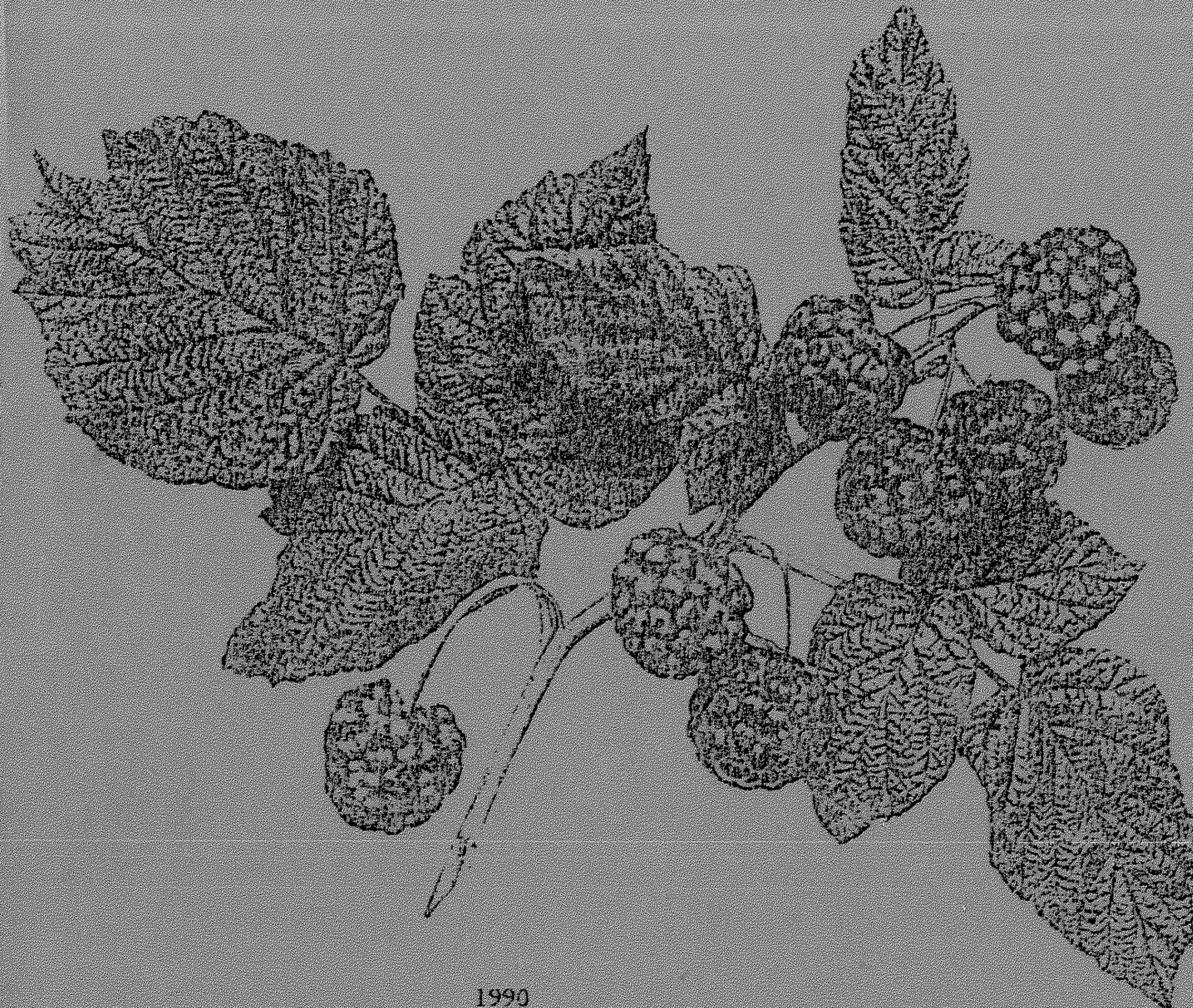

1990

RED RASPBERRY RESEARCH PROPOSALS

1989 PROGRESS REPORTS

to the

WASHINGTON STATE RED RASPBERRY COMMISSION

and

NORTHWEST RED RASPBERRY GROWERS ASSOCIATION

WASHINGTON RED RASPBERRY COMMISSION
1989-90

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SUMMARY
BUDGET REQUEST

Project No.	Short Title	Lead Scientist	Amount Requested
On-going Projects			
13C-3755-5641	Red Raspberry Breeding	Moore	$ 18,000
13C-3755-8640	Advanced Testing	Moore	2,700
13C-3755-4640	Machine Harvesting	Moore	-0-
13C-3761-6688	Water Logging-Growth	Bristow	-0-
13C-3755-3775	Cold Hardiness	Hummel	3,565
13C-3543-7956	Mgnt. Spider Mites	Shanks	-0-
13C-3555-2783	Advanced Testing-Caneburing	Cameron	7,404
13C-3555-5783	Leaf/Fruit Ratio/Yield	Cameron	2,500
13C-3555-5956	Perf.-Micropropagated Rasp.	Cameron	2,490
58091HS-8-114	Virus Testing-Cultivars	Converse	4,500
	Mite Predators-Europe	Messing	-0-
		Sub-total	$ 41,159
New Projects			
	Ground Water Contam.	Bristow	$ 2,625
	React. of Cultivars/Sel.-Ridomil	Bristow	800
	Role Overwinter. Predators/Mites	Shanks	9,350
	Influence Mite Feeding-Physiology	Cameron	1,545
	Development of BMP Manual	Howard	1,363
	Living Mulches	Howard	1,745
	Transformation of Raspberry(RBDV)	Martin	5,000
	Transformation of Rasp.(Tom RV)	Rochon	5,000
		Sub-total	$ 27,428
		GRAND TOTAL	$ 68,587

PROJECT No.: 13C-3755-5641

TITLE: Red Raspberry Breeding, Genetics and Clone Evaluation

PERSONNEL: Patrick P. Moore, Assistant Horticulturist; Jo Ann Robbins, Horticulture Research Specialist; WSU-Puyallup

JUSTIFICATION:

Red raspberry breeding programs in the Pacific Northwest have been very successful, as indicated by the fact that virtually all of the commercial acreage in this region utilizes cultivars developed by these programs. Willamette has been a consistent producer of fruit suitable for processing in the 40 years since its release.

New cultivars are needed which are better suited for fresh marketing, the most rapidly growing segment of the industry. In addition, improved resistance to *Phytophthora* root rot and immunity to raspberry aphid (a vector of several viruses) are needed. Recent research by Agriculture Canada scientists has demonstrated that aphid immunity effectively controls the spread of Raspberry Leafspot Virus, a virus disease found in many Pacific Northwest raspberry plantings. With the increase in labor costs and difficulty obtaining labor, suitability to machine harvesting is increasingly important. Finally, cultivars with improved marketable yields and fruit quality are also needed.

OBJECTIVES:

1. Develop red raspberry cultivars with improved yields and fruit quality, and resistance to root rot and raspberry aphids. Selections adapted to machine harvesting or fresh marketing will be identified and tested further.

2. Study the inheritance of fruit characteristics critical to fresh marketing (fruit weight, retention strength, firmness, color and soluble solids).

3. Propagate and evaluate red raspberry clones for trueness to type, yield and fruit quality.

PROGRESS:

Thirty eight crosses were made in 1989. Five of these crosses used primocane fruiting cultivars and the remaining 33 crosses used floricane fruiting cultivars and selections. Seedlings from these crosses will be planted at Puyallup in 1990 and evaluated for the first time in 1992.

Over 4,600 seedlings were planted in 1989. One hundred-eighty seedlings from six crosses will be used in a genetic study of the inheritance of fruit color development. All except those used for genetic studies were screened in the greenhouse for resistance to the raspberry aphid prior to planting in the field. Approximately two thirds of these seedlings are for cultivar development, the remaining third are for improving the genetic base and genetic studies. Selections will be made among these seedlings in 1991.

Forty-six selections and cultivars were planted in replicated selection trials for yield and fruit quality evaluations in 1990 and 1991. Nineteen of the clones were planted in a separate fall fruiting planting which will be managed only for the fall crop. Thirty seven selections and standard cultivars were planted in soil infested with root rot at Puyallup to determine levels of susceptibility to disease.

Seventeen new selections were made in 1989. Eight of these selections appear to be aphid resistant. All selections were tested for raspberry bushy dwarf virus and tested virus negative. One selection, WSU 1020, has exceptionally firm fruit. Two selections were yellow fruited and another selection apricot colored. One of the yellow fruited selections had very large fruit, but will be used only for breeding. These selections will be propagated and grown in selection trials and root rot evaluation plantings at Puyallup in 1990.

There were high populations of the raspberry aphid at Puyallup in 1989. This allowed many selections and seedlings to be evaluated for aphid resistance. The seedling planting of wild North American red raspberry (*Rubus strigosus*) established in 1988 was screened for aphid resistance. Seedlings were identified that were not colonized by aphids, and may be aphid resistant. These seedlings are being screened in the field for resistance to root rot. Seedlings will be selected in 1990 which will hopefully be both aphid and root rot resistant. The selections made in 1988 were evaluated for aphid resistance. Six selections were not colonized including five selections made from root rot trials at Vancouver. These five selections should be both aphid resistant and root rot tolerant.

The selection trial planted in 1986 did not establish well and was pruned to the ground at the end of 1987. This planting was harvested for the first time in 1989. The field was not uniform and there were no statistically significant differences for yield among selections (Table 1). The highest yield was for WSU 959. WSU 940, a previously promising apricot fruited selection, was disappointing. The fruit was small, round and lumpy. The best appearing fruit was WSU 951. It also scored highest in fresh market evaluations but yields were low. These plots will be harvested again in 1990.

The first year of data from the selection trial planted in 1987 is shown in Table 2. The highest yielding clones were Meeker and Schonemann. BC 80-28-53 had large fruit and above average yields, however it did not perform as well as has been reported in Abbotsford, BC. One plot of WSU 969 and part of a second plot had crumbly fruit. Apparently there was a mutation which occurred during propagation. These plots will be harvested again in 1990.

Virus free propagation material was maintained at Puyallup. Plants of Pacific Northwest cultivars and advanced selections were distributed to certified plant propagators.

PROPOSED RESEARCH:

Crosses in 1990 will emphasize aphid resistance and root rot resistance. Seedlings from 1989 crosses will be screened for aphid resistance prior to planting at Puyallup and will be available for selection in 1991 and 1992.

Selections made in 1989 will be planted with appropriate cultivars as controls in replicated yield trials and root rot evaluation plantings at Puyallup. Selections will be made among the 2,667 seedlings planted in 1988, and among the 600 wild North American red raspberries being evaluated for root rot tolerance and aphid resistance. Selections in previously established selection trials will be evaluated for yield, fruit weight, firmness, midpoint of harvest, and preharvest fruit rot. Fruit will be evaluated for fresh market and/or processing quality. Selections harvested in 1989 which had above average yield will receive the most attention.

Plants from nuclear stock will be distributed to Washington certified plant propagators. A sample of plants will be fruited out at Puyallup to test for freedom from crumbliness and trueness to type.

TERMINAL DATE OF BASE PROJECT: June 1991

DURATION OF THIS PROPOSAL: Second of two years.

BUDGET:

		1989-90	1990-91
00	Salary	$ 6,805 (.4 FTE)	$ 7,719 (.4 FTE)
01	Wages	2,500	4,000
03	Supplies and Services	2,800	3,775
04	Travel	600	300
07	Benefits	1,895	2,206
	Total	$14,600	$18,000

Table 1. 1989 harvest of 1986 planted raspberries at Puyallup, WA.

	Yield (t/a)	Yield/cane (g)	% Rot	Fruit weight (g)	Firmness (g)	Midpoint of harvest
WSU 959	9.80	547 ab	1.96	3.20 d-i	164 e-h	7/12 a-e
WSU 944	7.97	576 a	2.76	3.30 c-h	174 e-h	7/7 d-k
BC 72-1-7	7.95	367 a-e	2.01	2.82 f-i	186 c-h	7/7 d-k
WSU 948	7.86	448 a-c	5.98	3.29 c-h	215 a-f	7/8 b-j
WSU 942	7.61	390 a-e	1.65	4.10 ab	170 e-h	7/13 a-d
WSU 941	7.05	422 a-d	1.43	3.28 c-h	160 f-h	7/10 a-g
WSU 953	6.94	436 a-c	3.15	4.50 a	232 a-d	7/16 a
WSU 946	6.63	470 a-c	8.96	4.05 a-c	174 e-h	7/4 g-l
WSU 956	6.54	333 b-e	3.71	4.52 a	239 a-c	7/11 a-f
Skeena	6.39	370 a-e	1.70	3.29 c-h	185 c-h	7/2 i-l
WSU 608	6.29	378 a-e	3.52	3.06 d-i	156 hg	7/7 d-k
Meeker*	6.12	299	1.93	3.63	165	7/8
Comox	6.04	408 a-e	2.89	3.37 b-g	177 d-h	7/7 d-k
WSU 937	5.56	289 c-f	1.55	3.01 e-i	263 a	7/6 e-l
WSU 940	5.51	297 c-f	5.04	3.01 e-i	171 e-h	7/8 c-j
WSU 958	5.51	320 b-f	1.89	3.40 b-f	266 a	6/30 l
Willamette	5.38	357 a-e	1.26	3.13 d-i	157 hg	7/2 j-l
Chilliwack	5.37	407 a-e	2.08	3.61 b-f	244 ab	7/10 a-h
WSU 608C	5.37	342 b-e	4.29	2.58 g-i	148 hg	7/8 c-j
WSU 954	5.24	408 a-e	2.11	3.39 b-f	205 b-g	7/14 a-c
WSU 949	4.98	439 a-c	2.70	3.68 b-e	166 e-h	7/4 f-l
WSU 951	4.88	345 b-e	2.37	3.43 b-f	242 ab	7/9 b-i
Chilcotin	4.70	300 c-f	2.15	3.02 e-i	145 h	7/3 i-l
WSU 957	4.52	327 b-e	6.66	3.83 a-d	220 a-e	7/5 f-l
WSU 737	4.16	245 c-f	2.52	3.58 b-f	167 e-h	7/10 a-g
WSU 952	3.94	202 d-f	3.79	3.77 a-e	168 e-h	7/15 ab
WSU 935	3.56	186 ef	4.57	2.50 hi	154 hg	7/1 kl
WSU 938	2.67	203 d-f	1.88	2.46 i	164 e-h	7/5 f-l
WSU 936	1.96	97 f	4.26	2.45 i	133 h	7/3 h-l
Mean	5.74	352	3.13	3.35	187	7/7

Means of two replications of four hills each.
* Meeker only present in one replication, data omitted from ANOVA.

Table 2. 1989 harvest of 1987 planted raspberries at Puyallup, WA.

	Yield (t/a)	Yield/cane (g)	% Rot	Fruit weight (g)	Firmness (g)	Midpoint of harvest
Meeker	9.30 a	433 bc	1.97 cd	3.14 c-e	157 g-j	7/7 e-i
Schonemann	8.24 ab	649 a	3.21 cd	3.64 bc	174 d-h	7/12 b-d
WSU 965	8.12 ab	408 b-e	3.50 cd	3.34 b-d	194 c-g	7/15 ab
WSU 967	7.51 a-c	324 c-f	2.87 cd	3.64 bc	216 a-d	7/11 b-e
Comox	7.21 a-d	343 b-f	4.80 cd	3.80 b	221 a-c	7/8 d-i
WSU 968	6.90 a-d	304 d-g	5.67 cd	3.16 c-e	212 a-e	7/8 d-i
BC 80-28-53	6.64 a-e	429 b-d	4.00 cd	4.26 a	173 e-h	7/8 d-i
Chilliwack	6.57 b-e	310 c-g	1.44 d	3.60 bc	200 b-f	7/9 c-g
Willamette	5.56 b-f	239 f-i	1.86 d	2.96 d-f	130 ij	7/1 j
WSU 974	4.88 c-g	463 b	3.14 cd	4.47 a	238 ab	7/8 d-h
SCRI 6820/41	4.70 d-g	289 e-g	1.55 d	3.05 d-f	241 a	7/13 bc
WSU 970	4.01 e-h	238 f-i	7.25 c	2.82 e-g	142 i-j	7/5 g-j
WSU 960*	3.98	280	3.22	4.10	226	7/9
WSU 975	3.71 f-h	280 e-h	13.93 b	2.84 d-g	197 c-g	7/3 ij
WSU 966	3.23 f-h	184 g-i	1.11 d	3.03 d-f	176 d-h	7/18 a
WSU 973	3.06 f-h	158 hi	4.08 cd	2.40 g	165 f-i	7/4 h-j
Prestige	2.78 gh	190 g-i	2.37 cd	2.58 fg	122 j	7/10 b-f
WSU 971	2.34 gh	133 i	29.35 a	3.35 b-d	178 d-h	7/6 f-i
WSU 969	1.88 h	112 i	2.30 cd	3.14 c-e	187 c-g	7/7 e-i
Mean	5.29	304	5.14	3.33	187	7/8

Means of three replications of three hills each.
* WSU 960 only present in two replications, data omitted from ANOVA.

PROJECT NO.: 13C-3755-8640

TITLE: Advanced Testing of Washington State University Raspberry Selections

PERSONNEL: Patrick P. Moore, Assistant Horticulturist, WSU REC Puyallup
Robert A. Norton, Horticulturist, WSU NWREC, Mt. Vernon
J. Scott Cameron, Assistant Horticulturist, WSU SWRU, Vancouver

JUSTIFICATION:

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

OBJECTIVES:

1. To establish and maintain replicated plantings at WSU REC in Puyallup, WSU NWREU in Mt. Vernon and SWRU in Vancouver of advanced selections from the Washington State University and other regional raspberry breeding programs.

2. To measure yield, fruit quality, and susceptibility to pests in these selections as part of the ongoing cultivar development process.

3. To measure genotype by environment interactions in these selections for traits under improvement.

PROGRESS:

Advanced selection trials were established at Vancouver, Mt. Vernon, and Puyallup in 1988. WSU 892, WSU 781, WSU 805, and WSU 908 were planted along with Willamette, Meeker, Chilcotin, Chilliwack, and Comox. Three replications of three hills for each selection were planted at each location. These plots were maintained in 1989.

WSU 892 was commercially propagated for grower trials and planted in 1988-89. Grower response will be obtained in 1990.

PROPOSED RESEARCH:

In 1990, the advanced selection plantings will be harvested for the first time. Total yield, fruit rot, fruit weight, and midpoint of harvest will be obtained at all three locations, additionally fruit firmness will be obtained at Puyallup.

Grower reaction to WSU 892 will be obtained from growers harvesting this selection.

WSU 923, WSU 930, and WSU 933 from the 1985 selection trial appeared to have promise. However, their response in root rot plots at Puyallup was not encouraging. Their reactions to root rot will be determined in pot tests in the greenhouse this winter, in cooperation with Dr. Peter Bristow.

TERMINAL DATE OF BASE PROJECT: June 30, 1991

DURATION OF PROPOSAL: Third of three years, an updated proposal will be written in 1991.

BUDGET:

		1989-90	1990-91
01	Wages	$300	$2,250
03	Goods and Services	435	337
07	Benefits	15	113
	Total	$750	$2,700

Amount to be divided among the three project leaders.

PROJECT NO.: 13C-3755-4640

TITLE: Machine harvesting trial

PERSONNEL: Patrick P. Moore, Assistant Horticulturist, Washington State University Puyallup Research & Extension Center
Craig MacConnell, Cooperative Extension, Whatcom County, Bellingham, WA

COOPERATOR: Marty Maberry, Maberry Packing Inc., Lynden, WA.

JUSTIFICATION:

An increasing proportion of the red raspberry crop is machine harvested. However, in breeding programs in the Pacific Northwest, selection evaluation is based primarily on hand harvested data. The yield of selections under machine harvesting conditions may differ from the yield when a selection is hand harvested. Two examples are WSU 608 and WSU 738. WSU 608 had much greater yields than Willamette when it was hand harvested, but equal or lower yields when machine harvested. The growth habit of this selection resulted in low recovery of the fruit when machine harvested. When WSU 738 was machine harvested, green fruit and laterals were harvested with the ripe fruit because the fruit did not release from the receptacle easily. In grower trials, selections are tested by growers who hand harvest and by growers who machine harvest. The performance of a selection is compared with cultivars which the grower happens to be growing. Currently, there is no testing where the performance of recent releases and advanced selections are systematically compared under machine harvesting conditions. The performance of recent Pacific Northwest releases and advanced selections under machine harvesting conditions needs to be determined.

OBJECTIVES:

To determine the suitability of new and potential new cultivars to machine harvesting.

PROGRESS:

Plants of Willamette, Meeker, Chilliwack, Comox, Skeena, WSU 892, and BC 80-28-53 were planted Spring 1989 by Maberry Packing Inc., Lynden, WA. Each plot was one post length long with a space left between plots to clean out the machine. Some plots had several plants which did not survive.

PROPOSED RESEARCH:

Missing plots will be filled, and the plots cut down and allowed to resprout in 1990. the first harvest will be in 1991.

TERMINAL DATE OF BASE PROJECT: June 30, 1991

DURATION OF THIS PROPOSAL:

Second of four years, an updated proposal will be written for the third and fourth years.

BUDGET:

		1989-90	1990-91
01	Wages	0	
03	Goods and Services ...	$140	No funds
04	Travel	60	requested.
07	Benefits	0	
	Total	$200	

PROJECT NO.: 13C-3761-6688 (Final Report)

TITLE: The effects of waterlogging and *Phytophthora erythroseptica* on subsequent growth of red raspberry

PERSONNEL: Peter Bristow, Associate Plant Pathologist WWREC, Puyallup

Gwen Windom, Agricultural Research Technologist III, WWREC, Puyallup

JUSTIFICATION:

During the winter there is a high likelihood of the soil becoming saturated in many red raspberry fields in western Washington. Based on field observations and comments from Cooperative Extension agents and growers, it appears that red raspberries are sensitive to high soil moisture during the late winter and early spring. This time corresponds with the resumption of root growth. Even short periods of flooding, at this time, may cause significant root injury. The consequences of root injury are not observed until cane growth (both lateral production on floricanes and new primocanes) exceeds the ability of the root system to support that growth. Premature senescence of floricanes and reduced vigor of primocanes are symptoms associated with a poor root system. These symptoms are also associated with root rot caused by *Phytophthora erythroseptica*. The relative importance of flooding by itself in causing damage and how flooding and root rot interact, are not well understood. For this reason a study is proposed to look at the effects of flooding both in the absence and presence of *P. erythroseptica*.

OBJECTIVES:

This study will examine what impact the time of flooding and also the duration of flooding have on both non-inoculated and inoculated plants.

PROGRESS (Summary):

Phytophthora root rot had the greatest impact on primocane growth but surprisingly did not significantly reduce root dry weight of 'Willamette' red raspberry (Appendix - Table 1). Roots of inoculated plants were consistently darker than those of uninoculated plants. Many of the primocanes of inoculated plants wilted and died.

Flooding alone (uninoculated plants) caused no symptoms associated with root rot.

Flooding initiation date had no impact on any growth variable for uninoculated plants (Appendix - Table 2). Conversely, flooding duration reduced total plant dry weight of uninoculated plants because of a decrease in fruiting cane dry weight (Appendix - Table 3).

For inoculated 'Willamette' plants, flooding initiation date lowered primocane dry weight and, hence, the total plant dry weight (Appendix - Table 3). Similarly, flooding duration reduced the dry weight of all plant parts plus primocane length (Appendix - Table 3). The greatest reductions occurred after 8 and 16 days of flooding.

Flooding of inoculated plants did not alter the partitioning of dry matter between fruiting canes, primocanes and roots. For inoculated plants less dry matter was found in primocanes compared to other plant parts.

The rate of photosynthesis (carbon dioxide assimilation) was lower for inoculated than uninoculated plants. Although flooding alone did not change the appearance of uninoculated plants, it did lower fruiting cane growth (Appendix - Table 3) and this was reflected in lower rates of photosynthesis after 16 days of flooding (Appendix - Table 4). Flooding initiation date had no impact on photosynthesis in uninoculated plants. Both flooding initiation date and duration significantly slowed down photosynthesis in inoculated plants. The longer inoculated 'Willamette' plants remained flooded and the later into the winter flooding began, the greater the negative impact on photosynthesis.

Similar trends were recorded for 'Sumner' and 'Meeker' plants, but the magnitude of differences was much less. Measurements of photosynthesis were only made on 'Willamette' plants. Direct comparisons between the three test cultivars cannot be made because the size of the tissue culture propagated plants at the beginning of the study was so different.

CONCLUSIONS:

Winter flooding dramatically reduces plant growth and photosynthesis in plants with Phytophthora root rot. In the absence of the pathogen, flooding alone caused little if any damage. This suggests that in field sites where waterlogging is suspected as the cause of plant damage, the involvement of a root pathogen should be explored.

The objectives of this research were accomplished and the project terminated. We again express our appreciation for the financial support from the Commission for this multiple-year study.

APPENDIX

Table 1. The influence of *Phytophthora erythroseptica* on the subsequent growth of 'Willamette' red raspberries.

Growth variable	Uninoculated	Inoculated	Significance level
Dry weight, grams			
Total plant	52.9	25.7	0.001
Fruiting canes	11.8	10.2	n.s.*
Primocanes	27.6	7.1	0.01
Roots	13.5	8.4	n.s.
Length, cm			
Primocanes	273	81	0.01
Number, no. per plant			
Primocanes	3.36	2.56	0.05
Viability, %			
Fruiting cane buds	55.4	56.0	n.s.

* n.s. = not significant.

APPENDIX

Table 2. The influence of flooding initiation date on the growth of uninoculated and inoculated 'Willamette' plants.

Growth variable	Flood initiation date	Percent of check	
		Uninoculated	Inoculated
Fruiting cane dry weight		(check=11.9 g*)	(check=12.2 g)
	11 Jan	92 a	90 a
	25 Jan	106 a	90 a
	8 Feb	100 a	84 a
	22 Feb	108 a	65 a
	7 Mar	82 a	98 a
	24 Mar	112 a	75 a
Primocane dry weight		(check=28.7 g)	(check=20.4 g)
	11 Jan	103 a	102 a
	25 Jan	116 a	59 abc
	8 Feb	97 a	82 ab
	22 Feb	112 a	30 bc
	7 Mar	103 a	45 abc
	24 Mar	104 a	13 c

* g = grams.

APPENDIX

Table 3. The influence of flooding duration on the growth of uninoculated and inoculated 'Willamette' plants.

Growth variable	Flood duration, days	Percent of check	
		Uninoculated	Inoculated
Fruiting cane dry weight		(check=11.9 g*)	(check=12.2 g)
	1	122 a	97 ab
	2	109 ab	105 a
	4	86 c	76 bc
	8	100 bc	71 c
	16	84 c	68 c
Primocane dry weight		(check=28.7 g)	(check=20.4 g)
	1	113 a	94 a
	2	117 a	81 ab
	4	98 a	60 abc
	8	107 a	23 bc
	16	94 a	18 c
Root dry weight		(check=15.5 g)	(check=12.7 g)
	1	125 a	99 a
	2	123 a	96 a
	4	112 a	91 ab
	8	114 a	59 b
	16	105 a	60 b
Total plant dry weight		(check=56.1 g)	(check=45.2 g)
	1	110 a	79 a
	2	109 a	73 a
	4	90 b	60 ab
	8	101 ab	47 b
	16	87 b	43 b
Primocane length (total)		(check=254.1 cm)	(check=181.6 cm)
	1	113 a	83 a
	2	128 a	62 ab
	4	115 a	50 bc
	8	104 a	33 bc
	16	123 a	27 c

* g = grams.

APPENDIX

Table 4. The influence of flooding duration (A) and initiation date (B) on photosynthesis in fruiting cane leaves of uninoculated and inoculated 'Willamette' plants.

		Percent of check	
		Uninoculated	Inoculated
		(check=6.375*)	(check=5.618*)
A. Flood duration,	days		
	1	78 a	35 a
	4	74 ab	34 a
	16	62 b	7 b
B. Flood initiation,	date		
	11 Jan	70 a	37 a
	8 Feb	74 a	39 a
	24 Mar	71 a	4 b

* = $\mu mol\ CO_2\ m^{-2}\ s^{-1}$ (rate of photosynthesis).

PROJECT NO.: 13C-3755-3775

TITLE: Cold Hardiness of Red Raspberry

PERSONNEL: Rita L. Hummel, Assistant Horticulturist and Patrick P. Moore, Assistant Horticulturist, Washington State University - Puyallup Research and Extension Center

JUSTIFICATION:

Crop loss due to cold damage is a recurring problem for Washington red raspberry growers. According to the 1986-1987 edition of Washington Agricultural Statistics, the extreme cold during the winter of 1985-86 and spring frosts caused an average decrease in yield of 1,050 pounds per acre from 1985. The freeze damaged 1986 red raspberry crop was the lowest in average production since 1956. Following the 1987-88 and 1988-1989 winters, injury attributed to cold was again detected in Washington red raspberry plantings.

Cold hardiness in plants is a complex phenomena involving a variety of genetic and environmental factors. The seasonal change in cold hardiness can be divided into three components: acclimation, the change from the tender to the cold hardy state that occurs in autumn; ultimate midwinter hardiness, the lowest temperature the plant can tolerate at its maximum cold hardiness level; and deacclimation, the onset and rate of loss of cold tolerance in response to warm temperatures in late winter or spring. Improper development of any one of the cold hardiness components can result in cold damage or plant death. Differences in susceptibility of red raspberry cultivars to winter injury are an indication that the necessary genetic variability exists for improvement of this trait. In breeding for improved cold tolerance and in designing cultural practices to ameliorate cold damage it is essential to know which cold hardiness component is the weak point in the plant's ability to survive.

The results of our proposed research would provide information on the seasonal change in red raspberry cold hardiness, identify existing red raspberry cultivars adapted to Washington conditions, identify appropriately cold hardy parents for use in the breeding program and study the inheritance of cold hardiness in red raspberry.

OBJECTIVES:

1) To measure the seasonal change in cold hardiness of field-grown Rubus genotypes of potential importance to the breeding program.

2) To determine the difference in cold hardiness levels of five standard red raspberry cultivars.

3) To determine the relative cold sensitivity of stem and bud tissues on the same canes.

4) To determine whether or not differential thermal analysis can be used as an alternative to the visual browning method to determine the cold hardiness of red raspberry.

PROGRESS:

Cold hardiness of stems and buds of five standard commercial red raspberry cultivars, 'Chilliwack', 'Comox', 'Meeker', 'Skeena' and 'Willamette' was tested on November 7, November 28 and December 20 of 1988, and January 25, March 13 and May 1, 1989. On each freezing test date, a single cane was cut from six hills of each cultivar growing in the field at Farm 5 near Puyallup, Washington. Canes were taken to the laboratory, cut into two-bud segments after discarding the terminal 4 to 6 buds (a preliminary test indicated the terminal portion of the cane tended to have many damaged buds), and placed in contact with a moist paper towel in wide-mouth polyethylene tubes. Tubes were immersed in a polyethylene glycol bath at 0 C (32 F) and crushed ice was added to each tube to initiate ice nucleation and freezing of stems. The bath temperature was decreased to -2 C (28 F) where it was held overnight (about 14 hours), then lowered at the rate of 2 C (3.6 F)/hour and samples were removed at successively lower 2 or 4 degree C (3.6 or 7.2 F) temperature intervals. Samples were thawed in a refrigerator, removed from the tubes, placed with a moist paper towel in polyethylene bags, and incubated at room temperature and 100% relative humididty for 12 to 14 days. Control samples for each cultivar were placed directly into a polyethylene bag and incubated without freezing. After incubation, sample viability was determined by dissecting and visually evaluating stems and buds for tissue injury with the aid of a dissecting microscope. Stems and buds showing brown discoloration were rated as dead. Uninjured tissues remained green. The percentage of stems surviving each temperature was recorded. From these data a LST (lowest survival temperature), the freeze test temperature where no more than 50% of the tissue was injured was determined for buds and stems of each cultivar on each freezing test date.

Results of the November 7, 1988, freeze test indicated that 'Meeker' and 'Wilamette' cold acclimated more slowly in the fall than 'Chilliwack', 'Comox' and 'Skeena'. The LST for 'Meeker' and 'Wilamette' was -12 C (10 F) while the LST of 'Chilliwack', 'Comox' and 'Skeena' was -16 C (3 F). As the season progressed, cold hardiness of all cultivars increased until on the January 25, 1989, freezing test the LST of 'Skeena' was -22 C (-8 F). LST of the other cultivars was -18 C (0 F) for buds and -20 C (-4 F) for stems. After the January freezing test it was observed that even at the lowest test temperatures -24 and -28 C (-11 and -18 F) new leaves were growing from some buds on all of the cultivars. Upon closer examination it was determined that the leaf blade tissue was still alive but the vascular tissue and cambium at the base of the bud were killed.

Thus in the high relative humidity of the incubation environment, bud break and some enlargement of the leaf blade occurred even though the stem and tissue in the base of the bud were dead. Another useful observation following the January 25 freezing test was that canes showing visible symptoms of spur blight tended to be less hardy than uninfected canes. For example, diseased canes were killed by freezing at -20 C (-4 F) while healthy canes survived. The February freeze of 1989 where minimum air temperatures of -12 C (10 F) were recorded at ground level at Farm 5 did not cause significant visual damage to the raspberry plantings. Data on yield taken for the plant breeding program also indicated no significant decrease in yield at Farm 5 for most cultivars. Laboratory freezing test results seemed to indicate that the cultivars which acclimated most rapidly in the fall, 'Chilliwack', 'Comox' and 'Skeena' had deacclimated the most by March 13, 1989. Additional testing must be done to determine if this apparent relationship will hold true across a number of growing seasons.

PROPOSED RESEARCH:

Seasonal cold hardiness of the 5 red raspberry cultivars tested in 1988-1989 will be monitored for a second season by testing 2 or 3 times during the winter of 1989-1990. Freezing tests will be done during the 1989-1990 winter to gain cold hardiness information on additional red raspberry clones, selections from the breeding program and several Rubus species considered to useful for the improvement of red raspberry. The potential of differential thermal analysis (DTA), for measuring the hardiness levels of red raspberry will be determined. DTA is a rapid, objective method of measuring cold hardiness which may be useful as an alternative to the visual browning method which is slow, labor intensive and subjective. Before DTA can be used routinely, a system must be designed and built for the cold hardiness laboratory in Puyallup. Most of the component parts for DTA are in place therefore it is estimated that a DTA system can be built for relatively little additional equipment expense.

TERMINAL DATE OF BASE PROJECTS: June 30, 1990 June 30, 1991

DURATION OF THIS PROJECT: 2/3 Second year of a three-year proposal

BUDGET:

	1989-90	1990-91
00 Salaries	$2,790	$2,790
03 Supplies and Services	50	50
07 Benefits	725	725
TOTAL	$3,565	$3,565

PROJECT NO.: 13C-3543-7956 (1957)

TITLE: Management of Spider Mites on Red Raspberries

PERSONNEL: Carl H. Shanks, Jr., Entomologist
J. Scott Cameron, Assistant Horticulturist
WSU-Vancouver, Research & Extension Unit

Arthur H. Antonelli, Extension Entomologist
WSU-Puyallup, Research & Extension Center

Bruce D. Congdon, Assistant Professor
Seattle Pacific University

JUSTIFICATION: The twospotted spider mite, *Tetranychus urticae* Koch, is a sporadic pest of red raspberries. While severe infestations do not directly reduce either the current or following year's yields, severe defoliation before September makes the canes more susceptible to freeze damage. Also, buds may break in the fall instead of in the following spring.

Vendex is the only efficacious miticide registered on raspberries. Kelthane has been suspended, although existing stocks may be used, and mites in many fields are resistant to it. The mite is resistant to organophosphate miticides, e.g. Metasystox-R, in most fields. There are few new miticides under development but it may be possible to get one or more older chemicals registered.

Many predatory insects and mites help suppress spider mite populations in other crops. Mites in the family Phytoseiidae have an important role, but the biology and taxonomy of these predators in raspberries are poorly understood. Many pesticides kill the predators, which can result in the development of large spider mite populations. Research is needed to determine which species of predatory mites are present and the cultural and spray practices which would maximize the activity of these natural enemies. Also, certain cultural practices may discourage the build-up of spider mite populations.

Research conducted several years ago indicated that severe defoliation by spider mites in August reduced winter hardiness. Moderate injury to leaves did not appear to have an effect. Work is needed to determine just how much mites can reduce photosynthesis and still not affect accumulation of carbohydrates in the canes, which is critical to winter hardiness.

OBJECTIVES:

1. Determine the effect of various spray programs on red raspberries and on spider mites and their predators.
2. Determine the roles of other plants as either sources of spider mites or predators.
3. Test new miticides as they become available.
4. Determine the effect of spider mite feeding on raspberry photosynthesis and accumulation of carbohydrates in the canes.
5. Investigate the role of predators as controls for spider mites.

PROGRESS:

Objective 1: Spider mite populations were monitored in the same 19 raspberry fields from 1987-89. Pesticide application records were obtained from each grower in each year. In the first two years, fields which had populations of more than 25 mites/leaflet before the end of August had received about 2.5 times as many insecticides as fields which had lower mite populations. In 1989 the trend was the same; "problem" fields (half the fields) received about 5.0 times as many insecticide sprays as did "no-problem" fields. We conclude that even one insecticide spray, including malathion, greatly increases the chance of spider mites becoming a problem.

Objective 2. Raspberry plots with and without a permanent cover crop of white clover were established in May 1988. The purpose was to determine the effect of the clover on populations of spider mites and their predators. Only very small populations of spider mites developed in both sets of plots in 1989, in spite of an application of Ambush in May. Constant influx of predators, undetectable by conventional sampling methods, may have been the reason for this. We will continue to monitor those plots in 1990 and beyond.

Objective 3. Brigade 10WP was tested against spider mites on red raspberries after harvest at 0.05, 0.1, and 0.2 lb. ai/acre. Vendex 4L at 1.0 lb. ai/acre was used as a standard. The lowest rate of Brigade was ineffective but the highest rate gave 85% or more control for 4 weeks and the middle rate did the same for 3 weeks. Vendex was slow acting but did hold the mite population in check while on the untreated control plants the populations grew steadily.

Efficacy data with Omite CR against spider mites was obtained in 1988. Also, fruit samples from treated plots were shipped to a residue laboratory for analysis. The samples had not been analyzed by October 1, 1989 but supposedly soon will be. This is necessary before a petition for registration can be submitted to EPA.

Objective 4. The abnormally high number of cloudy days in July and August did not permit regular measurements of photosynthesis, so this work was not done.

Objective 5. Previous studies have shown that native predatory mites are usually very rare in raspberries but abundant and diverse on adjacent vegetation. Furthermore, releases of two commercially available predator species, Metaseiulus occidentalis and Phytoseiulus persimilis, in the 1988 season, apparently failed to become established and had no effect on spider mite populations. A study was conducted in 1989 to determine the factors responsible for the apparent failure of predatory mites to become established in raspberry fields.

Experimental arenas consisted of individual leaves left attached to the raspberry plants. Predators were confined by a Tanglefoot barrier at the base of the petiole. Arenas were placed in two commercial raspberry fields at three different times during the growing season. Spider mite numbers were low in June and July, so spider mites (from a laboratory colony) were placed on half the arenas 1-3 days prior to the release of predators. One week following the introduction of five adult female predators per arena, the arenas were removed to the laboratory where survivors and their offspring were counted. M. occidentalis and P. persimilis were used in all experiments, and one incorporated native Amblyseius andersoni and Typhlodromus pyri for comparison.

Predator survival and reproduction varied considerably among the times, sites, and conditions of the experiments. Maximum mean survival of the two exotic species occurred at site A during July in the presence of spider mite prey. Survival at site A was consistently higher than at site B and was greater in July than in June and August. Survival and reproduction were also usually higher on arenas to which spider mite prey had been added. The native predators released at site B in the August experiment exhibited survival and reproduction rates similar to the exotic species. Site A had large populations of native predatory mites in 1987 and 1988, so no experiments with native species were conducted there.

The key differences between the two sites and the three different times of year suggest that high relative humidity favors the establishment of predatory mite species. Site A was considerably more weedy than site B, and the extensive vegetation might have increased humidity within the field. Insecticide applications prior to the June experiment at site A apparently had no negative effect on predators, and site B received no insecticide applications except Dipel. Although mean, maximum, and minimum temperatures during the three experimental periods showed little relationship to the predator survival and reproduction rates, rainfall was much greater during the July experiments, which would have increased the humidity in the habitat occupied by the predators.

This study confirms the contention that climatic and cultural factors will prevent the successful establishment of M. occidentalis and P. persimilis in western Washington raspberries and gives some important insights. First, cultural practices (e.g. inter-row ground cover) which increase humidity probably favor development of native predatory mite populations, since increased humidity apparently favored the survival and reproduction of the two exotic species. Second, raspberries provide habitat suitable for predator survival and reproduction during the growing season, but factors such as a lack of overwintering habitat in the field may be responsible for the low numbers of predatory mites in most raspberry fields. Finally, incidental observations throughout the last two years suggest that the predatory beetle Stethorus may play a more significant role than previously thought in the suppression of spider mite populations. The latter two points are related, and form the basis for proposed future research.

PROPOSED RESEARCH:

This is the termination report for this project. Continuation and enhancement of some parts of it will be proposed for a new project.

TERMINAL DATE OF BASE PROJECT: March 31, 1991

DURATION OF THIS PROPOSAL: 3 Years

BUDGET: None requested

PROJECTS:\7956.89

PROJECT NO.: 13C-3555-2783

TITLE: Advanced testing of new compounds for caneburning of red raspberry

PERSONNEL: J. Scott Cameron, Assistant Horticulturist
Washington State University Research and Extension Unit, Vancouver

Stott W. Howard, Assistant Weed Scientist
Washington State University Research andExtension Unit, Mt. Vernon

JUSTIFICATION: The loss of dinoseb for caneburning in red raspberries has left the industry without an effective tool for primocane suppression. Research programs in Washington, Oregon, and British Columbia are seeking alternatives to dinoseb with the goal of having an effective replacement registered for use in the near future. One class of compounds, the diphenyl ethers, has shown considerable promise in recent field trials.

The efficacy of a compound in suppressing primocane growth is not the only factor which must be considered in selecting a caneburning method for commercial use. The effects of such compounds on productivity and long term growth and development must also be tested. This is of particular importance when dealing with chemicals such as diphenyl ethers, contact herbicides which are strong mitotic poisons. The purpose of this project is to thoroughly evaluate the influence of these potential caneburning compounds on the productivity, growth, and development of red raspberry.

OBJECTIVES:

1. Evaluate cane suppression characteristics and yield component relationships associated with the use of new caneburning compounds.
2. Study the long term effects of using these compounds on productivity, growth, and development of established red raspberry plantings.

PROGRESS: In 1989 we continued this project with a second year of the testing of three dinoseb alternatives in replicated plots at Vancouver and Mt. Vernon. These three compounds, oxyfluorfen, acifluorfen, and lactofen (tradenames respectively Goal, Tackle/Blazer, and Cobra) were applied once to newly emerging primocanes at five different rates: 0.1, .2, .4, .8, and 1.6 lbs/A. Other treatment groups included one receiving two applications of dinoseb and an untreated control. During harvest, yield component analysis was performed in which vegetative measurements and numbers of canes, laterals, fruit, flowers, and fruit weight were recorded.

In 1988, the seven-year-old commercial field (yearly primocane control) at Mt. Vernon showed no differential response in the first year. The seven-year-old field at Vancouver with no previous primocane control responded with positive correlation between herbicide rate and berry weight, and a negative relationship between rate and primocane heighth after harvest. In 1989, higher rates of the tested compounds have visibly stunted growth. In addition to reduced cane height, cane numbers also declined at higher rates of these compounds. Cane diameter was not significantly reduced, and, across all treatments, little or no reduction in yield was observed. It is clear that a single application of one of these materials can adequately control primocane growth.

A label for Goal is currently being prepared and we should be able to use this material in 1990, the year Dinoseb will be banned. Since Goal is a "hot" material, we will seek to educate the industry this winter concerning how this new material should be handled. Our goal is to use Goal as a replacement for Dinoseb while working towards having additional caneburning materials registered for use. This will avoid the disaster created by the industry's dependence on a single caneburning chemical (dinoseb) in the past.

While these materials all do a relatively good job of burning primocanes early in the season, the most important factor in determining the commercial utility of these materials will be their influence on subsequent regrowth and yields. While the red raspberry has the ability to maintain its productivity while individual components of yield are changing (compensation), it would appear that a decrease in yield can be anticipated in 1990 at the higher rates of these compounds. This will likely be due to reductions in cane number and cane height, and would, in the case of oxyfluorfen, be associated with the use of this chemical for three consecutive years at a rate 4-8x higher than the rate which is anticipated for the label.

PROPOSED RESEARCH: In 1990, the same experiment will be repeated at both sites in the same plots. The primocane suppression characteristics of each material will be rated, and, during harvest, yield component measurements will again be made in order to assess the influence of these chemicals on the yield potential of red raspberry. Fruit quality factors may also be evaluated where deemed appropriate. The 1990 season will be the first opportunity we have to evaluate the potential problems associated with the long-term use of these materials.

Additional studies are also being planned for 1990 with regards to the basic physiological responses of red raspberry to oxyfluorfen. These studies will help to characterize the biochemical and physiological consequences of short-term and long-term use patterns with this very potent herbicide. This research would involve measurements of photosynthetic response, fourth-derivative spectroscopy of photosynthetic action spectra, SDS polyacrilamide gel electrophoresis, and anatomical studies.

TERMINAL DATE OF BASE PROJECT: 10A-3555-0783, June 30, 1990 (JSC)
10A-3419-0740, June 30, 1989 (SWH)

DURATION OF THIS PROJECT: Third year of a three-year project.

BUDGET:

		1990-91	
		Vancouver	Mt. Vernon
01	Temporary employees	$2,800	$2,800
03	Supplies and services	212	212
04	Travel	500	500
05	Computer services	50	50
07	Benefits (5% of 01)	140	140
	SUBTOTAL EACH SITE	$3,702	$3,702
	TOTAL	$7,404	

PROJECT NO.: 13C-3555-5783

TITLE: Leaf/fruit ratio and yield potential in red raspberry

PERSONNEL: **J. Scott Cameron**, Assistant Horticulturist
Stephen F. Klauer, Agricultural Research Technologist II
Chuhe Chen, Research Associate\Visiting Scientist
Washington State University Research and Extension Unit, Vancouver

JUSTIFICATION: In tree fruits such as apple and cherry, it is known approximately how much leaf area is required to produce a fruit. This information has been extremely useful in developing a scientific approach to canopy design and cultural management. There are no published reports concerning leaf area/assimilate demand relationships in red raspberry; this type of information would be very useful in determining the yield potential of this crop. This in turn would aid in implementing new strategies to increase the efficiency of red raspberry culture, while also providing information valuable for studies concerning the influence of stresses such as those caused by diseases and insects on the productivity of red raspberry.

OBJECTIVES:

1. To characterize the influence of fruiting on the physiology of red raspberry over the course of the season.
2. To determine the influence of leaf:fruit ratio on carbon assimilation of red raspberry.
3. To model the yield potential of red raspberry.

PROGRESS: In 1988, we found that higher photosynthetic rates were associated with lower leaf:fruit ratios. Smaller unifoliate leaves directly subtending fruit had higher photosynthetic rates than larger trifoliate leaves subtending the entire node. In 1989 we continued this project by following the development of fruiting and defruited canes. At anthesis, hundreds of 'Meeker' canes were tagged and half of them were deflowered. Beginning at anthesis and continuing over a 17-week period, unifoliate and trifoliate leaves from fruiting and nonfruiting canes were sampled for physiological and anatomical analyses. Leaves were prepared each week for thin sectioning, and microscopic examination of leaf anatomy from these samples is currently underway. Photosynthetic action spectra of sampled leaves were characterized by fourth derivative spectroscopy using a scanning spectrophotometer equipped with an integrating sphere. Analyses of chlorophyll content and specific leaf weight were also performed weekly. Gas exchange measurements were made as weather permitted.

Data analyses are not yet complete as more than 1.3 million data points were collected. In general, fruiting and nonfruiting leaves were different in a number of ways. Differences in dry weight accumulation, chlorophyll content and anatomical characteristics were observed. Photosynthetic measurements demonstrated that the presence of fruit increases CO_2 assimilation rates in red raspberry. We were also able to confirm our previous observation that unifoliate leaves subtending fruit have higher photosynthetic rates compared to trifoliate leaves subtending the entire node.

PROPOSED RESEARCH: In 1990, we will continue to model the response of red raspberry to assimilate demand by repeating parts of the 1989 experiment and by manipulating leaf:fruit ratio on entire canes of 'Meeker' instead of at specific nodes. In 1987, our data suggested that assimilate demand relationships are expressed at the whole cane level, and confirmation of this observation in a controlled experiment with 'Meeker' would allow us to relate our physiological observations to the whole plant level. As expressed at the International Rubus\Ribes Symposium in 1989, researchers working with the growth and development of red raspberry are working at either the physiological or whole plant levels, and little has been done to bridge this gap. It is clear that the red raspberry is capable of considerable compensation among its components of yield, and it appears that we have observed compensation at the physiological level which may correlate well with these whole-plant relationships. In the final year of this project, we will attempt to develop a practical, yet scientific view of compensation in red raspberry. This information will not only be useful with regards to cultural management, but will also allow us to better understand the processes by which red raspberry responds to stresses imposed by serious attacks by pests such as diseases and insects.

TERMINAL DATE OF BASE PROJECT: June 30, 1990

DURATION OF THIS PROJECT: Third year of a three-year project.

BUDGET: Funding is primarily used for labor to perform analyses of plant material and for data collection.

		1989	1990
01	Temporary employees	$2,000	$2,000
03	Supplies and services	300	300
05	Computer services	100	100
07	Benefits (5% of 01)	100	100
	TOTAL	$2,500	$2,500

PROJECT NO.: 13C-3555-5956

TITLE: Phenotypic stability and field performance of micropropagated red raspberry cultivars

PERSONNEL: **J. Scott Cameron**, Assistant Horticulturist
Stephen F. Klauer, Agricultural Research Technologist II
Washington State University Research and Extension Unit, Vancouver

JUSTIFICATION: Micropropagated plants often have altered phenotypes (behavior) compared to conventionally-propagated plants of the same cultivar. Increases in vigor and productivity as well as differences in morphology have been reported in micropropagated strawberries, thornless blackberries, and blueberries. While small fruit breeding programs and commercial nurseries continue to rely on *in vitro* propagation methods, questions concerning the genetic stability and field performance of these plants remain unanswered. Temporary alterations in phenotype could require new selection strategies for breeders and modified cultural management for growers. There are currently no guidelines for our industry on how to handle micropropagated planting stock, and to date, there have been no published reports of field performance trials of micropropagated red raspberry plants.

OBJECTIVES:

1. To compare the field performance of micropropagated 'Willamette' plants to those conventionally-propagated from micropropagated foundation stock after one and two years in the field. Evaluate the potential of micropropagated planting stock.
2. To determine what characteristics of micropropagated plants are expressed during establishment which may make them more productive than conventionally-propagated plants.

PROGRESS: Micropropagated (MP) plants of 'Willamette' and 'Meeker' were established in a replicated planting with plants conventionally propagated from MP plants after one and two years in the field. Difficult first year (1987) establishment of micropropagated (MP) plants raised questions concerning the handling of MP planting stock. The questionable response of these plants to heat and low soil moisture as well as potential sensitivity to chemicals such as Ridomil (possible phytotoxicity at Vancouver) and herbicides (New York) may outweigh the advantage of observed increases in lateral branching in first year growth of MP plants. In 1989, the first bearing year of this planting, MP plants performed similarly to their conventionally-propagated counterparts. Yield components were evaluated, and yield potential was approximately 5% greater for MP plants. While not all of the data has been fully analyzed at this time, it would appear that there are probably a number of trends in direct and indirect yield component relationships among the propagation types. However, there appear to be very few statistically-significant differences among these propagation types for variables such as cane height and number, berry number and size, lateral number and length, cane diameter, node number and leaf area.

Another part of this project was initiated in late summer of 1989. Micropropagated and dormant, conventionally-propagated plants of 'Centennial' red raspberry were planted into 57 liter pots of field soil and established in the greenhouse. Over a two-year period, plants of each type will be evaluated in their growth behaviors and will be sampled for anatomical studies. Since we have determined that the differences between these two types of plants are most strongly expressed in the first year, we will attempt to do an exhaustive analysis of these plants after they are established and when they bear fruit.

PROPOSED RESEARCH: In 1990, a second harvest will be made in the field planting in order to determine if potential differences in resource allocations observed in 1989 will be reflected in yield in 1990. Emphasis will be placed on direct yield components in order to more accurately assess yield potential, as even slight increases in yield would offset the extra cost of more expensive MP planting stock. Reproductive traits relating to flowering and fruiting will be quantified, as well as vegetative characteristics which may reflect differences in plant strategies in producing a crop. In the final year of evaluation of this planting, this type of characterization should help to determine whether the differences observed until now have been due to an ongoing physiological response or to compensatory relationships resulting from differences in plant architecture during establishment.

Conventionally propagated and micropropagated plants of 'Centennial' established in large pots in 1989 will be evaluated in 1990 for differences in anatomy and morphology, as well as yield components. This study will characterize what differences in plant architecture may occur during establishment due to propagation method. It is these differences (such as increased lateral branching) which we have already observed which will ultimately determine the possible economic advantages of using MP planting stock. A new researcher in our program, Dr. Stephen Klauer, is a structure/function botanist who will have the major responsibility for this part of the project.

In 1989 we initiated another aspect of this project which we are pursuing without Commission funding. This project deals with characterizing the uniformity of plants propagated from roots, shoot cuttings and micropropagation. We will compare the growth rates and morphological charateristics of these plants in order to compare their uniformity of vigor and plant architecture. Preliminary evidence suggests that we may also be able to characterize uniformity by using SDS polyacrilamide gel electrophoresis to compare production of proteins by these plants. One of the perceived advantages of using micropropagated plants of other crops is uniformity of stand, and this project will help to determine whether this is the case with red raspberry.

TERMINAL DATE OF BASE PROJECT: June 30, 1990

DURATION OF THIS PROJECT: Based upon the results of our work in 1989, we are requesting an extension of this project for one year as we feel that the field planting should be harvested a second time. The pot study established with 'Centennial' will focus on the critical period of time during the development of these plants which we will need to observe in order to develop guidelines for the use of micropropagated planting stock in the Pacific Northwest. These studies will also give us new information about the general process of establishment in red raspberry plants.

BUDGET: We are reducing our request for 1990 as we seek funding primarily for the final harvest of the 1987 field planting, and for part of the labor costs associated with the analysis of the pot study.

		1989	1990
01	Temporary employees	$2,400	$1,800
03	Supplies and services	900	600
05	Computer services	100	-----
07	Benefits (5% of 01)	120	90
	TOTAL	$3,520	$2,490

PROJECT NO.: 58091HS-8-114

TITLE: Development of virus-tested red raspberry cultivars and of virus testing methods for them

PERSONNEL: Richard H. Converse, Research Plant Pathologist, USDA-ARS and Elizabeth Volk, Research Assistant, Department of Botany and Plant Pathology, Oregon State University, Corvallis, OR 97331

JUSTIFICATION:

Red Raspberry planting stocks from commercial nursery sources in Washington originate yearly from our USDA ARS screenhouse plant material that is indexed free from known viruses yearly. Established as well as new varieties are propagated by standard propagation techniques and released through requesting State Departments of Agriculture to participating nurseries in Washington and elsewhere each year. Funding for this service by USDA ARS has been partly provided by the Washington Red Raspberry Commission in the past, and a continuation of this support is requested for the period January-March 1990 to facilitate orderly harvest and distribution of dormant stock in 1990.

OBJECTIVES:

1. Test clones of major commercial red raspberry varieties for virus content.

2. Eliminate viruses in infected clones by heat therapy and tissue culture.

3. Increase and distribute propagants of tested clones to requesting State Departments of Agriculture.

PROGRESS: (if currently funded)

1. Ten varieties and 14 advanced red raspberry selections were prepared for 1990 distribution.

2. The variety Fallgold was heat treated and tissue cultured to develop clean clones, now under test and possibly ready for very limited distribution in 1990.

3. Similar work was done with blackberry varieties and advanced selections. This work will terminate with the plant harvest in March 1990.

PROPOSED RESEARCH:

TERMINAL DATE OF BASE PROJECT: September 1, 1994

BUDGET:

	Current 1988-89	Proposed 1990-91
00 Salaries	$2,800	$2,800
01 Benefits	1.700	1,700
	$4,500	$4,500

Note: As for 1989, the Commission is requested to make this grant to the USDA ARS TRust Fund that has been set up for this purpose. Current funds from the three supporting commissions are expected to be used in January 1990. The requested $4,500 from the Washington Red Raspberry Commission is essential to enable us to harvest and ship the plants in March, 1990 that are currently (September, 1989) entering dormancy in our screenhouse.

TITLE: Introduction and evaluation of a pesticide-resistant mite predator from Europe, *Amblyseius andersoni,* for enhanced spider mite control in red raspberries.

PERSONNEL: Dr. Russell H. Messing & Dr. Brian A. Croft
Dept. of Entomology
Oregon State University
Corvallis, OR, 97331-2907

JUSTIFICATION: Spider mites are a continuing though sporadic problem in raspberry fields of western Washington and Oregon. Predaceous mites are known to be effective in controlling spider mite populations, but these beneficials are usually killed by pesticides applied for leafrollers and other pests. By establishing pesticide-resistant predators in raspberry fields, we can greatly increase the likelihood of obtaining effective biological control.

A. andersoni is an excellent candidate for this purpose, as it is among the most common predaceous mites found in red raspberry, and a pesticide resistant strain has been found in northern Italy.

OBJECTIVES: 1. determine genetic compatibility of native and Italian strains of *A. andersoni.*

2. confirm pesticide susceptibility in the native strain and resistance in the Italian strain.

3. analyze pesticide response in the inter-strain hybrids and backcrosses, to determine the genetic basis of the resistance.

4. mass-rear and release pesticide-resistant predators in both sprayed and unsprayed raspberry fields.

5. analyze population dynamics of both predators and spider mite prey, in presence and absence of pesticide pressure.

PROGRESS:

Objective 1: reciprocal hybrid crosses and backcrosses with appropriate controls were carried out in the laboratory between native, Italian, and Dutch populations of *A. andersoni*. All strains freely crossed with all others, indicating conspecificity and free flow of genetic material.

The Dutch strain had a slightly higher rate of oviposition, but appeared more susceptible to low humidities, resulting in a higher percentage of shriveled eggs.

Objective 2: the extreme susceptibility of the Oregon and Dutch strains of *A. andersoni* to most insecticides was confirmed. In contrast, the Italian strain proved very resistant to organophosphates (malathion, azinphosmethyl, diazinon, and phosalone) and to carbaryl. All 3 strains were highly susceptible to fenvalerate.

Recommended field rates of organophosphates and carbaryl were almost perfectly discriminating: that is, they killed 100% of the native mites while killing none of the Italian mites.

Objective 3: bioassays of hybrids and backcrosses of the Oregon and Italy strains point towards a polygenic mechanism of resistance in *A. andersoni*. It is still unclear whether this represents additive mechanisms or whether each major gene in itself can confer tolerance to field levels of insecticides. Field hybridization of released Italian (resistant) mites with native (susceptible) mites may result in a dilution of the resistance.

Objective 4: attempts to mass-rear the Italian mites on a diet of corn pollen or grain mites have proven unsuccessful. At present, we rely on a system of rearing lima beans, then spider mites on the beans, then the predators on the spider mites. This is laborious and makes it difficult to obtain large numbers of predators.

A pilot trial was conducted releasing approximately 2,000 mites of each strain in a 6 acre red raspberry field, followed with a hand-spraying of malathion and weekly spider mite and predator counts. Indications are that larger numbers of mites will need to be reared and released in order to assess predator impact and address objective 5.

PROPOSED RESEARCH: Maintainance colonies of both native, Italian, and Dutch *A. andersoni* will be kept in the laboratory at OSU. Bioassays of reciprocal hybrids and backcrosses will be conducted during the winter to confirm the polygenic nature of the resistance. Also, feeding trials with various diets (pollens, grain mites, alternate prey, and combinations of these) will be conducted to improve the system for mass-rearing.

The principle investigator (Dr. Messing) will soon be leaving OSU to accept another position, and plans for next year's work are temporarily on hold. Thus we will not be requesting the second year's funding on the project at this time. When appropriate replacement personnel are identified and hired, we will approach the Commission again for a resumption of this funding.

PROJECT NO. New

TITLE: Potential for Ground Water Contamination from Soil-Applied Pesticides in Red Raspberries.

PERSONNEL: Peter R. Bristow, Associate Plant Pathologist, and
Craig G. Cogger, Assistant Soil Scientist
WSU-Puyallup Research and Extension Center

JUSTIFICATION:

In western Washington, the culture of high-value perennial crops such as red raspberries and strawberries poses special risks of ground water contamination by pesticides for the following reasons:

1. Heavy reliance is placed on the use of insecticides, herbicides, and fungicides, and pesticide use often extends continuously for many years on the same field.

2. Some of the pesticides used on red raspberries have the potential to move through soil, and simazine is on the EPA priority list of potential ground water pesticide contaminants.

3. Soils recommended for red raspberries are well drained and often coarse textured, both of which increase the risk of pesticide movement.

4. Red raspberries are grown on alluvial soils where the ground water aquifer often lies within several feet of the surface. The EPA has designated such agricultural lands as "at risk" with regard to ground water contamination.

To reduce the risk of ground water contamination, pesticides and the land to which they are applied need to be properly managed. To better protect ground water, it is essential to evaluate the potential for pesticide transport through soil to ground water under typical soil and cropping conditions.

OBJECTIVE:

To determine the presence and concentration of the three test pesticides and breakdown metabolites in ground water beneath red raspberries treated with the pesticides.

PROPOSED RESEARCH:

In 1986 a large field study was initiated to measure the dissipation and downward movement of carbofuran (Furadan), metalaxyl (Ridomil) and simazine (Princep) following their application to alluvial soils in western Washington. The three pesticides have been applied to red raspberry and strawberry plantings at two test sites. Commercial rates and timings were used. This is a five year project with pesticides being applied in each of the first 3 years. No pesticides will be applied in the last 2 years but the movement and fate of pesticides applied earlier will be followed.

Water samples are collected monthly from 13 groundwater monitoring wells permanently installed in the raspberry plantings. Water samples are analyzed for residues of the test pesticides plus 3 breakdown metabolites. The residue work is performed on a contract basis by the Department of Agricultural Chemistry at Oregon State University. The annual fee for this service is $5,250.00. This proposal requests funds to cover one-half of the fee. An identical proposal is being submitted to the Washington Strawberry Commission.

TERMINATION DATE OF THE BASE PROJECT:

Project No. 0741, December 31, 1990.

PROJECT DURATION: 1 year.

We anticipate that other funding sources will be secured for this portion of the project during the fifth or final year.

BUDGET:

	Proposed 1990-91
03 Goods and Services	$2,625.00
Total	$2,625.00

PROJECT NO. New

TITLE: Reaction of red raspberry cultivars and advanced selections to the root rot controlling fungicide Ridomil

PERSONNEL: Peter R. Bristow, Associate Plant Pathologist and
Patrick P. Moore, Assistant Horticulturist,
WSU Puyallup Research and Extension Center

JUSTIFICATION:

Previous research has shown that the yield of 'Sumner' and other selections increased when the soil was treated with Ridomil to control root rot caused by the soil-borne fungus Phytophthora erythroseptica. 'Sumner' and those selections are resistant or at least moderately resistant to root rot caused by this pathogen. The positive response to Ridomil indicates that root rot is causing damage to resistant cultivars and selections even though there was minimal cane death and wilting. In short, resistance is not complete and maximum yield potentials are not being realized when plants are infected. Recent selections, which exhibit no obvious symptoms of root rot, may similarly sustain yield losses when infected. Comparing the yields of Ridomil-treated and untreated plants will help determine the true yield potential of those selections.

OBJECTIVE:

To evaluate the performance of cultivars and advanced selections in both the presence and absence of Ridomil on a site naturally infested with P. erythroseptica.

PROPOSED RESEARCH:

Approximately 12 cultivars and advanced selections from the WSU and Agriculture Canada raspberry breeding programs will be planted in a replicated planting at the WSU Vancouver Research Unit. The planting will be established on soil naturally infested with the root rot pathogen Phytophthora erythroseptica. Plants will be evaluated under high disease pressure. There will be two plots of each cultivar or selection in every block. Ridomil will be applied to one plot of each twice yearly.

Plants will be set out in 1990, trellised in 1991 and harvested during both the 1992 and 1993 growing seasons. Data collected will include root rot severity, fruit yield, berry size and cane growth.

PROJECT DURATION:

The duration of this project will be 4 years. Canes produced in 1990, the establishment year, will be mowed off at ground level so there will be no "baby crop" in 1991.

BUDGET:

		Proposed 1990-91
Wages (timeslip)		$190.00
Employee benefits		10.00
Supplies and services		600.00
	TOTAL	$800.00

TERMINATION DATE OF BASE PROJECT:

Projects: 0640 June 30, 1991
0668 June 30, 1989

PROJECT NO.: New

TITLE: The role of overwintering native predators on spider mite populations in red raspberry fields.

PERSONNEL:

Carl H. Shanks, Jr., Entomologist, WSU-Vancouver.
Arthur H. Antonelli, Extension Entomologist, WSU-Puyallup.
Bruce D. Congdon, Asst. Professor of Biology, Seattle Pacific University.

JUSTIFICATION:

The two spotted spider mite Tetranychus urticae Koch, in high numbers can cause early defoliation of red raspberries. This can result in abnormal bud-break in the fall and greater susceptibility to freeze injury in the winter.

Mite populations are very sporadic. Research in the past three years has shown that some fields had high or low mite populations every year while others had very low populations for two years and then, inexplicably, had high numbers the third year. High mite populations were related to heavy use of insecticides in some cases but not in others. We hypothesize that, in many cases, the mite populations were kept low by predators which overwintered in raspberry fields or at their margins and were present early in the season in numbers too low for dependable counting. One strong candidate for this role is the small black lady beetle, Stethorus sp., but there are other possibilities. Confirmation of this hypothesis and knowledge of the species involved could lead to management practices that would attract mite predators and encourage their overwintering in the raspberry fields.

OBJECTIVES:

1. Develop a trap that can be used to monitor overwintering predators.
2. Quantify and study early season predator populations.
3. Determine the relationship between overwintering predator populations and subsequent summer spider mite densities.

PROPOSED RESEARCH:

Objective 1. Traps composed of bundles of burlap or soda straws will be placed at the base of raspberry canes or in adjacent cover crop or grassy areas. They will be put into place in early fall and examined for the presence of overwintering predators and/or spider mites in late November or early December.

Objective 2. Spider mite populations will be measured in several raspberry fields in August or early September. Populations of overwintering predators will be measured by trapping to determine if there is any correlation between mite and predator numbers. Spider mite populations will be measured in the following late spring and summer to determine the effect of the predators on them.

Objective 3. Small infestations of spider mites will be initiated and marked shortly after foliage appears in the spring. These experimental infestations will be used to monitor the density and reproductive rates of native predator species.

TERMINAL DATE OF BASE PROJECT: March 31, 1991.

DURATION OF THIS PROPOSAL: This will be the first of 3 years.

BUDGET:

		1990-91
01	Wages	$7,000[a]
03	Supplies	500
04	Travel	1,500
07	Benefits	350
Total		$9,350

[a] $5,000 for 2 months research by Ph.D. entomologist, $2,000 for student assistant.

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PROJECT NO.: New

TITLE: The influence of mite feeding and miticide applications on the growth and physiology of red raspberry

PERSONNEL:
J. Scott Cameron, Assistant Horticulturist
Carl H. Shanks, Jr., Entomologist
Stephen F. Klauer, Agricultural Research Technologist II
Chuhe Chen, Research Associate\Visiting Scientist
Washington State University Research and Extension Unit, Vancouver

JUSTIFICATION: The two spotted spider mite, *Tetranychus urticae* Koch, is a sporadic pest of red raspberries. The actual influence of mite feeding and damage on the growth and physiology of red raspberry is poorly understood. While mite damage can cause defoliation and thus reduce winterhardiness, it is less clear as to what influence mite damage might have on overall growth and ultimately yield. In 1988 (Project #13C-3543-7956), we were able to demonstrate that the damage caused by mite feeding on red raspberry leaves was capable of reducing photosynthetic rates as much as 60%. It was also observed that significant reductions in photosynthesis occurred without the presence of visible damage to the leaves. In some cases, feeding by only a few mites on one part of a plant appeared to have influenced the physiology of leaves which had not been exposed to mite attack. This suggests that red raspberry may respond to mite feeding in some manner which profoundly influences the physiology of the whole plant. This information has not been considered in determining the economic threshold for the control of mites, and determining the magnitude of this response would provide hard data for setting an accurate threshold for more efficient control of this pest.

Similarly, it has been observed that certain types of pesticides can have a negative influence the physiology of plants, and it has been suggested that some miticides may have such an effect on strawberry. It would be valuable to know if such an influence occurs in red raspberry, and if the combination of mite feeding and miticide applications can cause significant reductions in the photosynthetic potential and the growth of this plant.

OBJECTIVES:

1. To determine the influence of mite feeding and miticide applications on the physiology of red raspberry.
2. To evaluate economic damage thresholds in light of plant response to limited mite feeding.
3. Evaluate native and cultivated *Rubus* for response to mite feeding.

PROGRESS: As previously outlined, we have already characterized some of the physiological responses of red raspberry to mite damage. We have established a number of protocols which would be useful for testing plant responses to mite attack.

PROPOSED RESEARCH: Experiments will be conducted which will examine the response of red raspberry physiology to limited mite feeding, particularly with regard to mite number and the influence of isolated feeding on one part of the plant. The influence of the miticides Vendex and Omite on the physiology of infested and noninfested will be examined as well. Lastly, cultivars and native *Rubus* will be screened for their response to mite feeding. Potted plants in the growth chamber and greenhouse will be used to allow for repetitive experiments and for uniformity of plant material and environment. Gas exchange measurements will be made using a ADC-LCA2 portable photosynthesis measurement system. Spectroscopy and electrophoretic techniques will be used to determine the influence of mite feeding on chlorophyll content and general metabolism of leaves.

TERMINAL DATE OF BASE PROJECT: June 30, 1990 (JSC)
March 31, 1991 (CHS)

DURATION OF THIS PROJECT: One year with the possibility of renewal depending upon the results obtained in 1990.

BUDGET:

		1990
01	Temporary employees	$ 900
03	Supplies and services	500
05	Computer services	100
07	Benefits (5% of 01)	45
	TOTAL	$1,545

PROJECT NO: New

TITLE: Development of a Best Management Practice Manual for Red Raspberries

PERSONNEL: Stott W. Howard and Craig B. MacConnell, Washington State University, Mount Vernon Research and Extension Unit and Whatcom County Cooperative Extension, respectively.

JUSTIFICATION: Protection of groundwater has become a national issue with substantial consequences for all commodity groups in western Washington where groundwater is vulnerable to contamination from pesticides. One of the strategies that is currently being considered (and quite possibly soon to be implemented) by regulatory agencies to protect groundwater resources is the development of Best Management Practices (BMP). Best Management Practice guidelines would contain sufficient information regarding pesticide use, storage, application technology, and environmental considerations so that would-be pesticide users could make appropriate judgements regarding pesticides that would decrease the likelihood of groundwater contamination. In the future, BMP guidelines could conceivably be required for the continued use and registration of some or all pesticides and may even be required for selling of agricultural products in certain markets. This is not intended to replace current WSU or PNW pest control publications, rather it would be used as supplementary information. It will not contain pesticide recommendations, but will provide guidelines for pesticide users on how to avoid situations that may imperil ground water quality.

OBJECTIVE: To develop a Best Management Practice Manual for red raspberry growers.

PROPOSED RESEARCH: Conduct an extensive search of literature data bases for information germane to the development of a comprehensive BMP manual for red raspberries. The following types of information would be included in the publication: pesticide application technology, handling, storage, disposal, and environmental factors influencing pesticide mobility. The literature will then be summarized and related specifically to red raspberry production in western Washington. The BMP document will be reviewed by appropriate WSU Extension Specialists and Agents for format and informational content. The final draft will be submitted as a limited number of hard copies and on appropriate software. Reproduction, publishing and distribution of the BMP document to raspberry growers would be the responsibility of the red raspberry commission.

TERMINAL DATE OF BASE PROJECT: 10A-3419-0740, February 30, 1990

DURATION OF PROPOSAL: one year

BUDGET:

	1990-91
01 temporary employees	250
02 supplies and services	300
05 computer services	800
07 employee benefits	13
Total	1363

PROJECT NO: New

TITLE: Evaluation of Living Mulches for Use in Red Raspberries

PERSONNEL: Stott Howard, Carl Libbey, and Eric Hall. Washington State University Mount Vernon Research and Extension Unit. Craig B. MacConnell. Washington State University Whatcom County Cooperative Extension.

JUSTIFICATION: Weed control in red raspberries is achieved primarily through the use of herbicides. This reliance upon herbicides is due to a lack of equally effective and economical alternative methods of weed control. Currently, however, herbicide use is being critically evaluated by growers because of cost, nonperformance, and crop injury. In addition, many growers that have used annual herbicide programs for weed control in perennial crops are finding it difficult to rotate into other crops or replant the same crop due to a build-up of residual herbicides. Further, contamination of groundwater from the use of agricultural pesticides is a growing concern in agricultural communities, because many states, including Washington, have discovered pesticides in groundwater. Many productive farmlands in western Washington are susceptible to ground water contamination as they consist of coarse-textured alluvial soils with fairly shallow water tables and there is substantial winter rainfall that introduces significant downward flux of water through the soil profile. For these reasons, as well as the progressively restrictive legislation continually being implemented to regulate pesticide use, there is a need for a research effort in western Washington to evaluate weed control techniques that reduce herbicide inputs into red raspberry culture. One technique for weed suppression that is being used in many perennial cropping systems is intercropping of living mulches. The idea being that a low-growing, shallow-rooted, plant material established in row-middles will suppress weed growth (thus eliminating or reducing the need for soil residual herbicides in row-middles) and not compete with the red raspberries for resources. Many new mulches are being evaluated throughout the country for use in various perennial cropping systems and, therefore, those with the most desireable characteristics should be evaluated for use in western Washington red raspberry production. Additional benefits associated with the use of living mulches include decreased erosion, increased soil tilth, and increased water infiltration.

OBJECTIVES: 1) Evaluate several living mulch varieties at Washington State University Mount Vernon for establishment, development, weed suppression, reseeding, and water-use characteristics. 2) Establish demonstration plots of the same mulch varieties on a red raspberry farm in Whatcom county and seek input from growers regarding the feasibility and practicality of the various living mulches at the farm level. 3) Evaluate the effects of selected mulch varieties on red raspberry growth (based on results obtained in objectives 1 and 2).

PROPOSED RESEARCH:

Objective 1. In 1990 plots will be established at the WSU research facility in Mount Vernon. Following standard site preparation techniques, George black medic, Kalo dwarf English trefoil, Berseem clover, Geraldton and Dalkeith subclovers, and Zorro fescue will be planted in 10 by 20 ft plots (replicated 4 times). Establishment rates, developmental characteristics, weed suppression characteristics, reseeding ability, and water use of each mulch variety will then be determined. Included in the trials will be a standard cultivation treatment and the use of fall-seeded spring barley (the current convention) for comparison. These plots will not be established in a red raspberry planting and will be used solely to determine the characteristics and of the mulches. Often the most effective and economical approach for studying the integration of new production techniques into a cropping system is to separately evaluate the different components. There are no data on the performance characteristics of these mulch varieties in western Washington and whether or not they can survive in this unique climate. It would be quite costly to establish replicated plots of adequate size in red raspberries to sufficiently evaluate all of the mulch varieties and determine their effects on red raspberry growth. Therefore it makes more sense to initially evaluate the mulches in smaller replicated plots, select the top performing mulches, and then evaluate the effects of the selected mulches on red raspberry growth in subsequent experiments.

Objective 2. In 1990 'on-farm', unreplicated demonstration plots will be established in Whatcom county using the aforementioned mulch varieties in order to determine the feasibility of integrating living mulch technology into standard red raspberry cultural procedures. Plots will be two row-middles wide and 120 ft long. Standard farm equipment and red raspberry production techniques will be used as much as possible to simulate practical establishment and use patterns. During the process of establishing and maintaining the living mulch demonstration plots, records will be kept of grower impressions and acceptance. Evaluation of mulch characteristics that support and/or interfere in red raspberry production will be carefully noted. Such documentation will be critical to the success of a living mulch program and will enable the integration of farmer requested needs and changes into living mulch production practices.

Objective 3. In 1991 the most effective mulches identified in objectives 1 and 2 will be further evaluated within a red raspberry planting. This will determine the interactive nature between the mulch varieties and the red raspberries. The selected mulch varieties will be established the fall prior to interplanting the red raspberries. Mulch plots will be 20 ft wide by 30 ft long. The following spring, three rows of red raspberries 30 ft long will be planted into each mulch plot, one in the center of the 20 ft width and two border rows. Data describing the growth and development of red raspberries as affected by the mulch variety will be taken from the center row of red raspberries. In addition to the mulch varieties, there will be conventional methods of row-middle management included in the experiment for comparisons.

Each treatment will be replicated four times. Standard fertilizer and pest control practices will be followed as needed. These results will provide the necessary information for the development of recommendations and guidelines that will allow implementation of mulch use into red raspberry culture.

TERMINAL DATE OF BASE PROJECT: 10A-3419-0740, 28 February 1990.

DURATION OF PROPOSAL: two years (and possibly beyond....)

BUDGET FOR:	1990-91	1991-92*
01 Temporary employees	900	
02 Supplies and services	350	
04 Travel	250	
05 Computer services	200	
07 Employee benefits	45	
Total	1745	

*Budget for this time period will depend on the number of mulch varieties selected for advanced testing from the initial screening.

Project No: New

Title: Transformation of Raspberry with the Coat Protein of Raspberry Bushy Dwarf Virus.

Personnel: Robert R. Martin, Agriculture Canada Research Station, 6660 NW Marine Dr., Vancouver, B.C. V6T 1X2

Justification:

Raspberry bushy dwarf virus (RBDV) is the most common virus disease of raspberries in the Pacific Northwest. Currently, only two raspberry cultivars (Willamette and ~~Chilliwack~~ Chilcotin) grown in this area are resistant to RBDV. With the technology of incorporating plant virus coat proteins into plants and the finding that these plants express some form of resistance to subsequent infection by the virus we have the tools required to develop synthetic resistance to plant viruses.

Objectives:

During the first year of this project we will identify and sequence the coat protein of RBDV which is a prerequisite to developing synthetic resistance. During year 2 and 3 of the project the coat protein gene of RBDV will be put into several raspberry cultivars and these lines challenged with virus to evaluate their reaction to RBDV.

Progress:

We have not started this project at this time. In my lab we have sequenced the potato leafroll virus and have put the coat protein of this virus into potato. We are now challenging these plants to evaluate the reaction of these plants to infection by potato leafroll virus. In the work with potato leafroll virus we have learned the cloning and sequencing techniques and will be able to carry out this work. We have also developed some expertise in the transformation of plant tissue using Agrobacterium tumefaciens as well as experience with tissue culture of raspberry. We have obtained experience with the techniques to carry out the project while working on a parallel project in potato.

Proposed Research:

During the first year of the project we will clone and sequence the coat protein of RBDV. This requires the purification of the virus, extraction of the viral RNA, making a double stranded DNA copy of the RNA, identifying the coat protein gene of the virus, and sequencing this gene. The purification of RBDV we have done before when we made monoclonal antibodies to this virus and this is a relatively easy virus to purify. We have also carried out the RNA extraction from purified RBDV. I have made cDNA to several different viruses and have sequenced several different viruses so this technology is available in my lab. These methods are all quite straight forward but very labor intensive.

The second and third year of this project I plan to introduce the coat protein gene of RBDV into several raspberry cultivars. The transformed plants (plants with the coat protein gene inserted into the plant genome) will be tested for the presence of the inserted DNA, then checked to make sure the corresponding RNA is produced and that the gene is expressed and the coat protein is produced in the plants. Plants expressing high levels of coat protein will be graft inoculated with RBDV to test for resistance. In addition to these tests an application will be made to be allowed to plant these plants in the field to test for field resistance. Since we want to see a response in the field, initially we will want to use cultivars that are readily infected with RBDV in the field. Meeker will be our first choice of cultivar to work with.

Termination date of Base Project: Jan. 1, 1994.

Duration of this project: 1/3

Budget:	Proposed	1990-91
03 Goods and Services		5000.00
TOTAL		5000.00

I am trying to get a student to work on this project. The students salary will hopefully be paid by a scholarship program. The enzymes, radioisotopes, plastic ware and other supplies are quite expensive for this work.

WASHINGTON RED RASPBERRY COMMISSION

Project No: New

Title: Transformation of Raspberry with the Coat Protein of Tomato Ringspot Virus.

Personnel: D'Ann Rochon and Robert R. Martin, Agriculture Canada Research Station, 6660 NW Marine Dr., Vancouver, B.C. V6T 1X2

Justification:

Tomato ringspot virus (TomRSV) can be a serious problem in red raspberry in the Pacific Northwest. Currently, there are no known raspberry cultivars that are resistant to TomRSV. With the recent discovery that the incorporation of plant virus coat protein into plants confers some form of resistance to subsequent infection by the virus there is the potential to develop synthetic resistance to many plant viruses.

Objectives:

Develop conditions required to transform raspberry plants with *Agrobacterium tumefaciens*.

Transform raspberry plants with the coat protein gene of TomRSV and challenge these transformed plants with TomRSV to evaluate the level of resistance obtained.

Progress:

The project has not been started. However, prerequisite to doing this work the sequence of the coat protein gene of TomRSV needs to be known. The coat protein of TomRSV has been obtained by cloning and sequencing RNA 2 of the virus. This work was part of a project on the genome organization and expression of nepoviruses.

Proposed Research:

During the first phase of the project we will determine the conditions required for the successful transformation of raspberry. This involves emperical optimization of hormone levels, temperature, light conditions and vector construction to give efficient transformation. The results of these experiments will be useful for transformations with TomRSV as well as transformations with any other genes into raspberry, such as raspberry bushy dwarf virus. The transformed plants (plants with the coat protein gene inserted into the plant genome) will be tested for the presence of the inserted DNA, then levels of transcription and translation will be determined. Plants with varying levels of expression of the coat protein will be selected for further testing.

During the second year of the project transformed plants will be challenged with the TomRSV to determine the levels of resistance obtained. Transformed plants will be inoculated by graft inoculation, mechanical transmission and nematode transmission. Inoculation with nematodes will be the most difficult but the most important since this is the route of inoculation that occurs in the field. Plants expressing high levels of coat protein will be graft inoculated with TomRSV to test for resistance. In addition to these tests an application will be made for permission to test these plants in the field for resistance.

Termination date of Base Project: Jan. 1, 1993.

Duration of this project: 1/2

Budget: Proposed	1990-91
00 Salaries	3000.00
03 Goods and Services	2000.00
TOTAL	5000.00

This project will also be submitted to the Oregon Caneberry Commission for funding.

PROJECT NO.: New

TITLE: Captan on Red Raspberries: Efficacy and Residues

PERSONNEL: Peter R. Bristow, Associate Plant Pathologist
Gwenyth E. Windom, Agricultural Research Technologist III
WSU Puyallup Research and Extension Center

JUSTIFICATION:

The fungicide Captan is widely used by Pacific Northwest raspberry growers to control fungal fruit rots including gray mold (Botrytis cinerea). Because Captan has a multi-site mode of action, its continued use is critical in managing resistance to dicarboximide (Ronilan, Rovral) and benzimidazole (Benlate) fungicides.

Captan is currently undergoing special review by the U.S. Environmental Protection Agency. The use of Captan on caneberries will be suspended in early 1990 and it will not be re-registered until acceptable residue and, possibly, efficacy data are generated.

Projects to obtain the necessary data have been submitted to the IR-4 program for funding in 1990. IR-4 gives this project its highest priority rating; however, it will be several months before the outcome of the funding request is known. It is not yet known whether IR-4 will fund both the field studies (efficacy and collection of fruit for residue testing) and the laboratory residue analyses. Often IR-4 programs fund the field study and ask impacted grower groups to finance the residue tests.

Oregon and eastern states growers will likely participate in the field studies. It is hoped they will share with Washington growers in the funding of such a project. Which other states must conduct field studies and the number of residue tests needed is not yet known.

OBJECTIVES:

1. Supply Captan-treated and untreated red raspberries grown in Washington for residue analysis.

2. Evaluate the efficacy of Captan against fruit rots in red raspberries in Washington.

PROPOSED RESEARCH:

Field trials will be conducted on red raspberries during the 1990 growing season.

a. Plots will be evaluated for fruit rot control.
b. Ripe fruit will be hand harvested, frozen and shipped in dry ice to the designated residue laboratory.

DURATION OF BASE PROJECT:

Project to terminate June 30, 1990.

DURATION OF THIS PROJECT:

One year

PROPOSED BUDGET:

Field trial (if not funded by IR-4)	$1,000.00
Residue analyses (16 samples x $180/sample)	2,880.00