits[4]	3,660
Total	**$12,584**

[1,4]Salary (0.15 FTE) and benefits (0.61 OPE) are required for a postdoctoral associate (L. Valenzuela-Estrada) to conduct the work on capturing and analyzing root images and for microscopic assessment of the root traits.
[2]Field maintenance costs.
[3]Travel for one to two trips per month (18 trips @ $118 ea.) to the field site for Valenzuela-Estrada.

Other support of project:

Plant material will be provided by Sakuma Bros. Nursery and field plots will be maintained by WSU. USDA-ARS will provide a vehicle for travel to and from the field site, supply the camera and computers for the minirhizotron work, and pay for the use of light and electron microscope facilities at OSU. See current and pending support for funding on other crops and projects.

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Current Support

Name (List PI #1 first)	Supporting Agency and Project #	Total $ Amount	Effective and Expiration Dates	% of Time	Title of Project
Bryla, D.	Current: Oregon Blueberry Commission	$31,000	July 1, 2005 - June 30, 2010	5%	Guidelines for nitrogen fertigation of blueberry.
Strik, B., D. Bryla, D. Sullivan, and C. Seavert	USDA CSREES Integrated Organic Program	$469,852	July 1, 2008 - June 30, 2011	5%	Integrating weed management and fertility in organic highbush blueberry production systems to optimize plant growth, yield and grower return.
Bryla, D. and L. Valenzuela-Estrada	Washington Red Raspberry Commission	$12,604	January 1, 2009 - December 31, 2009	5%	Identifying root traits associated with root rot resistance in red raspberry.
Bryla, D.	Northwest Nursery Crop Research Center	$55,898	January 1, 2009 - December 31, 2011	10%	Optimum soil temperatures for maximum root function and efficiency in ericaceous nursery crops.
Strik, B. and D. Bryla	Northwest Center for Small Fruits Research / Oregon Organic Cropping Research	$136,592	October 1, 2009 - September 30, 2012	10%	Weed, water, and nutrient management practices for organic blackberry production.

Pending Support

Name (List PI #1 first)	Supporting Agency and Project #	Total $ Amount	Effective and Expiration Dates	% of Time	Title of Project
Bryla, D. and L. White	Pending: Northwest Center for Small Fruits Research	$104,490	September 1, 2010 - August 31, 2013	10%	Irrigation guidelines for sprinkler frost protection in cranberry.

Project No:

Title: Cooperative raspberry cultivar development program

Personnel: Chad Finn, Research Geneticist, USDA-ARS, HCRL; 3420 NW Orchard Ave. Corvallis, OR 97330

Reporting Period: 2009

Accomplishments:

Our goal is develop new raspberry cultivars that either are improvements over the current standards or that will complement current standards. In addition, the information generated on advanced selections from the WSU and B.C. programs will be made available and aid in making decisions on the commercial suitability of their materials. We will not finish harvest until later in October on the primocane fruiting raspberries, so our conclusions are preliminary. ORUS 1142-1 has promise, it harvested well in the Washington machine harvest trial and it has continued to look good in our trials. We will put it into grower trials as soon as feasible. 'Ukee' has not stood out for us as a potential new cultivar. We have three outstanding primocane fruiting selections that will be pushed into grower trials. ORUS 1167-2 is among the earliest ripening primocane fruiters with a bright attractive fruit. ORUS 2786-2 and ORUS 2786-5 have large crops of very attractive, excellent flavored primocane fruit. I hope to name ORUS 2786-5 in the coming year. WSU 1499 still has small plant and small fruit concerns in Oregon, it looked much better in 2009 than in our previous trials. ORUS 3229-1 and ORUS 3229-2 are 1/8 *R. coreanus* and have tremendous vigor and hopefully root rot tolerance. While not likely commercial quality, they are close and offer hope for the next generation.

Results:

Crosses were successfully made in spring 2009. A new seedling field was established containing red raspberry (25%) and blackberry (75%) seedlings. As of 5 October, 32 floricane and primocane fruiting red raspberry selections had been made. In addition, a half dozen selections were made out of raspberry x black raspberry crosses that will hopefully be a source of disease resistance in the future. The 32 selections were mostly selected as potential cultivars however several are germplasm selections with *R. crataegifolius*, *R. coreanus*, and *R. parvifolius* in their background that are imparting tremendous vigor and disease resistance. We have been working with this germplasm for several generations and it is now nearly cultivar quality. We hope this material will be useful to our program as well as to Pat Moore's and Chaim Kempler's. We are still harvesting our primocane fruiting raspberry trials and will not have final results available from these until mid-October; Table RY1 lists the genotypes that were considered for harvest in 2009. Presented in Tables RY2-RY5 are the results from 2008. Complete results of all trials for 2008 will be available in mid October.

While not directly related to red raspberry at first glance, our current efforts in black raspberry have identified resistance to the raspberry aphid in populations from South Dakota, Michigan, Maine, and Ontario. If these sources hold up they can relatively easily be moved into red raspberry especially if there are molecular markers to facilitate identifying genotypes with resistance.

Publications:

Until a new cultivar is released and the notice published in a scientific journal, results from our trial are mostly presented informally in Oregon and Washington Commission reports and oral presentations. Also this work is published in our annual NCCC-22 Small Fruit Research Workers report.

Table RY1. Raspberry genotypes potentially harvested in 2009.

Floricane fruiting		Primocane fruiting	Black Raspberry
BC 87-11-33	ORUS 3229-1	ORUS 1167-2	ORUS 2931-1
BC 90-05-30	ORUS 3229-2	ORUS 1173-2	ORUS 3012-1
BC 90-08-11	ORUS 3251-1	ORUS 1173R-2	ORUS 3012-2
BC 90-08-20	WSU 1206	ORUS 1179-2	ORUS 3012-3
BC 90-11-44	WSU 1253	ORUS 2786-1	ORUS 3012-4
BC 90-19-08	WSU 1384	ORUS 2786-2	ORUS 3012-5
BC 91-17-10	WSU 1387	ORUS 2786-3	ORUS 3012-6
BC 92-5-47	WSU 1468	ORUS 2786-4	ORUS 3013-1
BC 93-09-40	WSU 1447	ORUS 2786-5	ORUS 3013-2
BC 93-26-25	WSU 1472	ORUS 2786-6	ORUS 3018-1
BC 96-37-1	WSU 1484	ORUS 2786-7	ORUS 3021-1
BC 97-30-3	WSU 1499		ORUS 3021-2
BC 1-17-1	WSU 1502	Heritage	ORUS 3025-1
BC 1-50-2	WSU 1503	Himbo Top	ORUS 3030-1
BC 1-50-14	WSU 1539	Jaclyn	ORUS 3031-3
BC 1-86-7	WSU 1582	Joan J	ORUS 3032-2
BC 1-87-9	Cascade Bounty	Polana	ORUS 3032-3
BC 1-88-6	Coho	Polka	ORUS 3038-1
OSC 892	Meeker		ORUS 3217-1
ORUS 1025-10	Moutere		ORUS 3217-2
ORUS 1040-1	Saanich		ORUS 3217-3
ORUS 1040-10	Tulameen		ORUS 3219-1
ORUS 1107R-1	Ukee		ORUS 3219-2
ORUS 1142-1			ORUS 3409-2
ORUS 1149-1			ORUS 3413-1
ORUS 1149-2			Pequot
ORUS 1179-1			Munger
			Explorer (primocane)

Table RY2. Mean yield and berry size for floricane fruiting raspberry genotypes at OSU-NWREC planted in 2004. Harvested in 2006-08.

Genotype	Berry Size (g)[z]				Yield (kg/plant)	Yield (t/a)
	2006	2007	2008	2006-08	2006-08	2006-08
Rep						
2006				4.7 b	3.49 ns	5.03 ns
2007				5.4 a	3.52 ns	5.07 ns
2008				5.5 a	3.00 ns	4.32 ns
WSU 1226	5.7 a	7.0 a	6.8 a	6.5 a	3.86 a	5.55 a
Cascade Dawn	3.8 c	4.3 b	4.6 b	4.2 c	3.50 a	5.03 a
Tulameen	**4.5 b**	**4.9 b**	**5.3 b**	**4.9 b**	**2.66 b**	**3.83 b**
Observation						
Saanich	2.9	3.4	3.1	3.1	2.91	4.19
BC 90-04-48	2.8	3.9	3.2	3.3	2.52	3.62
BC 92-05-1	3.3	4.4	3.6	3.8	2.05	2.96
Ukee (BC 92-06-41)	2.7	3.7	3.6	3.3	1.56	2.24

Mean separation within columns by Duncan=s $p \leq 0.05$.

Table RY3. Mean yield and berry size for floricane fruiting raspberry genotypes at OSU-NWREC planted in 2005. Harvested in 2007-08.

Genotype	Berry Size (g)[z]	Yield (kg/plant)	Yield (t/a)
	2007-08	2007-08	2007-08
Rep			
2007	3.5 b	3.04	4.37
2008	3.8 a	2.50	3.59
ORUS 1040-10	4.8 a	5.29 a	7.61 a
Coho	3.7 b	2.73 b	3.93 b
ORUS 1142-1	3.8 b	2.61 b	3.75 b
Meeker	**3.1 c**	**2.33 b**	**3.35 b**
Ukee (BC 92-06-41)	3.3 c	1.98 b	2.85 b
ORUS 1025-10	3.2 c	1.66 b	2.39 b
Observation			
WSU 1387	5.0	5.08	7.31
WSU 1472	3.8	4.08	5.87
BC 90-05-30	4.6	3.62	5.20
BC 87-11-33	3.5	3.25	4.68
BC 90-19-08	4.4	3.02	4.34
WSU 1468	4.0	2.63	3.78
WSU 991	5.0	2.62	3.77
BC 90-08-11	4.8	2.59	3.73
WSU 1384	5.1	2.55	3.66
WSU 1253	4.0	2.53	3.65
BC 91-17-10	3.8	2.25	3.23
BC 90-11-44	3.8	2.01	2.89
BC 96-37-1	2.6	1.92	2.76
WSU 1539	3.8	1.47	2.11
WSU 1499	2.1	1.34	1.93

Mean separation within columns by Duncan=s $p \leq 0.05$.

Table RY4. Mean yield and berry size for floricane fruiting raspberry genotypes at OSU-NWREC planted in 2006. Harvested in 2008.

Genotype	Berry Size (g)[z]	Yield (kg/plant)	Yield (t/a)
	2007-08	2007-08	2007-08
Replicated			
ORUS 1040-1	3.6 cd	2.54 a	3.65 a
ORUS 1149-2	4.1 b	2.19 ab	3.14 ab
Moutere	4.0 bc	1.67 a-c	2.41 a-c
WSU 1253	3.3 de	1.48 a-c	2.13 a-c
ORUS 1149-1	4.5 a	1.47 a-c	2.12 a-c
Meeker	**3.1 ef**	**1.46 bc**	**2.10 bc**
WSU 1502	2.6 g	1.10 cd	1.58 cd
Cascade Dawn	3.9 bc	1.09 cd	1.57 cd
OSC 892	2.7 g	0.83 cd	1.19 cd
ORUS 1179-1	2.8 fg	0.36 d	0.51 d
ORUS 1107R-1	3.4 de	0.19 d	0.27 d
Observation			
Cascade Bounty	3.4	2.55	3.67
BC 90-8-20	4.3	1.34	1.93

Mean separation within columns by Duncan=s $p<0.05$.

Table RY5. Mean yield and berry size for primocane fruiting raspberry genotypes at OSU-NWREC planted in 2004-05.

	Berry Size (g)	Yield (kg/plt)				Yield (t/a)			
Genotype	2005-08	2006	2007	2008	2005-08	2006	2007	2008	2005-08
2004 Planted									
Non-rep									
ORUS 2786-3	5.0		3.17	0.61	1.89		4.57	0.87	2.72
Heritage	**2.5**	**2.97**	**2.43**	**1.03**	**1.81**	**4.28**	**3.50**	**1.48**	**2.60**
ORUS 2786-2	3.7	2.10	2.26	1.45	1.69	3.02	3.25	2.09	2.43
ORUS 2786-1	3.0	1.16	1.45	0.81	0.88	1.67	2.08	1.16	1.27
ORUS 2786-4	3.4	0.17	0.34	0.08	0.24	0.25	0.48	0.11	0.34
2005 Planted									
	2006-08	2006	2007	2008	2006-08	2006	2007	2008	2006-08
2006	3.3 b				1.75 a				2.52 a
2007	3.4 b				2.41 a				3.47 a
2008	3.9 a				0.72 b				1.03 b
Replicated									
Heritage	**2.7 d**	**2.62 a**	**2.40 b**	**0.95 a**	**1.99 a**	**3.77 a**	**3.46 b**	**1.37 a**	**2.87 a**
ORUS 1173-2	4.2 a	2.10 ab	3.32 a	0.27 a	1.90 a	3.02 ab	4.77 a	0.39 a	2.72 a
ORUS 1173R-2	3.8 b	0.90 c	2.34 b	0.93 a	1.39 b	1.30 c	3.37 b	1.34 a	2.00 b
ORUS 2786-5	3.3 c	1.40 bc	1.58 bc	0.71 a	1.23 b	2.02 bc	2.27 bc	1.02 a	1.77 b
Non-rep									
Himbo Top	3.0	1.13	2.02	1.08	1.41	1.62	2.90	1.56	2.03
ORUS 2786-6	3.8	1.01	2.22	0.07	1.10	1.45	3.19	0.10	1.58
Jaclyn	3.1	0.51	2.07	0.07	0.88	0.74	2.97	0.10	1.27
ORUS 2786-7	2.8	0.44	1.40	0.45	0.76	0.63	2.01	0.65	1.10

Mean separation within columns by Duncan=s $p \leq 0.05$.

Table RY6. Mean yield and berry size for primocane fruiting raspberry genotypes in 2008 at OSU-NWREC planted in 2006-07. BRY= Black raspberry.

	Berry size (g)	Yield (kg/plt)	Yield (t/a)
2006 Planted			
Replicated			
ORUS 1167-2	3.0 ab	2.09 a	3.01 a
ORUS 1179-1	3.1 ab	2.05 a	2.95 a
Heritage	**2.7 b**	**1.66 ab**	**2.39 ab**
ORUS 1107R-1	3.4 ab	1.09 b	1.57 b
Explorer (BRY)	2.0 c	0.10 c	0.15 c
Non-rep			
ORUS 3409-2 (BRY)	2.5	0.33	0.48
2007 Planted			
ORUS 2786-5	3.2 a	1.48 a	2.13 a
Heritage	**2.5 b**	**0.32 b**	**0.46 b**

Mean separation within columns by Duncan=s $p < 0.05$.

Table RY7. Ripening season for primocane fruiting red raspberry genotypes at OSU-NWREC. Planted in 2004-08 and harvested 2005-08.

Genotype	Year planted	Harvest season 5%	50%	95%	Years in mean	Rep/ Obsv.
Cascade Dawn	2004	21-Jun	2-Jul	19-Jul	3	R
BC 87-11-33	2005	21-Jun	5-Jul	16-Jul	2	O
WSU 1539	2005	25-Jun	5-Jul	19-Jul	2	O
WSU 1499	2005	28-Jun	5-Jul	19-Jul	2	O
BC 90-05-30	2005	25-Jun	5-Jul	19-Jul	2	O
ORUS 1142-1	2005	25-Jun	5-Jul	23-Jul	2	R
Cascade Dawn	2006	8-Jul	8-Jul	15-Jul	1	R
ORUS 1107R-1	2006	8-Jul	8-Jul	22-Jul	1	R
ORUS 1179-1	2006	8-Jul	8-Jul	29-Jul	1	R
WSU 991	2005	25-Jun	8-Jul	16-Jul	2	O
ORUS 1025-10	2005	25-Jun	8-Jul	23-Jul	2	R
BC 90-19-08	2005	28-Jun	8-Jul	23-Jul	2	O
Meeker	**2005**	**28-Jun**	**8-Jul**	**23-Jul**	**2**	**R**
Ukee(BC 92-06-41)	2004	29-Jun	9-Jul	23-Jul	3	O
BC 90-11-44	2005	28-Jun	12-Jul	23-Jul	2	O
Saanich	2004	1-Jul	12-Jul	21-Jul	3	O
BC 9205-1	2004	2-Jul	12-Jul	26-Jul	3	O
Tulameen	2004	2-Jul	12-Jul	28-Jul	3	R
BC 9004-48	2004	6-Jul	12-Jul	21-Jul	3	O
WSU 1384	2005	28-Jun	12-Jul	23-Jul	2	O
WSU 1387	2005	28-Jun	12-Jul	2-Aug	2	O
Ukee(BC 92-06-41)	2005	2-Jul	12-Jul	26-Jul	2	R
WSU 1253	2005	2-Jul	12-Jul	26-Jul	2	O
OSC 892	2006	8-Jul	15-Jul	15-Jul	1	R
WSU 1253	2006	8-Jul	15-Jul	22-Jul	1	O
WSU 1502	2006	8-Jul	15-Jul	22-Jul	1	O
Moutere	2006	8-Jul	15-Jul	22-Jul	1	R
BC 90-08-20	2006	8-Jul	15-Jul	29-Jul	1	O
Meeker	**2006**	**8-Jul**	**15-Jul**	**29-Jul**	**1**	**R**
ORUS 1149-1	2006	8-Jul	15-Jul	29-Jul	1	R
WSU 1502	2006	8-Jul	15-Jul	29-Jul	1	R
ORUS 1040-1	2006	8-Jul	15-Jul	5-Aug	1	R
ORUS 1149-2	2006	8-Jul	15-Jul	12-Aug	1	R
Coho	2005	2-Jul	16-Jul	2-Aug	2	R
WSU 1468	2005	5-Jul	16-Jul	30-Jul	2	O
ORUS 1040-10	2005	2-Jul	19-Jul	6-Aug	2	R
BC 90-08-11	2005	5-Jul	19-Jul	26-Jul	2	O
WSU 1472	2005	5-Jul	19-Jul	26-Jul	2	O
WSU 1226-0	2004	9-Jul	21-Jul	4-Aug	3	R
WSU 1253	2006	8-Jul	22-Jul	29-Jul	1	R
Cascade Bounty	2006	8-Jul	22-Jul	19-Aug	1	O
BC 91-17-10	2005	8-Jul	23-Jul	2-Aug	2	O
BC 96-37-1	2005	8-Jul	23-Jul	2-Aug	2	O

Project No: New

Title: Cooperative raspberry cultivar development program

Year Initiated: 2010 **Current Year:** 2010-2011 **Terminating Year:** continuing

Personnel: Chad Finn, Research Geneticist, USDA-ARS, HCRL; 3420 NW Orchard Ave. Corvallis, OR 97330

Justification:

The Pacific Northwest is one of the most important berry production regions in the world. This success is due to a combination of an outstanding location, top notch growers, and a strong history of industry driven research. The USDA-ARS raspberry, blackberry, and strawberry breeding programs in Corvallis have a long history of developing cultivars that are commercially viable. New cultivars that are high yielding, machine harvestable, and that produce very high quality fruit are essential for the long term viability of the industry. Cultivars that replace or complement the current standards, primarily 'Meeker' would help towards that goal. Our release, 'Coho' was an example of what we are striving for. While 'Coho' was initially embraced for its high quality machine harvest product, its susceptibility to root rot prevented it from being widely planted.

The Pacific Northwest breeding programs in Oregon, Washington, and British Columbia have a long history of cooperation. We exchange parents, seedlings, and ideas and thoroughly test and evaluate each others selections. Cultivars developed by these integrated programs should benefit the entire industry in the Pacific Northwest.

Objectives:

To develop raspberry cultivars for the Pacific Northwest in cooperation with Agriculture and Agri-Food Canada and Washington State University that are high-yielding, machine harvestable, disease/virus resistant and that have superior processed fruit quality (#1 Commission Research Priority). New fresh market raspberry cultivars will be pursued as well that provide season extension either through floricane or primocane fruiting types (#3 Commission Research Priority).

Procedures:

This is an ongoing project where cultivars and current selections serve as the basis for generating new populations from which new selections can be made, tested, and either released as a new cultivar or serve as a parent for further generations. All of the steps are taking place every year i.e. crossing, growing seedlings, selecting, propagating for testing, and testing.

Crosses will be done each year to produce seed. Seedling populations are grown and evaluated in Corvallis, Ore. Selections are made and propagated for testing at the Oregon State University - North Willamette Research and Extension Center (Aurora, Ore.). Washington State University and Agriculture and Agri-Food Canada selections, in addition to the USDA-ARS selections, that looked outstanding as a seedling or that have performed well in other trials, are planted in replicated trials (3 replications of 3 plants each plus a 3 plant observation plot). Selections that we are less sure of are generally planted in smaller observation trials (single, 3 plant plots). Fruit from replicated and observation plots are harvested and weighed, and plants and fruit are subjectively evaluated as well for vigor, disease tolerance, winter hardiness, spines, ease of removal, color, firmness, and flavor.

Fruit from the best selections are processed after harvest for evaluation in the off season.

Selections that look promising are propagated for grower trials, machine harvest trials, and for evaluation trials at other locations in Washington and B.C. This usually involves cleaning up the selections in tissue culture and then working with the various nurseries to generate plants for trials.

While not directly related to red raspberry at first glance, our current efforts in black raspberry, which are supported by separate funding (see Current Funding and Support), have the potential to positively impact red raspberry. While much of this work is very specific to black raspberry, our work on aphid resistance may have applications for red raspberry. We have assembled a collection of black raspberry germplasm from across the eastern US (~150 locations) and have screened each population for resistance to raspberry aphid, which is a major vector for several raspberry viruses. To this point we have identified four sources of resistance (South Dakota, Michigan, Maine, Ontario). We are in the process of studying these sources further and of developing molecular markers that can be used to more efficiently select for this trait in the breeding program. If these sources hold up they can relatively easily be moved into red raspberry especially if there are molecular markers to facilitate identifying genotypes with resistance.

Anticipated Benefits and Information Transfer:

This breeding program will develop new raspberry cultivars that either are improvements over the current standards or that will complement current standards. In addition, the information generated on advanced selections from the WSU and B.C. programs will be made available and aid in making decisions on the commercial suitability of their materials.

Results of all trials will be made available to the industry to help them make decisions in their operations.

Budget:

Funds from the USDA-ARS will be used to provide technician support and the bulk of the funding of the overall breeding project.

Amount allocated by Commission for previous year: $ 4,000

Request for FY 2009-2010	
Student labor (GS-2)	$2,000
Operations (goods & services)	500
Travel[1]	500
Other: "Land use charge" ($3500/acre)	1,500
Total	**$4,500**

[1]To visit Puyallup, Abbotsford, and/or grower trials and field days in Washington.

Other support of project:

See attached form on the current and pending support.

While the USDA-ARS program dates to the 1920s, it took a major step forward when it was developed as the Northwest Center for Small Fruit Research and began hiring new scientists in 1993. This program has ongoing breeding program in red raspberries, blackberries, black raspberries, blueberries, and strawberries. While our program has historically been well funded and we have bred red raspberries and willingly tested selections from Washington and British Columbia with almost no direct Commission financial support, costs have risen dramatically in the past few years with no significantly increased federal budget. The USDA-ARS and the Oregon Blackberry and Raspberry Commission through their support of our cooperator Dr. Bernadine Strik at the North Willamette Station have been the primary supporters of this effort. Due to increased costs it is becoming increasingly difficult to continue all of these activities. While we are doing our best to be efficient we also are asking the industry to help us continue the activities we have done in the past.

Current Support

Name (List PI #1 first)	Supporting Agency and Project #	Total $ Amount	Effective and Expiration Dates	Title of Project
Strik, B.C. and C.E. Finn	Oregon Raspberry and Blackberry Commission	$10,000	2009	Production System/Physiology Research and Cooperative Breeding Program- Raspberries and Blackberries
Tzanetakis, I.E., and 11 team members.	USDA Specialty Crop Research Initiative	1,463,234 (~7K/yr to our program)	2009-2011	Management of virus complexes in Rubus.
Finn, C.E.	USDA-ARS PEO Germplasm Evaluation grant	$15,505	2008-2009	Evaluation of wild black raspberry (Rubus occidentalis L.) for disease resistance, phenology, vigor, and fruit characteristics

Pending Support

Name (List PI #1 first)	Supporting Agency and Project #	Total $ Amount	Effective and Expiration Dates	Title of Project
Finn, C.E.	Northwest Center for Small Fruit Research	$34,988	2009-2010	Molecular markers for aphid resistance in black raspberry
Finn, C.E.	USDA-ARS PEO Germplasm Evaluation grant	$15,505	2010	Evaluation of wild black raspberry (Rubus occidentalis L.) for disease resistance, phenology, vigor, and fruit characteristics

Project No: 13C-3455-4635

Title: Efficacy of a phosphite product for controlling raspberry root rot caused by *Phytophthora rubi*

Personnel: Thomas Walters, Small Fruit Horticulture Program, WSU-Mount Vernon NWREC
Debra Inglis, Vegetable Pathology Program, WSU-Mount Vernon NWREC

Reporting Period: 2009

Accomplishments:

We are evaluating Pro-Phyt, a labeled phosphonate product, in greenhouse evaluations, when plants are challenged with *Phytophthora rubi* (a major cause of raspberry root rot). Reports from other locations in the world indicate that this product has efficacy against the disease. We verified that we were able to reliably inoculate plants in the greenhouse, and that we could provide conditions conducive to infection. The 2009 results will be presented to growers at the Small Fruit Workshop and at the Washington Red Raspberry Commission meeting in Lynden.

Results:

Tissue culture-propagated 'Meeker' plugs, were planted into a 2:1 mix of soil and vermiculite in the greenhouse. Seven treatments were established. Treatments 1-5 were inoculated with *P. rubi* (mycelia and ~1.5 x 10^3 oospores per g soil mix. Treatments 1-6 were flooded for 48 hr every two weeks. Treatment 1 was a foliar treatment with ProPhyt® fungicide at 4 pt/A with four bi-weekly applications made beginning the day after planting. Treatment 2 was two bi-weekly applications of ProPhyt® at 4 pt/A beginning the day after planting. Treatment 3 was four bi-weekly drenches with ProPhyt® made beginning the day after planting. Treatment 4 was a single drench application of Ridomil Gold at 0.25 pt/1000 ft row made the day after planting. Treatments 6 and 7 were non-inoculated controls. Each treatment was replicated five times and the entire experiment was performed twice during April and June. Eight weeks after planting, plants were removed, washed and evaluated. Plant heights were recorded regularly; the area under the plant height curve (AUPHC) was significantly greater for plants in Treatments 6 and 7 (non-inoculated). There were no consistent significant differences among the inoculated treatments, i.e. the non-treated, Ridomil-treated and Pro-Phyt-treated plants were similar. The same trends were seen in the other measurements taken: root dry weight, shoot dry weight, root rot rating and proportion of roots diseased. Oospores (consistent with *P. rubi*) were associated with the roots of inoculated plants, but not with roots of non-inoculated plants. Some roots were affected with a dark discoloration that did not resemble symptoms of *P. rubi*. This may have been a physiological reaction of 'Meeker' to the growing container conditions, since we did not see similar symptoms in 'Tulameen' plants, evaluated in another experiment simultaneously.

The procedure and inoculum preparation method we used was shown by Wilcox to be effective for establishing disease in greenhouse plants, but oospsores were not quantified in the Wilcox procedure. Recent work in Walters' lab indicates that 100 oospores/g potting mix can be sufficient for disease development, and the higher density used in our experiment may have masked treatment efficacy.

Publications:

Walters, T., Gundersen, B., Particka, M., Gigot, J., and Inglis, D. 200x. Evaluation of a phosphite product for controlling Phytophthoraroot rot on raspberry caused by *P. rubi*, 2009. Plant Disease Management Reports x:xxx (in preparation for December 2009 submission).

2009 Raspberry Phosphite Greenhouse Trial I (Inoculated & transplanted on 4/20/09)

Treatments and rates	AUPHPC (5/20–6/1)	Root area (mm)[e]	Root length (mm)[e]	Foliar biomass dry wt (g)	Root biomass dry wt (g)	Root rot rating[fg]	Proportion of diseased roots[gh]
Inoculated and Flooded							
ProPhyt 4 pt/A foliar application[a]	1352 d	12,442[d]	5,533	8.8 b	7.4 c	4.20	5.20 a
ProPhyt 4 pt/A foliar application[b]	1339 d	8,819	3,556	9.6 b	8.0 c	3.80	3.40 bcd
ProPhyt 4 pt/A drench application[c]	1561 cd	8,559	4,139	10.8 b	7.4 c	4.20	4.60 abc
Ridomil Gold 0.25 pt/1000'[d]	1832 bc	8,768	4,301	11.6 b	8.6 bc	4.07	5.00 ab
Non-treated control	1476 cd	10,675	4,885	9.4 b	7.2 c	4.13	4.20 abc
Inoculated and Not Flooded							
Non-treated control	2435 a	25,608	10,541	21.2 a	11.2 a	4.00	2.60 d
Not Inoculated and Not Flooded							
Non-treated control	2124 ab	22,193	9,974	21.0 a	10.6 ab	4.36	3.43 cd
LSD ($P \leq 0.05$)	385.0	------[e]	------[e]	3.96	2.45	ns	

[a]Four bi-weekly applications, beginning at transplanting.
[b]Two bi-weekly applications beginning 4 weeks after transplanting.
[c]Four bi-weekly drench applications beginning 1 day after transplanting.
[d]One application at transplanting.
[e]Of three plants from one replication only, therefore, data not analyzed.
[f]Based on a 1-9 scale where 0 = abundant feeder roots with few discolored and 9 = few feeder roots with most discolored.
[g]Mean separations made on ranked data; data back-transformed for presentation.
[h]Based on a 1-9 scale where 1 = <12.5% and 9 = >87.5% diseased roots.

Greenhouse Trial II was inoculated and transplanted on 4/21/09. Results were similar to Trial I (data not shown). Based on the results of the two trials we think it would be best to pursue drench application treatments in subsequent experiments.

Project No: 13C-3455-4635

Title: Efficacy of a phosphite product for controlling raspberry root rot caused by *Phytophthora rubi*

Year Initiated: 2009 **Current Year:** 2010 **Terminating Year:** 2010

Personnel: Thomas Walters, Small Fruit Horticulture Program, WSU-Mount Vernon NWREC
Debra Inglis, Vegetable Pathology Program, WSU-Mount Vernon NWREC

Justification and Background:

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

Nearly 10% of the operating budget for raspberry production is dedicated to control of Raspberry root rot (MacConnell and Kangiser 2007), but this disease nonetheless continues to limit the longevity of many raspberry plantings. Current control measures include treatment with mefenoxam, use of resistant varieties (Moore 2004; Moore and Finn 2007), and planting on hills. Drip line placement can have an effect (Walters and Particka 2008), as can preplant treatments including soil solarization and gypsum amendment (Maloney, Pritts et al. 2005). Phosphorous acid and phosphonate products are moderately effective in controlling raspberry root rot (Bristow and Windom 1992; Maloney, Pritts et al. 2005). Timing of phosphonate applications is critical to effective control of late blight on tomato (Inglis, unpublished) and late blight and pink rot on potato (Johnson, Inglis et al. 2004). Application timing may also be critical to effective control of raspberry root rot, but optimal timing is unknown.

Objectives:

1. Determine the efficacy of a labeled phosphonate product in preventing Phytophthora root rot of raspberry under greenhouse conditions.

2. Determine whether this product must be applied prior to infection in order to be effective. (Note: If effective, we anticipate following up with field or microplot studies in the future to investigate effects of different application timings.)

Procedures:

This past year, we evaluated Pro-Phyt, Ridomil Gold and non-treated raspberry plants in the greenhouse, but we could not establish any consistent, significant effects of Ridomil or Pro-Phyt treatments. We believe this may have been a consequence of the high inoculum level used (~1.5 x 10^3 oospores/g soil). The procedure and inoculum preparation method we used (Wilcox 1989) was known to be effective for establishing disease in greenhouse plants, but oospsores were not suggested to be quantified in that procedure. Recent work in our lab indicates that 100 oospores/g potting mix can be sufficient for disease development. We propose to compare high and low inoculum levels, possibly with zoospores rather than oospores, and to evaluate plants at different times following inoculation.

A preliminary experiment is now being done to assess effects of inoculum density and spore type on disease development. Next spring, tissue culture-propagated 'Tulameen' raspberry plant plugs(3-6 month-old), will be planted into a 2:1 mix of soil and vermiculite within SC-10 cone-tainers™ (Stuewe and Sons, Inc, Tangent OR) in the greenhouse. The potting mix will be amended with inoculum of *P. rubi* to achieve rates of ca. 1.0 x 10^2 and 1.0 x 10^3 oospores/g potting mix. Plants will be treated with (i) a biweekly drench of ProPhyt® (Luxembourg-Pamol, Memphis TN) at 4 pt/A, (ii) a single drench of Ridomil Gold (Syngenta, Greensboro NC) at 0.25 pt/1000 ft row, or (iii) left untreated. All three treatments will be flooded for 2 days every 2 weeks following planting. In addition, non-inoculated reference controls, both flooded and non-flooded, will be included. Plants will be harvested and root systems evaluated at four, six, eight and ten weeks after planting. The experiment will be duplicated.

Two inoculum levels:		Three treatments:		Four evaluation times:
High (1000 oospores/g)	×	ProPhyr®	×	4 weeks
Low (100 oospores/g)		Ridomil Gold		6 weeks
		non-treated		8 weeks
				10 weeks

There will be five replicates of each treatment/inoculum level/evaluation time combination arranged in a randomized complete block design. Each replicate will include two plants in individual containers. Experimental setup, maintenance and evaluation will follow previously established procedures (Walters, Pinkerton et al. 2008). Four, six, eight and ten weeks after planting, sample plants with their roots will be removed from the pots, washed and evaluated. Proportion of diseased roots, root rot severity, and root and shoot dry weights will be recorded. Infected roots will be examined for oospores and other reproductive structures to verify that the infection is caused by *Phytophthora*. Data will be analyzed using analysis of variance, with Fisher's protected LSD test for mean separations. Walters will be responsible for ordering plants, producing inoculum, and assembling greenhouse materials. Inglis will be responsible for root rot evaluations and data analysis. Personnel from both programs will participate in experimental set-up, maintenance and take-down, and in preparing presentations and publications.

Our 2009 evaluations did not enable us to draw any conclusions about the efficacy of ProPhyt relative to Ridomil, but if ProPhyt proves efficacious in the 2010 evaluation, future field or microplot experiments will be warranted.

References:

Bristow, P. R. and G. E. Windom (1992). "The effect of sodium tetrathiocarbonate and fosetyl-Al in controlling phytophthora root rot of red raspberry in the Pacific Northwest." Phytopathology **82**: 1132 (abstr.).

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Maloney, K., M. Pritts, et al. (2005). "Suppression of Phytophthora Root Rot in Red Raspberries with cultural practices and soil ammendments." HortScience **40**(6): 1790-1795.

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Walters, T. W., J. N. Pinkerton, et al. (2008). "Methyl Bromide alternatives for raspberry nurseries (abstract)." HortScience **43**(4): 1252.

Wilcox, W. F. (1989). "Identity, Virulence, and Isolation Frequency of 7 Phytophthora Spp Causing Root-Rot of Raspberry in New-York." Phytopathology **79**(1): 93-101.

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Anticipated Benefits and Information Transfer:

Results will be presented to Washington raspberry growers at field days, grower meetings and at commission meetings. The results will also be incorporated into an extension bulletin on irrigation practices for berry crops in Washington. This knowledge will help growers understand whether Phosphite products could play a role in raspberry root rot control, and could potentially set the stage for future collaborative studies. Better yields and less disease will help berry production remain an economically viable activity in the state, and will contribute to rural economic health. Finally, reference information on effects of inoculum density and spore type will assist future research studies.

Budget:

Amount allocated by Commission for previous year: $4,326

Request for FY 2009-2010

	From WRRC (this request)	From WSCPR	Total for project
Salaries[1]	$1,524 $1,959	$1,524	$3,048 $1,959
Time-slip		$1,500	$1,500
Operations (goods & services) [2/]	$37	$750	$787
Travel			
Projected Needs			
Meetings[3/]		$70	$70
Other[4/]		$100	$100
Equipment			
Employee Benefits (Salaried)[5/]	$579 $646	$579	$1,158 $646
Employee Benefits (Time-slip)		$222	$222
Total	**$4,745**	**$4,745**	**$9,490**

[1/] M. Particka, 0.08333 FTE (1 month salary and benefits). B. Gunderson, 0.04166 FTE (0.5 month)
[2/] Tissue-cultured plants, culture media and petri dishes, greenhouse supplies
[3/] Travel by Walters/Inglis to grower meetings ($0.55/mile)
[4/] Publication costs
[5/] RA benefits 38%; time-slip 14.8%

Other support of project:

Approximately 0.5 FTE of a Research Associate is provided to the small fruit horticulture program by the WSU Agricultural Research Center. Likewise, approximately 0.5 FTE of a Research Associate is provided to the vegetable pathology program by the WSU Department of Plant Pathology. Approximately 5 to 10% of their time is anticipated for this project.

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

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

THOMAS WALTERS

Current Support

Name (List PI #1 first)	Supporting Agency and Project #	Total $ Amount	Effective and Expiration Dates	% of Time	Title of Project
Walters Inglis	Washington Red Raspberry Commission	$4,326	1/1/09 to 12/31/09	0.05	Efficacy of a phosphite product for controlling raspberry root rot caused by Phytophthora rubi
Walters Inglis	Washington State Commission on Pesticide Registration	$4,298	1/1/09 to 12/31/09	0.05	As above (matching funds)
Walters Zasada	Washington Red Raspberry Commission	$7,633	1/1/09 to 12/31/09	0.05	Evaluation of novel nematicides for root lesion nematode control in red raspberry.
Walters Zasada	Washington State Commission on Pesticide Registration	$7,633	1/1/09 to 12/31/09	0.05	As above (matching funds)
Pinkerton Walters et al	USDA-ARS Methyl Bromide Alternatives Program	$36,439	1/1/09 to 9/30/09	0.25	Methyl Bromide alternatives for red raspberry and forestry nurseries
Walters	NARF	$9,150	1/1/09 to 12/31/09	0.1	Evaluation of Small Fruits at WSU Mount Vernon
Inglis, Miles et al	SREP	$1,999,002	9/30/09-9/30/2011	0.15	Biodegradable Mulches for Specialty Crops Produced Under Protective Cover
Pitts et al	Specialty Crop Research Initiative	$49,479	10/2009-6/2010	0.1	Placing Fruit Canopy Management Automation Technology in the Field

Pending Support

Name (List PI #1 first)	Supporting Agency and Project #	Total $ Amount	Effective and Expiration Dates	% of Time	Title of Project
Walters Zasada	Northwest Center for Small Fruit Research	$32,951	7/1/2010 to 6/30/2011	0.2	Biological and Chemical Alternatives to Broadcast Fumigation for Raspberry
Walters Miller	Northwest Center for Small Fruit Research	$34,325	7/1/2010 to 6/30/2011	0.2	Interactions between raspberry cane burning and soil-borne disease

DEBRA INGLIS

Current Support

Name (List PI #1 first)	Supporting Agency and Project #	Total $ Amount	Effective and Expiration Dates	% of Time	Title of Project
Inglis,D.A.and Gundersen, B..	WSU-CSANR Biologically Intensive Agriculture and Organic Farming International Competitive Grants Program	$20,419	Jul 1, 2008 to Oct 30, 2009	7.5%	Forecasting late blight for northwestern Washington organic potato production.
Inglis, D. and Miles, C., et al.	CSREES SCRI	$1,999,002	Oct 1, 2009 to Sep 30, 2012	30%	Biodegradable mulches for specialty crops grown under protective covers.
Inglis, D.	The Natur Conservancy	$37,356	Apr 1, 2009 to Dec 30, 2010	10%	Effects of flooding on soilborne plant pathogens of potatoes in the Skagit Valley of Western Washington.
Inglis, D., Gundersen, B., and Hamm, P.	Washington State Potato Commission	$25,879	Jul 1, 2009 to Jun 30, 2010	15%	Silver scurf: A polycyclic disease that requires new management approaches.
Walters, T. and Inglis, D.	Washington Red Raspberry Commission	$4,326	Jan 1, 2009 to Dec 30, 2009	1.5%	Efficacy of a phosphate product for controlling raspberry root rot caused by *Phytophthora rubi.*

Pending Support

Name (List PI #1 first)	Supporting Agency and Project #	Total $ Amount	Effective and Expiration Dates	% of Time	Title of Project
Walters, T. and Inglis, D.	Washington Red Raspberry Commission	$4,413	Jan 1, 2010 to Dec 30, 2010	1.5%	Efficacy of a phosphate product for controlling raspberry root rot caused by *Phytophthor rubi.*
Brown, C., Johnson, D., and Inglis, D.	WSDA-ARS Potato Proposals	$120,000	Jul 1, 2010 to Jun 30, 2011	10%	Managing incipient late blight inoculum from latently-infected potato seed tubers.
Inglis, D., Gundersen, B., and Hamm, P.	Washington State Potato Commission	$28,838	Jul 1, 2010 to Jun 30, 2011	15%	Silver scurf: A polycyclic disease that requires new management approaches.

Project No: ARF 5703

Title: Evaluation of Novel Nematicides for Root Lesion Nematode Control in Red Raspberry

Personnel: Inga Zasada, USDA-ARS Horticultural Crops Research Laboratory, Corvallis OR
Thomas Walters (Co-PI), WSU- NWREC, Mount Vernon, WA
Ekaterina Riga (Cooperator), WSU-IAREC, Prosser, WA

Reporting Period: 2009

Accomplishments:

Nine nematicides were tested in can (soil only) and pot (soil plus raspberry plant) trials. Based upon results of these trials, several nematicides will be selected for future evaluation in microplot and field trials. Results will be presented to growers at the Small Fruit Workshop and at the Washington Red Raspberry Commission meeting in Lynden.

Results:

In year 1 of this research (2009) we tested nine nematicides in can (soil only) and pot (soil plus raspberry) trials (Table 1); Nemacur, Vydate and nontreated were included as controls. Results from replicated can trials demonstrated that the nematicide differed in their ability to kill nematodes. Nematode recovery 7 and 14 days after treatment was always lowest from fosthiazate-treated soil. Unfortunately it is unlikely that fosthiazate will be registered for use on raspberry because it is an organophosphate, and this group of compounds is being strictly regulated by USEPA. Root lesion nematode recovery 14 days after treatment was lower in soils treated with Vydate, Nema-Q (10,000 PPM), Cordon (600 PPM) and Lannate compared to the nontreated control (Table 1). Results from pot trials are still being collected and will be available prior to selecting nematicides for screening in field and microplot trials.

Table 1. Recovery of Pratylenchus penetrans from soil 7 and 14 days after treatment with nematicides.*

Nematicide	7 Days	14 Days
Fosthiazate	17 d	9 d
Nemacur	43 c	88 abc
Vydate	52 bc	68 bc
MCW2	67 abc	111 abc
Multiguard	130 a	128 ab
Nema-Q (5,000 PPM)	82 abc	107 abc
Nema-Q (10,000 PPM)	72 abc	57 c
Root Feed	104 ab	132 abc
BWE 1000	108 abc	124 ab
Cordon (300 PPM)	110 a	101 abc
Cordon (600 PPM)	56 bc	24 cd
Lannate	120 ab	84 bc
Root Power	105 ab	130 ab
Control	119 a	168 a

* All nematicides were applied on an area basis in 37.5 ml water. Trials were similar for both sampling dates ($P = 0.08$ and 0.32), therefore the data was combined. Values followed by the same letter are not significantly different ($P < 0.05$). All data was log transformed prior to analysis, non-transformed data is presented. N = 12.

Project No: ARF 5703

Title: Evaluation of Novel Nematicides for Root Lesion Nematode Control in Red Raspberry

Year Initiated: 2009 **Current Year:** 2010 **Terminating Year:** 2011

Personnel: Inga Zasada, Research Plant Pathologist/Nematologist, (541)758-4051, inga.zasada@ars.usda.gov
Thomas Walters (Co-PI), Assistant Horticulturist, WSU-Mount Vernon NWREC, 16650 State Route 536, Mount Vernon, WA 98273, (360)848-6124, twwalters@wsu.edu

Cooperator: Ekkaterina Riga, Assistant Nematologist, WSU-Prosser IAREC, 24106 N. Bunn Rd., Prosser, WA 99350, (509)786-9256, riga@wsu.edu

Justification:

The root lesion nematode, *Pratylenchus penetrans*, is prominent in western Washington soils and has been shown to reduce raspberry vigor (McElroy, 1992). Root lesion nematodes are migratory endoparasites, migrating between the soil and roots. On raspberry, nematode feeding on feeder roots can reduce the capacity of the plant to uptake nutrients and water. The rate of raspberry decline depends upon the nematode population density but usually occurs over a 3- to 4-year periods (Ellis et al., 1991). Rate of decline will depend upon the variety, but clearly, when this nematode is left unchecked and population densities increase in established raspberry plantings, significant yield loss can occur. Presently there are no nematicides labeled for post-plant treatment of the root lesion nematode in raspberry.

Previous studies evaluated the effect of Vydate, Nemathorin (fosthiazate), DiTerra, Cordon and mustard (*Brassica carinata)* seed meal on nematode population densities in a heavily infested field of 'Nootka' raspberries. Only Vydate and Nemathorin effectively reduced root lesion populations. The states of Washington and Oregon requested a Section 18 emergency label for Vydate on caneberries, but EPA rejected the request. The registrant (DuPont) is in negotiation with EPA regarding the Vydate label. These negotiations may clear the path for a Section 18 label for Vydate (possibly with additional monitoring requirements), or they may not (Norm McKinley, personal communication).

The uncertainty of the registration of Vydate™ for post-plant use on raspberry, coupled with potential changes to USEPA regulations regarding fumigant use on all commodities, means that pre- and post-plant management options available to control the root lesion nematode (*Pratylenchus penetrans*) in red raspberry are limited. The root lesion nematode attacks the roots of raspberry and slowly causes feeder roots to die, limiting the capacity of the plant to uptake water and nutrients resulting in decline. If the root lesion nematode is not managed it can result in the reduced lifespan of a raspberry planting. We propose to continue our evaluations of novel nematicides (organophosphates, biopesticides, etc.) in field and microplot trials to identify a product that can be integrated into raspberry production systems as a post-plant management strategy for the root lesion nematode. We expect to identify the most promising nematicides currently registered by USEPA and begin the process of adding raspberry to existing labels. This research directly addresses a

#1 priority of the Washington Red Raspberry commission, soil fumigant techniques and alternatives.

Objective:

Test the most promising nematicides identified in can and pot trials in replicated field and microplot trials against root lesion nematode on established raspberry.

Procedures:

Over a three-year period we proposed to evaluate available novel nematicides in controlled and field environments; the first year of this research has been completed. In year 2 (2010) we propose to establish a replicated field trial to screen the most promising nematicides identified in can and pot trials. A field site has already been identified for this endeavor and there is room for a 40 plot experiment allowing for 8 treatments (including a nontreated control) replicated 5 times each. In October 2009 all plots will be sampled for nematodes. Soil and root samples will be collected and extracted on a Baermann funnel or in a mist chamber, respectively (Ingham, 1994). At this time the Nemacur control treatment will be established by applying Nemacur (1 gal/a directed) as a directed application to soil. In the spring (April 2010) the novel nematicide treatments will be established. Nematicides that will definitely be included in this field trial are: Nema-Q (10,000 PPM), Cordon (600 PPM) and Lannate (3 pt/a directed). Another nematicide likely to be included in the trial is Movento, a foliar-applied systemic nematicide which has shown promise in California perennial production systems. Movento was included in our pot trials and results will be forthcoming. Root lesion nematode populations will be determined two weeks after treatment and at the end of the growing season as described above. Fruit yield will be determined through weekly harvests as an indicator of phytotoxicity. Data will be transformed as required to meet ANOVA assumptions and will be analyzed using the SAS GLM protocol to determine treatment effects.

We have also established 60 microplots (individual raspberry plants contained in 30-in diameter, 30-in deep cylinders buried in the soil and inoculated with root lesion nematodes) at WSU-NWREC. These microplots provide an ideal venue in which to fine-tune nematicide application strategies as well as to look at long-term effects of the nematicides on root lesion nematode populations and plant productivity. There is room in this experimental design for 10 treatments (including a nontreated control) replicated 6 times each; Nemacur will be included as the industry standard comparison treatment. Treatments that could be potentially included in the microplots are: spring vs. fall applications of Nema-Q, Lannate and/or Cordon; spring application timing of Movento, and; repeated yearly applications of nematicides. The treatment structure of this experiment will be determined once more data is available. Data collection in the microplot trial will include: root lesion nematode population densities pre-treatment, two weeks after treatment, at the end of the growing season and fruit yield. Data will be analyzed similar to that described above.

Relationship to WRRC Research priority(s):

This proposed research directly addresses a #1 priority of the WRRC, soil fumigant techniques and alternatives.

Timeline:

Activity	2009	2010	2011
Nematode sampling in field and microplot trials	Oct	April and Sept	April and Sept
Application of post-plant nematicides in field and microplot trials	Oct	April	
Measurement of raspberry response to nematicides		July and Aug	July and Aug

Anticipated Benefits and Information Transfer:

This research will identify which novel nematicides currently registered by USEPA are effective at controlling the lesion nematode in red raspberry. Results will lay the foundation for future research with only the most promising compounds to identify appropriate rates, application methods as well as economic viability. Our research results will be presented to red raspberry growers at meetings (Berry Workshop, Lynden) and the annual WSU-NWREC field day. Results will also be communicated to the Washington Red Raspberry Commission and to Peerbolt Crop Management for inclusion in their newsletters.

References:

Ellis, M.A., Converse, R.H., Williams, R.N., and Williamson, B. 1991. Compendium of Raspberry and Blackberry Diseases of Insects. American Phytopathological Society, St. Paul, MN.

Ingham, R.E. 1998. Nematodes. In: Methods of Soil Analysis Part 2 – Microbiological and Biochemical Properties. Soil Science Society of America, Inc., pp. 459-490.

McElroy, F.D. 1992. A plant health care program for brambles in the Pacific Northwest. Journal of Nematology 24:457-462.

San Martin, R. 2004. Use of Quillaja saponins to control nematodes. In: Development of a commercial product: QL AGRI. International Conference on Saponins, Pulawy, Poland, p. 6.

Budget[1/]:

	2010	2011
Salaries	$	$
Time-Slip[2/]	$5856	$6090
Operations (goods & services)	$	$
Travel[3/]	$1115	$1115
Meetings	$202	$202
Other[4/]	$1800	$
Equipment	$	$
Benefits[5/]	$867	$901
Total	**$9,840**	**$8,308**

[1/]Money went to OSU last year, but this year will go directly to WSU because the majority of the work will be conducted by WSU employees.
[2/]Professional Worker (Jack Pinkerton, USDA-ARS retired) will be responsible for the day-to-day management of this research as a WSU employee.
[3/] 2010 (Pinkerton 4, Zasada 2 trips, Corvallis - Mt. Vernon); 2011 (Pinkerton 4, Zasada 2 trips, Corvallis - Mt. Vernon). Zasada will travel to Washington once a year to present research findings to the commission and at the WSU Small Fruits Workshop.
[4/] $300, Trellising supplies for microplots; $1500 grower payment for crop-destruct.
[5/] Benefits 14.8%

Funding:

Total amount requested: $11,854 (2010) $10,054 (2011)

Other sources of funding: Funding from the Washington State Commission on Pesticide Registration will be solicited as well as contributions from nematicide registrant companies whose products are being tested in field trials.

Current funding already received for this project: $7,633 (WRRC) and $7,633 (WA Pesticide Commission)

INGA ZASADA

Current Support

Name (List PI #1 first)	Supporting Agency and Project #	Total $ Amount	Effective and Expiration Dates	% of Time	Title of Project
Zasada & Pinkerton	Washington Blueberry Commission	15,160	1/2008 – 12/2010	5%	Pathogenicity of plant-parasitic nematodes on blueberries.
Zasada & Walters	Washington Red Raspberry Commission	7,633	2/2009 – 12/2009	2.5%	Evaluation of novel nematicides for root lesion nematode control in red raspberry.
Walters & Zasada	Washington Pesticide Commission	7,633	2/2009 – 12/2009	2.5%	Evaluation of novel nematicides for root lesion nematode control in red raspberry.
Walters & Zasada	Pacific Area-Wide Pest Management Program for Integrated Methyl Bromide Alternatives	41,439	1/2009 – 12/2010	5%	Methyl bromide alternatives for raspberry nurseries.
Tzanetakis et al.	USDA-SCRI	1,200,000	9/2009 – 8/2013	10%	Management of virus complexes in Rubus.

Pending Support

Name (List PI #1 first)	Supporting Agency and Project #	Total $ Amount	Effective and Expiration Dates	% of Time	Title of Project
Zasada & Moore	Northwest Center for Small Fruits Research	13,500	10/2010 – 9/2012	5%	Evaluation of Rubus spp. hybrids for Pratylenchus penetrans Resistance.
Walters & Zasada	Northwest Center for Small Fruits Research	73,735	7/2010– 6/2013	5%	Biological and chemical alternatives to broadcast fumigation for raspberry.

THOMAS WALTERS

Current Support

Name (List PI #1 first)	Supporting Agency and Project #	Total $ Amount	Effective and Expiration Dates	% of Time	Title of Project
Walters Inglis	Washington Red Raspberry Commission	$4,326	1/1/09 to 12/31/09	0.05	Efficacy of a phosphite product for controlling raspberry root rot caused by Phytophthora rubi
Walters Inglis	Washington State Commission on Pesticide Registration	$4,298	1/1/09 to 12/31/09	0.05	As above (matching funds)
Walters Zasada	Washington Red Raspberry Commission	$7,633	1/1/09 to 12/31/09	0.05	Evaluation of novel nematicides for root lesion nematode control in red raspberry.
Walters Zasada	Washington State Commission on Pesticide Registration	$7,633	1/1/09 to 12/31/09	0.05	As above (matching funds)
Pinkerton Walters et al	USDA-ARS Methyl Bromide Alternatives Program	$36,439	1/1/09 to 9/30/09	0.25	Methyl Bromide alternatives for red raspberry and forestry nurseries
Walters	NARF	$9,150	1/1/09 to 12/31/09	0.1	Evaluation of Small Fruits at WSU Mount Vernon
Inglis, Miles et al	SREP	$1,999,002	9/30/09- 9/30/2011	0.15	Biodegradable Mulches for Specialty Crops Produced Under Protective Cover
Pitts et al	Specialty Crop Research Initiative	$49,479	10/2009- 6/2010	0.1	Placing Fruit Canopy Management Automation Technology in the Field

Pending Support

Name (List PI #1 first)	Supporting Agency and Project #	Total $ Amount	Effective and Expiration Dates	% of Time	Title of Project
Walters Zasada	Northwest Center for Small Fruit Research	$32,951	7/1/2010 to 6/30/2011	0.2	Biological and Chemical Alternatives to Broadcast Fumigation for Raspberry
Walters Miller	Northwest Center for Small Fruit Research	$34,325	7/1/2010 to 6/30/2011	0.2	Interactions between raspberry cane burning and soil-borne disease