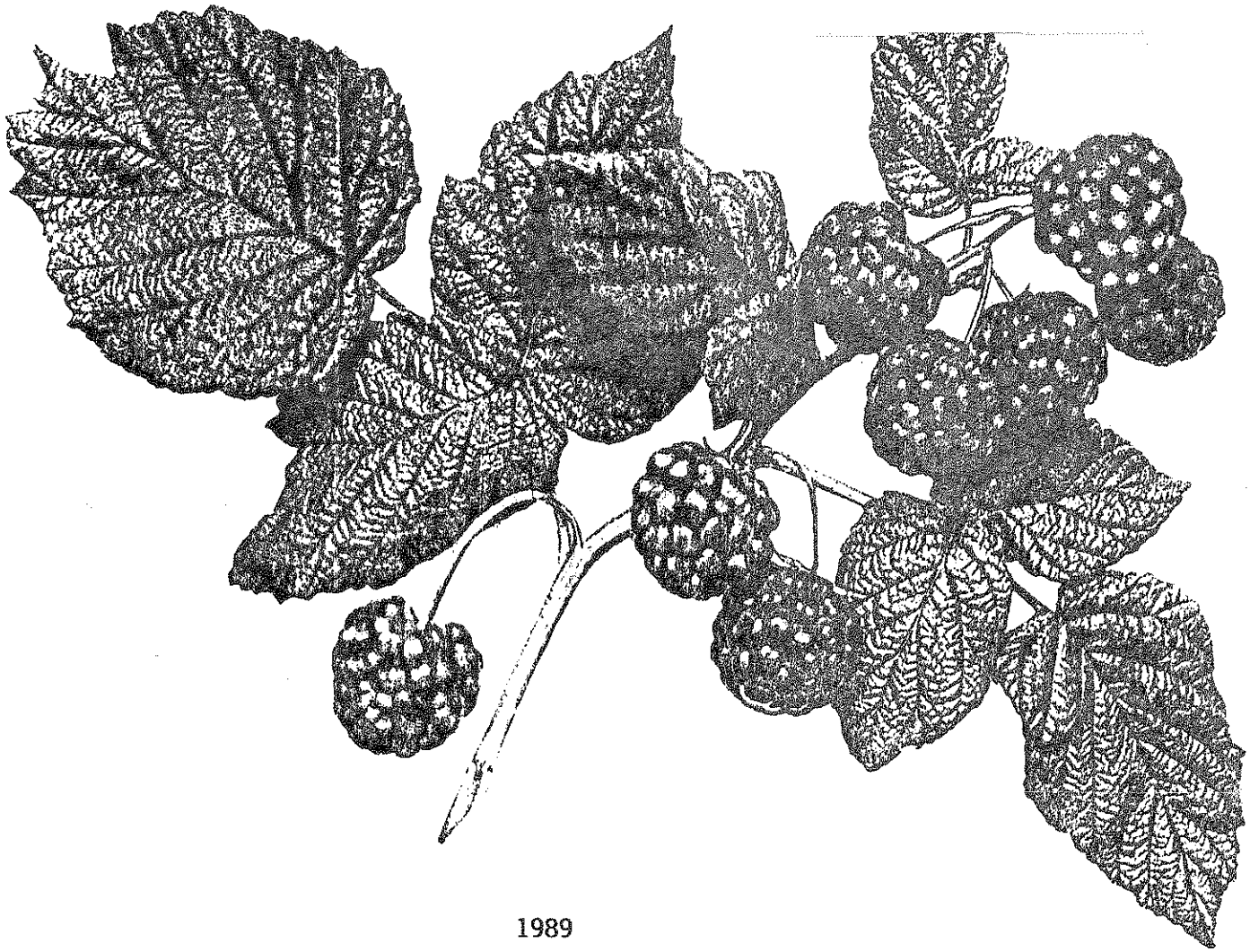


1989

RED RASPBERRY RESEARCH PROPOSALS

1988 PROGRESS REPORTS

to the

WASHINGTON STATE RED RASPBERRY COMMISSION

and

WASHINGTON RED RASPBERRY GROWERS ASSOCIATION

WASHINGTON RED RASPBERRY COMMISSION

Marty Maberry, President
816 Loomis Trail Road
Lynden, WA 98264 — Tel. (206)354-2094

Frank DeVries, Vice President
752 Loomis Trail Road
Lynden, WA 98264 — Tel. (206)354-5212

Dick Carkner, Treasurer
4520 River Road East
Tacoma, WA 98443 — Tel. (206)922-1604

Gerry Beckman
6321 119th Ave. E.
Puyallup, WA 98372 — Tel. (206)841-4644

Randy Kraght
3480 Cedarville Road
Bellingham, WA 98226 — Tel. (206)592-5197

George Tsugawa
206 Whalen Loop Road
Woodland, WA 98674 — Tel. (206)225-8672

Anne Metzger, Administrator
Washington Red Raspberry Commission
1333 Lincoln St., #182
Bellingham, WA 98226 — Tel. (206)671-1437

Dan Petek, Marketing Director
Washington Red Raspberry Commission
Marketing and Promotion Office
1626 North Atlantic
Spokane, WA 99205 — Tel. (509)328-7307

WASHINGTON RED RASPBERRY GROWERS ASSOCIATION

Marvin Jarmin, Manager
1354 Old Highway 99
Burlington, WA 98233 — Tel. (206)757-3931

TABLE OF CONTENTS

PAGE

ON-GOING PROJECTS

WSU - Puyallup

Moore, Patrick P., Jo Ann Robbins — 1
Equipment for small fruit breeding at WWREC

Moore, Patrick P., Robert A. Norton, J. Scott Cameron — 2
Advanced Testing of Washington State University Raspberry Selections

Moore, Patrick P., Jo Ann Robbins — 4
Red raspberry breeding, genetics and clone evaluation

Bristow, Peter, Patrick P. Moore — 9
Development of root rot screening techniques for red raspberry

Bristow, Peter, Gwen Windom — 12
The effects of waterlogging and *Phytophthora erythroseptica* on subsequent growth of red raspberry

WSU - Vancouver

Cameron, J. Scott, Carol A. Hartley — 15
Phenotypic stability and field performance of micropropagated red raspberry cultivars

Cameron, J. Scott, Stott W. Howard — 17
Advanced testing of new compounds for caneburning of red raspberry

Cameron, J. Scott, Carol A. Hartley — 19
Leaf/fruit ratio and yield potential in red raspberry

Shanks Jr., Carl H., Arthur Antonelli, Bruce D. Congdon — 21
Management of Spider Mites on Red Raspberries

USDA-ARS - OSU - Corvallis

Converse, R. H., E. Volk — 25
Development of virus-tested red raspberry cultivars and of virus testing methods for them

TABLE OF CONTENTS, Cont.

PAGE

NEW PROJECTS

WSU - Puyallup

Hummel, Rita L., Patrick P. Moore 30
Cold hardiness of red raspberry

Moore, Patrick P., Craig MacConnell 32
Machine harvesting trial

Agriculture Canada

Martin, Robert R. 34
Detection of raspberry viruses

USDA-ARS - OSU - Corvallis

Converse, Richard H. 35
Development of virus-tested red raspberry cultivars and of virus testing methods for them. SPECIAL EQUIPMENT REQUEST

OSU - Corvallis

Messing, Russell H., Brian A. Croft 37
Introduction and evaluation of a pesticide-resistant mite predator from Europe, *Ambylseius andersoni*, for enhanced spider mite control in red raspberry

SUMMARY

BUDGET REQUEST

Project No.	Short Title	Lead Scientist	Amount Requested
On-going Projects			
13C-3755-3640	Equipment	Moore	$ -0-
13C-3755-8640	Advanced Testing	Moore	750
13C-3755-5641	Breeding, genetics, evaluation	Moore	9,700
13C-3761-5668	Root rot screening	Bristow	-0-
13C-3761-6688	Effects of waterlogging	Bristow	1,800
13C-3555-5956	Stability - micropropagated cultivars	Cameron	3,520
13C-3555-2783	Caneburning compounds	Cameron	7,404
13C-3555-5783	Leaf/fruit ratio	Cameron	2,500
13C-3543-7956	Management - spider mites	Shanks	7,500
58-91HZ-8-114	Virus-tested cultivars	Converse	9,900
		Sub-total	$ 43,074
NEW PROJECTS			
	Cold Hardiness	Hummel	$ 2,255
	Machine harvesting	Moore	200
	Detection raspberry viruses	Martin	900
	ELISA reader	Converse	9,000
	Mite predator	Messing	9,280
		Sub-total	$ 21,635
		GRAND TOTAL	$ 64,709

PROJECT NO.: 13C-3755-3640

TITLE: Equipment for small fruit breeding at WWREC

PERSONNEL: Patrick P. Moore, Assistant Horticulturist
JoAnn Robbins, Agricultural Research Technologist III, WSU Puyallup REC.

JUSTIFICATION:

The funding of the small fruit breeding program at Washington State University has been primarily for labor for harvest, data collection and for supplies directly required for the establishment of studies. Monies have not been available to upgrade and maintain equipment and buildings in order to stay current with advancing technological development. The program has expanded and there is a need for additional equipment and capitol expenditures to sustain expansion and to allow efficient operation.

PROGRESS:

The following items were obtained through assistance of the Washington Red Raspberry Commission and the Washington Strawberry Commission.

1. Two AST 286/premium computers each with 1 mB of RAM, 40 mB disk drive, monitor, modem, and wide carriage printer.

2. An Omnidata 602 Polycorder and American Scientific portable electronic balance.

3. A Minolta 200b portable tristimulus colorimeter.

A laminar flow transfer hood and screenhouse repairs in the original request were obtained through Washington State University sources.

TERMINAL DATE OF BASE PROJECT:

Strawberry: June 30, 1990
Raspberry: June 30, 1991

PROJECT NO.: 13C-3755-8640

TITLE: Advanced Testing of Washington State University Raspberry Selections

PERSONNEL: Patrick P. Moore, Assistant Horticulturist, WWREC, Puyallup
Robert A. Norton, Horticulturist, NWREC, Mt. Vernon
J. Scott Cameron, Assistant Horticulturist, 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 WWREC in Puyallup, 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:

WSU 738 was approved for release as 'Centennial'. 'Centennial' is a seedling selected from a 'Meeker' X 'Skeena' cross made in 1974. It is large fruited and has been productive both in grower trials and in test plantings. Crumbly fruit occurred in some plants propagated for the grower trials. All of the plants were derived from one propagation stock and no additional plantings of crumbly fruited plants have been noted.

New 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.

WSU 892 was commercially propagated for grower trials. At least seven growers in Washington and Oregon have established or will establish plantings in 1988-89. Plants were not available until late July and several growers will wait until 1989 to establish plantings.

PROPOSED RESEARCH:

In 1989-90 the advanced selection plantings established in 1988 will be maintained. These plantings will be harvested for the first time in 1990.

WSU 892 will be planted at additional grower fields in 1989.

WSU 933 planted in the 1985 selection trial is a promising selection. It is a selection from the cross between WSU 738 (Centennial) and 'Haida'. It had the second highest yield for two years harvest, is large fruited, the fruit releases from the receptacle much easier than either parent, and is aphid resistant. WSU 933 will be propagated for future advanced selection trials and will be considered for grower trials.

TERMINAL DATE OF BASE PROJECT: June 30, 1991

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

BUDGET:

		1988-89	1989-90
01	Timeslip	0	$300
03	Goods and Services	$600	435
07	Benefits (5% of 01)	0	15
	Total	$600	$750

Amount to be divided among the three project leaders.

PROJECT No.: 13C-3755-5641

TITLE: Red Raspberry Breeding, Genetics and Clone Evaluation

PERSONNEL: Patrick P. Moore, Assistant Horticulturist; JoAnn Robbins, Agric. Research Technologist III; 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 maturation parameters critical to fresh market shelf life (fruit weight, retention strength, firmness, pigment concentration and soluble solids).

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

PROGRESS:

Sixty-five crosses were made in 1988. Thirty-six of the crosses used an aphid resistant selection or cultivar as one parent. Rubus spectabilis, R. crataegifolius, R. hawaiiensis, R. sumatranis, and R. idaeus vulgatis were used in six crosses to broaden the genetic base. Sixteen crosses will be used to investigate the inheritance of crumbly fruit in WSU 738. One additional cross will be used to determine the potential for crumbly fruit in an advanced selection. Six crosses will be used in an inheritance study of fruit color and cold hardiness. Selections also will be

made from the crosses made for inheritance studies if superior plants result.

A seedling planting of 2667 raspberry seedlings was established at Puyallup with material from 1987 crosses and supplemental material from Agriculture Canada. These seedlings will be available for selection in 1990 and 1991. An additional 600 seedlings from Rubus strigosus open pollinated seed were planted in soil infested with root rot. This planting will be used to select for genetic sources for root rot resistance. Twenty selections and standard cultivars were planted in soil infested with root rot at Puyallup to determine levels of susceptibility to disease. Twenty-five selections and standard cultivars were planted in replicated selection trials for yield and fruit quality evaluations in 1990 and 1991.

New breeding plots were established in 1988. The new planting consists of three replications with room for 160 selections and cultivars. All clones were tested for the presence of raspberry bushy dwarf virus. New selections and cultivars will be added as they become available, and old ones removed if found to be diseased or no longer of value. These plots will be used for breeding, propagation, and material for replicated studies.

Twenty new selections were made in 1988. Nine of the selections were made from plantings at Puyallup. Two of these are primocane fruiting types. Eleven selections were made at Vancouver from seedlings which had been inoculated with root rot and planted in root rot infested soil. Two of these selections are yellow fruited. All selections will be propagated and grown in selection trials and root rot evaluation plantings at Puyallup in 1989.

The data from one harvest for the 1984 and 1985 selection trials was lost as a result of an electronic failure of the data recording device. The missing harvest data was estimated from a weighted mean of preceding and following harvest dates.

The results of cultivar and selection evaluations in the 1984 planted selection trial are given in Table 1. Over the three year period, WSU 908 was the highest yielding and had the latest midpoint of harvest each year. The yield of WSU 892 was comparable to 'Comox' both in 1988 and over the three year period.

The results of the 1985 planted selection trial are given in Table 2. BC 72-1R-7, a selection used in breeding for aphid resistance, was the highest yielding selection in 1988. However, the fruit is small and soft. The highest yielding WSU selections were WSU 933 and WSU 930. Both were late season in 1988 and had large fruit. WSU 933 was judged to have the best fruit appearance for the July 5 harvest.

A replicated planting of 10 Willamette clones was evaluated for the second year in 1988. Eight of these clones are from older commercial fields and two clones are from certified planting stock. There were no significant differences in yield in either 1987 or 1988. There were significant differences for fruit weight and midpoint of harvest in both 1987 and 1988.

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

PROPOSED RESEARCH:

In addition to the emphasis on yield, fruit size, and fruit quality, crosses in 1989 will emphasize aphid resistance and lateral strength. Seedlings from 1988 crosses will be screened for aphid resistance prior to planting at Puyallup and will be available for selection in 1990 and 1991.

Selections made in 1988 will be planted with appropriate cultivars as controls in replicated yield trials and root rot evaluation plantings at Puyallup. Selections in previously established selection trials will be evaluated for yield, fruit weight, firmness, midpoint of harvest, and preharvest rot. Fruit will be evaluated for fresh market and/or processing quality.

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 30, 1991

DURATION OF THIS PROPOSAL: Current project: Terminated 1989
Proposed project: Two years (1989-91)

BUDGET:

		Current 1988-89	Proposed 1989-90
01	Timeslip labor	$4,000	$6,000
03	Supplies and services	2,000	2,800
04	Travel	300	600
07	Benefits (5% of 01)	200	300
	Total	$6,500	$9,700

Table 1. 1986-88 evaluations of 1984 planted raspberry selections at Puyallup.

SELECTION	YIELD (TONS/ACRE) 1986	1987	1988	MEAN	FRUIT ROT (%) 1986	1987	1988	FRUIT WEIGHT (G) 1986	1987	1988	FRUIT FIRMNESS (G) 1986	1987	1988	MIDPOINT OF HARVEST 1986	1987	1988
WSU 908	4.0	9.6	7.8 a	7.1	3.7	0.1	2.1 b	3.7	3.4	3.5 de	125	216	185 a-d	7/12	7/17	7/25 a
WSU 878	4.8	8.5	6.1 a-f	6.5	1.9	0.1	0.1 b	3.5	2.7	2.6 h-n	113	163	160 a-e	7/10	7/12	7/23 a-c
WSU 901	2.8	8.6	6.3 a-e	5.9	7.4	0.3	0.5 b	4.1	5.3	5.0 a	185	222	165 a-e	7/4	7/3	7/12 j-m
WSU 909	3.2	8.0	6.5 a-d	5.9	4.2	0.3	0.8 b	3.6	3.7	3.4 d-f	103	204	178 a-d	7/5	7/8	7/21 a-e
CHILCOTIN	1.3	9.1	6.7 a-c	5.7	10.2	0.2	0.6 b	3.3	3.1	2.9 e-k	81	137	127 de	7/1	7/5	7/15 g-j
WSU 861	3.1	8.9	5.1 b-j	5.7	6.2	0.0	0.1 b	2.7	2.6	2.4 k-n	98	125	125 de	7/4	6/30	7/9 l-n
WSU 863	3.1	7.9	6.1 a-f	5.7	7.8	0.3	1.7 b	2.5	2.6	2.4 k-n	117	154	163 a-e	7/4	7/6	7/17 d-i
WSU 896	3.1	7.8	5.7 a-h	5.5	5.1	0.2	2.5 b	3.3	4.0	4.0 bc	102	175	149 b-e	7/4	7/4	7/17 d-i
WSU 892	3.2	8.1	5.0 b-j	5.4	2.4	0.0	0.4 b	3.6	3.7	3.5 d-f	173	162	190 a-c	7/1	7/2	7/10 l-n
COMOX	2.6	8.4	5.0 b-j	5.3	5.8	0.1	1.0 b	3.7	3.3	3.2 d-g	159	169	168 a-e	7/4	7/4	7/13 i-l
WSU 738	1.1	9.0	5.8 a-h	5.3	4.8	0.1	0.5 b	3.6	3.0	3.1 d-i	95	157	139 c-e	7/6	7/9	7/17 d-i
WSU 895	3.1	7.6	5.2 b-j	5.3	3.4	0.4	5.1 b	2.7	3.1	2.3 l-n	110	153	204 ab	7/4	7/7	7/18 d-i
MEEKER	1.0	8.3	6.4 a-e	5.2	3.7	0.1	1.6 b	2.8	3.2	2.9 f-l	84	148	155 b-e	6/30	7/7	7/19 b-h
WSU 862	2.5	8.6	4.6 c-j	5.2	6.5	0.1	5.0 b	2.9	3.0	2.6 h-n	104	138	158 a-e	7/4	7/10	7/20 a-f
WSU 866	1.9	7.4	6.0 a-f	5.1	5.5	0.0	2.5 b	3.3	4.0	3.1 d-j	112	196	182 a-d	7/1	7/6	7/17 d-i
WSU 902	3.6	7.4	4.3 c-j	5.1	3.8	0.1	0.5 b	3.8	3.3	3.1 d-j	158	245	217 a	7/9	7/10	7/19 b-g
SKEENA	2.4	7.5	4.1 d-j	4.7	5.3	0.1	0.2 b	2.8	3.0	2.6 h-n	112	159	152 b-e	7/1	7/1	7/7 n
CHILLIWACK	2.8	6.9	3.6 f-j	4.4	3.1	0.1	0.4 b	2.9	3.0	2.7 g-m	158	190	161 a-e	7/2	7/2	7/15 g-j
WSU 859	1.6	7.0	3.7 f-j	4.1	5.7	0.0	0.3 b	3.5	2.7	2.3 l-n	98	145	127 de	7/1	7/4	7/15 g-k
WSU 899	2.6	6.2	3.2 i-k	4.0	4.0	0.1	1.5 b	3.1	2.9	2.4 k-n	100	128	153 b-e	7/4	7/5	7/18 d-i
SUMNER	0.5	5.7	5.5 a-i	3.9	6.6	0.0	0.5 b	2.4	2.4	2.1 n	61	109	169 a-e	6/30	7/1	7/16 e-j
WILLAMETTE	0.4	4.7	3.5 h-k	2.9	7.5	0.1	0.2 b	2.5	2.9	2.9 f-l	102	131	112 e	6/28	6/26	7/8 mn
WSU 904		8.3	7.2 ab			0.2	1.0 b		5.3	4.2 b		236	184 a-d		7/9	7/19 b-h
WSU 900		8.8	5.6 a-i			0.0	1.5 b		2.9	2.9 e-k		241	206 ab		7/16	7/24 ab
WSU 857		7.7	6.4 a-e			0.4	2.0 b		3.7	3.6 cd		169	192 a-c		6/25	7/10 k-n
WSU 858		7.9	6.0 a-f			0.1	0.5 b		2.9	2.4 k-n		152	151 b-e		7/1	7/12 j-n
WSU 865		8.2	4.9 b-j			0.0	1.0 b		2.5	2.5 j-n		127	177 a-d		7/8	7/21 a-e
WSU 911		7.9	4.2 c-j			0.1	1.6 b		4.0	3.1 d-j		197	191 a-c		7/13	7/23 a-c
WSU 905		7.4	4.3 c-j			0.0	2.9 b		2.9	2.3 l-n		164	175 a-d		7/8	7/19 b-h
WSU 864		7.0	4.0 e-j			0.0	0.2 b		3.2	2.7 g-m		180	165 a-e		7/9	7/16 e-j
WSU 877		7.7	3.3 h-k			0.0	0.2 b		3.3	3.2 d-h		245	199 a-c		7/18	7/21 a-e
WSU 903		6.7	4.2 c-j			1.6	6.4 b		4.9	3.3 d-g		211	191 a-c		7/7	7/22 a-d
WSU 875		7.3	2.9 jk			0.1	1.7 b		2.6	2.2 mn		125	140 c-e		7/3	7/14 h-l
WSU 884			6.0 a-g				2.3 b			3.1 d-j			167 a-e			7/19 b-g
WSU 883			5.0 b-j				1.0 b			3.0 d-k			190 a-c			7/20 b-g
WSU 881			1.2 k				15.3 a			2.5 i-n			156 a-e			7/18 c-i
MEAN	2.5	7.8	5.0	5.2	5.2	0.2	1.8	3.2	3.3	2.9	116	172	167	7/3	7/6	7/16

WSU 908 = SHRI 6820/41 x WSU 738
WSU 892 = Cherokee x Skeena

Table 2. 1987-88 evaluations of 1985 planted raspberry selections at Puyallup.

SELECTION	YIELD (TONS/ACRE) 1987	1988	MEAN	FRUIT ROT (%) 1987	1988	FRUIT WEIGHT (G) 1987	1988	FRUIT FIRMNESS (G) 1987	1988	MIDPOINT OF HARVEST 1987	1988
BC 72-1R-7	7.9	10.1 a	9.0	0.1	0.9 b-d	2.7	2.8 d-g	121	120	6/24	7/10 cd
WSU 933	8.8	8.3 ab	8.5	0.3	1.5 b-d	3.4	3.5 a-c	119	170	7/5	7/20 a
WSU 930	9.4	7.5 b-d	8.4	0.1	0.4 d	3.5	3.7 a	110	155	7/16	7/22 a
WSU 738	10.8	5.8 b-f	8.3	0.0	0.6 cd	3.7	3.3 a-d	113	171	7/6	7/20 a
WSU 918	7.4	8.1 a-c	7.8	0.1	0.5 d	2.8	3.0 c-f	97	132	7/4	7/19 a
WSU 913	9.0	6.4 b-e	7.7	0.4	2.2 bc	3.0	2.5 fg	133	158	7/7	7/20 a
WSU 915	8.7	6.3 b-e	7.5	0.2	1.2 b-d	2.7	2.9 d-g	105	168	7/7	7/22 a
WSU 923	7.5	7.3 b-d	7.4	0.1	0.2 d	3.6	3.8 a	125	160	6/28	7/8 d
MEEKER	7.5	6.9 b-e	7.2	0.0	0.9 b-d	2.8	2.9 d-g	106	167	7/4	7/19 a
WSU 844	7.2	5.3 c-f	6.3	0.1	0.6 cd	3.1	2.9 d-g	126	148	6/24	7/9 d
SKEENA	7.1	5.4 c-f	6.3	0.2	1.3 b-d	3.2	3.1 b-e	126	172	6/25	7/8 d
WSU 928	8.0	4.4 ef	6.2	0.0	0.2 d	2.9	2.5 fg	151	172	7/11	7/20 a
WSU 914	7.4	4.3 ef	5.8	0.1	0.5 d	3.3	2.9 d-g	150	138	6/26	7/14 b
WILLAMETTE	5.2	4.7 d-f	5.0	0.0	2.4 ab	3.2	2.8 d-g	118	147	6/24	7/12 bc
WSU 924		5.8 b-f			0.8 b-d		2.6 e-g		155		7/11 b-c
SUMNER		5.6 b-f			3.9 a		2.4 g		129		7/10 cd
CHEROKEE		3.4 f			0.8 b-d		3.6 ab		147		7/4 e
MEAN	8.0	6.2	7.2	0.1	1.1	3.1	3.0	121	153	7/2	7/14

WSU 933 = WSU 738 x Haida
WSU 930 = (Newburgh x BC 64-6-68) x Glen Prosen

PROJECT NO.: 13C-3761-5668

TITLE: Development of root rot screening techniques for red raspberry

PERSONNEL: Peter Bristow, Associate Plant Pathologist, WWREC, Puyallup
Patrick Moore, Assistant Horticulturist, WWREC, Puyallup

JUSTIFICATION:

Root rot, caused by Phytophthora erythroseptica and possibly other Phytophthora spp., is a serious problem throughout the red raspberry production areas of the Pacific Northwest. While the fungicide metalaxyl effectively controls this disease, the development of root rot resistant cultivars remains the most promising long term solution to the problem. Genotypes, which have been identified as root rot resistant, are for one reason or another not commercially acceptable. Thus, one of the major objectives of the red raspberry breeding program is to combine root rot resistance with desirable horticultural traits.

Growing seedlings in naturally infested field sites to identify resistant plants is both time consuming and limits the number of seedlings that can be tested. A technique for inoculating seedlings with the pathogen under greenhouse conditions has been used for three seasons. Seedlings surviving this test have been placed out in naturally infested soil at WSU's Research Unit in Vancouver to confirm their resistance and to begin the process of evaluating them for horticultural characteristics. Seedlings from crosses which could yield cultivar quality material have been included in tests each year. In addition, open-pollinated seedlings from different Rubus spp. have been included to identify other potential sources of resistance that may be used in the breeding program.

OBJECTIVES:

1. To develop a rapid, reproducible screening technique for evaluating root rot resistance in raspberry seedlings and plants derived from rooted cuttings.

2. To determine the inheritance of resistance to Phytophthora erythroseptica in red raspberries.

3. Evaluate open pollinated progenies of native and introduced Rubus spp. for potential sources of root rot resistance.

PROPOSED RESEARCH (1988-89):

1. Survivors from the previous seedling inoculation tests which are in field plantings at the WSU Vancouver Research Unit will be evaluated for root rot and horticultural characteristics in 1988. The most promising of these plants will be selected for propagation and advanced testing.

2. The seedling inoculation test will be modified in order to test for root rot resistance in plants derived from rooted cuttings. Plants grown from rooted cuttings of a susceptible (Skeena) and a resistant (Cherokee) cultivar will be used. Age of the rooted cutting (plant size), inoculum concentrations and type of inoculum (mycelium vs. zoospores) will be varied to determine the most satisfactory combination for differentiating resistant and susceptible genotypes.

3. The following additional research is proposed for the coming year. Rooted cutting plants of a susceptible cultivar will be inoculated with the different fungal isolates to determine which ones are capable of causing root rot.

PROGRESS:

Plants which survived the 1986 greenhouse seedling inoculation list were evaluated in 1988 for root rot and horticultural traits. Six plants were selected for propagation and advanced testing in replicated plots at Puyallup. 'Cherokee' was the female parent of four of the plants selected. 'Cherokee' is resistant to root rot, but also has fruit which separates easily from the receptacle. This trait is desirable for mechanical harvesting so selection was not based solely on resistance to root rot. Some seedlings of salmonberry and thimbleberry have not shown symptoms of root rot and may represent a source of resistance different than that found in red raspberry cultivars such as 'Latham' and 'Cherokee'. These two native Rubus species, however, are susceptible to powdery mildew, a foliar disease not found on commercial red raspberry cultivars grown in the Pacific Northwest.

Preliminary evaluation of 100+ isolates of Phytophthora isolated from red raspberries in western Washington and British Columbia suggests that most are similar and may be the same species. Representative isolates were sent to two other laboratories for specialized testing to aid in identification.

We were unable of carrying out items 2 and 3 of the proposed research in 1988. The main difficulty was that the root material available was already infected and clean plants could not be obtained for inoculation tests.

Of the $3,300 allocated by the Commission for this project in 1988-89, $3,138 remains as of September 30, 1988. We request that the grant be extended until March 31, 1990 without additional funds. The balance of the 1988-89 budget will be used to carry out the proposed research outlined in items 2 & 3.

DURATION OF BASE PROJECTS: 0668, expiration June 30, 1989 and 0640, expiration June 30, 1991.

DURATION OF THIS PROPOSAL: 1 year until March 31, 1990.

BUDGET:

	Item	Current 1988-89	Proposed 1989-90
01	Wages	$2,400	$ 0
03	Supplies and Services	420	0
04	Travel	285	0
05	Computing Services	75*	0
07	Benefits	120	0
	Total	$3,300	$ 0

* for 1988-88 (9% of Item 01).

PROJECT NO.: 13C-3761-6688

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. At this time, even short periods of flooding may cause significant injury to roots. 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. Effects of treatment on subsequent cane growth, root development and severity of root rot will be determined.

PROPOSED RESEARCH:

The experiment will be conducted in a covered screenhouse where potted plants will be subjected to ambient air temperatures but soil moisture can be controlled. The experimental protocol will be to start plants of three cultivars (Meeker, Willamette and Sumner) in pots this coming spring (1987) and allow them to produce 1-2 canes per pot. In October we will inoculate the soil in one-half of the pots with the root rot fungus P. erythroseptica. All plants will be allowed to go dormant. Then in January 1988 flooding treatments will start; through the winter at 2-3 week intervals groups of plants will be exposed to soil flooding

to saturate the soil in the pots. The period of saturation will vary up to a maximum of 16 days. Following treatment the pots will be permitted to drain naturally to allow the water content of the soil to return to that of the untreated checks. There will be two types of checks that will not be flooded at any time; a) non-inoculated and b) inoculated.

In the spring and summer of 1988 we expect that certain plants will grow normally compared to the untreated checks, whereas others are likely to grow poorly or to die. Data will be collected on floricane performance, primocane growth and upon termination of the experiment on root development and root rot severity.

PROGRESS:

Disease free tissue culture propagated plants of the three cultivars Willamette, Meeker and Sumner were transplanted in late spring 1987. Each plant was transplanted into steamed soil in a two-gallon plastic pot.

The inoculation (late fall 1987) and flooding (January-April, 1988) treatments were completed as outlined above. Subsequent plant growth was followed through the summer of 1988 at which time the experiment was terminated. All plants were then destructively sampled to determine i) the growth of both primocanes and floricanes, ii) the size of the root system and iii) the severity of root rot. Data on the oven dry weight of canes are still being collected and root systems are still being recovered from soil. The following report must be considered as preliminary because not all of the data has been collected from this large experiment.

Most inoculated plants showed symptoms of root rot by late spring. Symptoms ranged from the wilting of a few primocanes to death of the plant. Generally, cane symptoms were more severe i) the later into the winter the flooding occurred and ii) the longer the soil remained flooded. All three cultivars were susceptible to attack by *Phytophthora erythroseptica*. In June Dr. Scott Cameron took photosynthesis and gas exchange measurements on the test plants. Root rot decreased gas exchange rates.

None of the non-inoculated plants showed symptoms of root rot or any obvious signs of stress when growth resumed in the spring even though some plants had been flooded for 16 days during the winter. Even though the plants were symptomless, flooding did decrease gas exchange rates indicating that flooding has a negative physiological impact. The root system of plants flooded for 16 days was smaller than that of plants not flooded or those flooded for shorter periods.

DURATION OF BASE PROJECT: Project No. 0518, June 30, 1989

DURATION OF THIS PROPOSAL: One year extension of a two year project, until March 31, 1990.

BUDGET:

The 1989-90 request is for funds to complete this project. The 1988-89 request for wages to hire timeslip labor to collect data and wash soil from roots will not cover those costs as both tasks are much more time consuming than anticipated.

	Item	1988-89	1989-90
01	Wages	$1,525.00	$1,475.00
03	Supplies	900.00	100.00
05	Computing Services	50.00*	50.00**
07	Benefits	75.00	175.00
	Total	$2,550.00	$1,800.00

* 9% of Item 01 for 1988-89.
** 12% of Item 01 for 1989-90.

PROJECT NO.: 13C-3555-5956

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

PERSONNEL: J. Scott Cameron, Assistant Horticulturist
Carol A. Hartley, Agricultural Research Technologist II
Washington State University Research and Extension Unit, Vancouver

JUSTIFICATION: Micropropagated plants often have altered phenotypes compared to conventionally-propagated plants. 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 phenotypic stability of these plants remain unanswered. Temporary alterations in phenotype could require new selection strategies for breeders and modified cultural management for growers. To date, there have been no published reports of field performance trials of micropropagated red raspberry plants.

There are also concerns about the genetic integrity of micropropagated plants. Observations of crumbly fruit in the selection WSU 738 after micropropagation is a recent example. It is not known whether the occurrence of this disorder in WSU 738 was a result of using different source plants, differences in handling or environment, differences among clonal lines generated *in vitro*, or a post-cultural predisposition of micropropagated plants to changes in somatic cell genetics. Identifying the source(s) of such variability would be of great value to plant breeders, propagators, and growers in efforts to insure the clonal integrity and uniformity of plants which are used in red raspberry breeding and production.

OBJECTIVES:

1. Phenotypic stability: 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.
2. Genotypic stability: To determine whether clonal lines derived from micropropagation are potential sources of variability in the field performance of micropropagated red raspberry plants.

PROGRESS:

Phenotypic stability: In late spring of 1987, a planting was established at Vancouver which compared micropropated plants (MP) with planting stock derived from micropropagated foundation stock which had been in the field for either one (MP1) or two (MP2) years. The first establishment year was a difficult one for MP plants as hot spring weather and suspected phytotoxicity from a mild Ridomil dip hurt their establishment. These difficulties raise questions concerning potential problems which growers may face when using small, greenhouse-hardened micropropagated plants as planting stock.

In the second establishment year (1988), MP plants were still not as well-established as MP1 and MP2 plants. In general, MP plots had fewer and shorter canes. It is unclear whether or not this is a result of poorer establishment or physiological differences or both. No differences were observed

among MP, MP1 or MP2 plants in individual leaf area or petiole length, however, MP and MP1 plants had greater dry weight per leaf unit area than M2 plants. Greater dry weight accumulation in leaves of MP and MP1 plants may reflect a physiological difference which is not readily explained at this time. Thus, while increased branching (canes per hill and laterals) was observed in MP and MP1 plants in the first establishment year, these differences probably did not result in a significant advantage in growth and establishment in the second year.

Genotypic stability: Delays were experienced in our attempts to micropropagate clonal lines for a spring 1988 planting. The physiological state of propagating material did not allow us to establish healthy cultures of WSU 738 until mid-summer, 1988, and thus has delayed planting until spring of 1989. This will actually be to our advantage as we will have time to establish larger, more hardened plants to plant than we would have had this year - the importance of which has already been demonstrated as described above.

PROPOSED RESEARCH:

Phenotypic stability: In 1989, data will be collected for direct and indirect components of yield in order to understand potential differences in MP plant growth and physiology. 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. For example, if (as has been demonstrated in other micropropagated crops) the "enhanced vigor" of MP plants "fades" after one or two years, there may be little or no advantage to using micropropagated plants for direct field planting; especially if they are more expensive and more difficult to establish than conventional planting stock.

Genotypic stability: In 1989, 5 plants from each of 25 clonal lines established *in vitro* in our lab will be planted in the field at Vancouver as individually staked plants spaced 2.75 m apart. These plants will be observed for uniformity through measurements of vegetative growth and physiological parameters such as photosynthesis/gas exchange. Conventionally-propagated plants will be included in the planting for comparison.

TERMINAL DATE OF BASE PROJECT: June 30, 1990

DURATION OF THIS PROJECT: Third year of a three-year project. We will request an extension of this project next year if the current investment in the project merits another year of evaluation, particularly in the case of the genotypic stability study.

BUDGET: No additional funds are requested for establishing the genotypic stability study, but a budget identical to last year's for maintaining and evaluating both plantings is requested for 1989.

		1988
01	Temporary employees	$2,400
03	Supplies and services	900
05	Computer services	100
07	Benefits (5% of 01)	120
	TOTAL	$3,520

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: Three alternative compounds for caneburning were tested in replicated plots at Vancouver and Mt. Vernon. The 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. Primocane suppression was rated subjectively shortly after treatments were applied. During harvest, yield component analysis was performed in which vegetative measurements and numbers of canes, laterals, flowers, and fruit weight were recorded.

Subjective ratings of primocane suppression at both locations indicated that excellent (equal to or better than dinoseb) primocane control could be obtained with one application of any of the compounds at a number of different rates. Thus, as contact herbicides, there is little question that a single application of one of these materials can adequately control primocane growth.

The most important factor in determining the utility of these materials for commercial use, however, will be their influence on subsequent yields and regrowth. At this time, our analysis of the first year data reveals no treatment differences in yield components at the Mt. Vernon site, a seven-year-old commercial field. At Vancouver, where the experiment was conducted at the WSU research unit, differences *were* observed among the various treatments. A reasonable explanation for different responses at the two sites might be that primocane control has never been practiced in the seven-year-

old planting at Vancouver, while caneburning has been done annually in the seven-year-old commercial field at Mt. Vernon.

At Vancouver, two of the important observations made this year concerned berry weight and primocane heigth after harvest. As can be seen in Figure 1, as the rate of the materials increased, berry weight increased and primocane heighth decreased. This relationship is important as it demonstrates the influence of primocane growth on resource allocation in red raspberry. Primocanes act as competing sinks for the products of photosynthesis, and removal of these sinks through caneburning allows for the allocation of these resources to fruit.

PROPOSED RESEARCH: In 1989, the same experiment will be repeated at both sites in the same plots. The primocane suppression characteristics of each material will be rated, and photosynthesis/gas exchange measurements will be made prior to bloom in order to determine any influence which these herbicides may have on floricane physiology. 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.

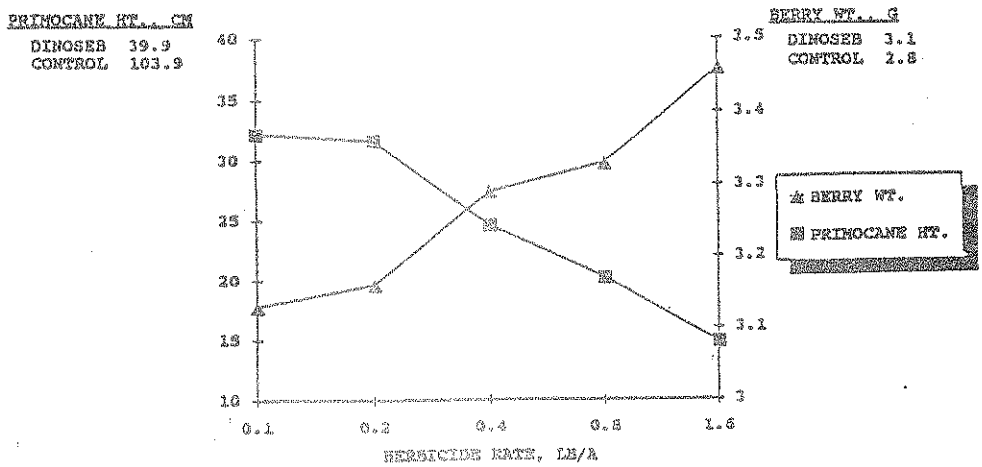
TERMINAL DATE OF BASE PROJECT: 10A-3555-0783, June 30, 1990 (JSC)
10A-3419-0740, June 30, 1989 (SWH)

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

BUDGET:

		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	

FIGURE 1: EFFECT OF PRIMOCANE BURNING ON BERRY WEIGHT AND PRIMOCANE HEIGHT, VANCOUVER CANEBURNING TRIALS, 1988



PROJECT NO.: 13C-3555-5783

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

PERSONNEL: J. Scott Cameron, Assistant Horticulturist
Carol A. Hartley, Research Technologist II
Washington State University Research & Extension Unit, Vancouver

JUSTIFICATION: In tree fruits such as apple and cherry, it is known approximately how many leaves are required to produce a fruit. This information has been extremely useful in developing a scientific approach to canopy design and cultural management. A major goal of this area of research is to understand the mechanics of light penetration so as to maximize photosynthetic potential of the leaves. Many plant species produce more leaf surface area than is required to make fruit. Excess products from photosynthesis not exported into fruit can accumulate as starch in chloroplasts and reduce the photosynthetic efficiency of the leaf. Conversely, when insufficient leaf area is present to supply photoassimilates, fruit will not develop normally or will be smaller in size. 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 while implementing new strategies to increase the efficiency of its culture.

PROGRESS:

Leaf to fruit ratio relationships. Ninety nodes from the upper third of 'Meeker' canes consisting mainly of unexpanded green fruit were chosen in the field, and measurements were taken on these nodes over a period of three days. Variables monitored were rates of carbon assimilation (photosynthesis) in both the trifoliate leaf subtending the fruiting lateral and the unifoliate leaf on the fruiting lateral itself, leaf area at both of these sites, and total fresh weight of fruit at the node. Using techniques of multiple linear regression, and simple and partial correlation analyses, a high degree of correlation was observed between fruit load and total carbon assimilated from both the unifoliate and trifoliate leaves. Using stepwise regression analysis, it was found that of these two carbon sources, total unifoliate carbon assimilation values were more predictive of changes in fruit load. Partial correlations suggested this may be due in large part to changes in carbon assimilation rate per unit leaf area with changes in fruit load. In addition, while the relationship between total carbon assimilation at the unifoliate site and fruit load represents a first order relationship, the relationship between total trifoliate carbon assimilation and fruit load appears to have a higher order component.

Leaf to fruit ratio manipulation. In order to further examine the partitioning of photoassmilates along the cane in response to changes in fruit load relative to leaf area, leaf area per cane was manipulated in 'Amity' canes in the field by removing 1/3 or 2/3 of the total leaf area along 20 canes which contained mainly unexpanded green fruit. Carbon assimilation rates were measured 24 hours later on trifoliate leaves subtending the fruiting lateral. Yield components were also monitored including leaf area per node and per cane, and variables reflecting reproductive productivity including fresh weight of fruit per node and per cane. Statistically significant increases were observed in total carbon assimilated per leaf and carbon assimilation rates per unit leaf area with decreased total leaf area per node and per cane. Preliminary regression analysis suggests an asympototic non-linear relationship between fruit load per node and per cane, and carbon assimilation rates.

In combining the results of these two studies, it can be seen that rates of carbon assimilation (photosynthesis), leaf area, and fresh fruit weight are highly interdependent, particularly when these relationships are examined at the node level. Both 'Meeker' and 'Amity' are able to compensate for

decreases in leaf area relative to fruit load by increasing their carbon assimilation rates over a wide range of leaf to fruit ratios. This implies an ability of these two cultivars to support increased fruit loads at a node by increasing local production of photoassimilates as opposed to recruiting carbohydrates from other photosynthetically active regions of the cane. However, at the low extremes of leaf to fruit ratio which were artificially induced in 'Amity' the asymptotic relationship between fruit load and carbon assimilation rates suggests that there are limits in terms of this cultivar's ability to compensate fully for decreased leaf area below a critical value of leaf to fruit ratio, this value determining the maximum physiological yield potential of this cultivar.

PROPOSED RESEARCH: As a result of studies conducted in 1988 some of the interactions between components of carbon assimilate partitioning within the red raspberry cane have been elucidated. While there appears to be compensation for decreases in leaf to fruit ratio within a node, it is not known to what extent differential light penetration within the canopy in a field situation affects the ability of the photosynthetic machinery within the leaf to respond to increased assimilate demand. Hence, the relationship between ambient photon flux density (light intensity) within the canopy on leaf to fruit ratios, carbon assimilation rates (photosynthesis), and yield will be investigated in a field of 'Meeker' being grown under a modified hedgerow cultural system. Light penetration at different levels within the canopy will be assessed during early stages of fruit development using a LiCor light meter with a quantum point sensor and one meter long quantum probe. In addition, data on leaf area, number of fruit per node, fruit weight per node, fruit size, and carbon assimilation rates will be surveyed along the cane. Using methods of multiple regression and correlation analysis, the effect of shading on relationships within and between nodes will be characterized. Following this characterization of ambient field conditions, leaf area will be manipulated to determine to what extent 'Meeker' is able to compensate at the node level for decreases in leaf area in relation to fruit load under varying degrees of light penetration.

In order to intelligently design a cultural system for increasing the productivity of red raspberry, pruning and trellising practices should be based on a prior knowledge of the interrelationship among variables involved in fruit production. Because of the limiting nature of photon flux density (light intensity) on carbon assimilation rates, and the correlation between photosynthetic rate and fruit load seen in our studies done in 1988, the next logical step is the determination of the extent to which decreased light penetration affects fruit development within the canopy. The information collected from this investigation should prove useful by determining whether light penetration under current cultural practices influences the carbon balance at a node and along the cane, and thus the overall productivity of the raspberry plant.

TERMINAL DATE OF BASE PROJECT: June 30, 1990

DURATION OF THE PROPOSAL: Second year of a proposed three-year project.

BUDGET:

		1988	1989
01	Temporary employees	$1,500	$2000
03	Supplies and services	200	300
05	Computer services	--	100
07	Benefits (5% of 01)	75	100
	TOTAL	$1775	$2500

PROJECT NO.: 13C-3543-7956

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 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: Twospotted spider mite populations were monitored in 20 red raspberry fields from mid-June to early September, 1988. Eight fields developed mite populations in excess of 25 mites/leaflet before September 1. Four of the eight fields were owned by one grower. In general, the fields having or not having mite problems were the same as in 1987, which indicates a cultural practice leading to the problem. The 1988 spray programs had not been obtained at the time of this writing.

Objective 2: Spider mite populations rose to over 90 per leaf on pigweed and to 10 per leaf on lambsquarter. These weeds could act as sources of mites for reinfestation after a field was sprayed.

Raspberry plots with and without a permanent cover crop of white clover were established. Their effect on spider mite populations and mite predators will be observed beginning next year.

Objective 3: Vendex was registered for use on raspberries. Omite was compared with Vendex at 1.8 and 0.5 lb./ai per acre, respectively. They reduced mite number 97 and 91%, respectively, for at least 2 weeks. After 2 weeks, mite numbers dropped 89% in the untreated check, so the effect of the chemicals could not be measured. Samples of fruit from Omite-treated plots were sent to a laboratory for residue analysis.

Objective 4: Raspberry plants in a greenhouse were infested with mites at various times. Measurements of photosynthesis showed a probable correlation of time of infestation and mite numbers with photosynthetic rate.

Objective 5: The objective of this study was to determine and quantify the native phytoseiid species occurring in raspberry and adjacent native vegetation, particularly blackberry. From raspberry fields near Vancouver, Puyallup, and Mount Vernon a total of 506 specimens was collected. Most of these were Amblyseius

fallacis, collected from two fields. Typhlodromus arboreus was fairly common, a few A. andersoni were found, and T. pyri, A. scyphus, and T. rhenanoides were rare. In uncultivated blackberry, 14 phytoseidd species were collected, with T. pyri, T. arboreus, and A. andersoni among the most common. Phytoseiids were generally much more abundant in blackberries than in raspberries. Almost all of the phytoseiids from raspberry were collected from one field, while predators appeared sporadically and at very low densities at the other study sites.

The potential for biological control of various spider mite species by A. fallacis, T. arboreus, A. andersoni, and T. pyri has been suggested by other workers. The main barrier to biological control in raspberries involving predator species seems to be their failure to become established in the fields. The sporadic occurrence of native species in raspberries suggests that some migration from surrounding vegetation does occur, but that low reproduction or survival rates prevent permanent colonization.

PROPOSED RESEARCH:

Spray programs. This part of the program will be as in 1987 and 1988. Selected growers who were willing to participate in this study in 1987 and 1988 will be asked to again allow us to periodically take leaf samples from their fields and to make available to us their spray records. Leaf samples will be collected on a regular schedule during the summer and the mites will be counted. Spray records will be studied for a possible correlation with mite population trends.

Biological control. A study of factors influencing establishment in cultivated raspberries of native and introduced phytoseiid species will be made. This will involve marking predatory mite release sites and after one week, assessing those sites for the presence of phytoseiids and progeny. Relationships between establishment rates and weather, spider mite density, and pesticide applications will be determined. Tentative recommendations on predator release and conservation strategies could then be developed for the conditions unique to western Washington raspberry fields.

Cover crop. Spider mite populations will be compared on plots with and without the clover cover crop. If differences are detected, populations of predators on the raspberry plants and in the clover plots will be measured to determine whether the clover might be harboring predators.

New miticides. Miticides that are registered on other crops, will be tested on red raspberries. Sprays will be applied with equipment similar to that used by growers. Treatments will be replicated and randomized. Mites will be counted just prior to and at intervals after treatment. Berry samples will be collected for residue analysis if necessary.

Effect of mites on photosynthesis and carbohydrate storage. Raspberry plants will be grown in the greenhouse and kept free of mites until use. At various times during the summer, leaves on the primocanes will be infested with twospotted spider mites. Photosynthesis and mite populations will be measured periodically thereafter. Visible leaf condition will be rated subjectively at the end of the growing season. Leaf area and weight per leaf unit area will be measured. Carbohydrate content of the canes will be determined as this is an indicator of the canes' winter hardiness.

TERMINAL DATE OF BASE PROJECT: March 31, 1991

DURATION OF THIS PROPOSAL: 3 Years

BUDGET:

			Current	Proposed
		1987	1988	1989
01	Temporary Employees	$ 5,200	$ 6,000	$6,000
03	Supplies & Services	408	440	200
04	Travel	432	1,000	1,000
07	Employee Benefits (Social Security, etc.; 5% of 01)	260	300	300
	T O T A L	$ 6,300	$ 7,740	$7,500

PROJECTS:\7956f

1. PROJECT NO.: USDA ARS Trust Fund No. 58-91HZ-8-114

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

3. PERSONNEL: R. H. Converse, Research Plant Pathologist, USDA-ARS; and E. Volk, Research Assistant, Oregon State University.

4. JUSTIFICATION: Virus-tested raspberry clones are essential for a raspberry nursery industry based upon certified stock and for healthy commercial raspberry fruit plantings. USDA-ARS maintains a group of virus-indexed clones of most of the currently popular commercial red raspberry cultivars of the Pacific Northwest. These clones are periodically tested for viruses and are vegetatively propagated in screenhouses in small quantities for research workers and for State Departments of Agriculture. Most of these clones come from heat-treated, shoot-apex-propagated sources in this laboratory. New selections from publically supported raspberry breeding programs in the Pacific Northwest, as well as superior clones of standard cultivars are passed through this virus detection, heat therapy, tissue culture and increase program by USDA-ARS as they become available.

   Detection of the viruses in red raspberry is also an area of ongoing research and improvement in this laboratory. Rapid, accurate, comprehensive virus detection methods are essential for the production of virus-tested raspberry clones. In addition to using present standard graft indexing and serological methods for virus detection of viruses already known to occur in the Pacific Northwest, this USDA-ARS lab is exploring new techniques for detection of known viruses and ways to identify viruses new to the region.

5. OBJECTIVES:

   a) Develop virus-tested clones of PNW cultivars and advanced selections through extensive indexing, heat therapy and shoot apex culture, where such clones are needed but not yet available.

   b) Evaluate virus content and conduct heat therapy and shoot apex culture of possibly superior clones of major PNW red raspberry cultivars, as they are recognized and made available for testing.

c) Improve raspberry virus detection methods with respect to accuracy, sensitivity, rapidity, and breadth.

d) Index, maintain, and increase desirable virus-tested raspberry clones for distribution to research workers and to State Departments of Agriculture.

6. PROGRESS:

a) The following heat-treated, meristem-propagated red raspberry cultivars were increased and distributed to requesting research workers and State Departments of Agriculture in 1988; Amity 85M, August Red 85HT, Canby 81M, Chilcotin 86M, Heritage 86M, Meeker 81M, Skeena 79, Willamette 80M, OR-US selections 576-47 (ORUSM 191), 1658 (ORUSM 78), 1835 (ORUSM 37), 2033 (ORUSM 250) and 716-4 and 932-2. Munger 81M black raspberry and 7 blackberry cultivars and 3 ORUS blackberry selections were also similarly increased and distributed.

b) Explants (identified by ORUS selection numbers) that were developed in 1988 in high carbon dioxide therapy and 100 micron shoot-apex tissue culture include: 573-38, 534-10, 680-1, 716-4, 744-2 and 1734.

c) The following red raspberry cultivars and ORUS selections were either placed in the therapy program or are being readied for it: Fall Gold, and ORUS; 932-2, 979-2, 959R-1 and 1472.

Plants of a collection of possibly superior Willamette clones identified by Dr. T. Sjulin at WSU Puyallup are being held in our screenhouse to await horticultural evaluations by Dr. Moore at WSU Puyallup.

d) In addition to the cultivars and selections listed in a) above, the following red raspberry cultivars and selections are being increased in our screenhouse for March 1989 distribution to requesting public agencies and through them to nurseries: Comox 87, Chilliwack 87, Summit 88 (formerly ORUS 2033 ORUSM 250), and ORUS: 1836 (ORUSM 162). 744-2 (ORUSM 288, 289 and 290, one of which will be chosen as best horticultural clone by the USDA ARS plant breeder, Dr. F. J. Lawrence). Distribution of the ORUS selections will, as usual, be at Dr. Lawrence's direction.

e) The survey of viruses in commercial fruiting red raspberry fields in Washington and Oregon is nearing completion. A report of the work to date was submitted Sept. 29, 1988 to the Washington Red Raspberry Commission. In brief, for Washington 11 of 21 fields

tested for known raspberry viruses were infected with one or more viruses (52%). Raspberry bushy dwarf virus and the raspberry mosaic virus complex were the two most common viruses to be detected in this Washington survey. Tomato ringspot virus and tobacco streak virus occurred at lower levels. Although not all data are yet taken on the samples collected, it is already clear from this and previous surveys that commercial Washington red raspberry growers can expect to increase their fruit yield and fruit quality by 1) routine preplant testing for plant parasitic nematodes including the dagger nematode that transmits tomato ringspot virus, followed by preplant fumigation if indicted, and 2) exclusive use of certified plant stock to plant new fields.

7. PROPOSED RESEARCH:

a) Continue the program of heat treatment in high carbon dioxide atmosphere, followed by shoot apex tissue culture and screenhouse propagation and limited distribution of red raspberry cultivars and advanced selections identified by USDA, OSU and WSU Horticulturists as having promise for the PNW commercial red raspberry industry. Continued funding of this work by the Washington Red Raspberry Commission and the Oregon Caneberry Commission is essential to provide the funds for the salary of the Research Assistant (Ms E. Volk) who does the greenhouse, heat therapy, tissue culture and screenhouse phases of this ongoing work.

b) Finish data collection and analysis on the PNW red raspberry virus survey.

c) Continue the work in progress to prepare specific antisera to detect latent infections of Rubus downy mildew, and develop a rapid, sensitive detection procedure for the presence of downy mildew in infected raspberry and blackberry plants with or without definite symptoms. Such a test will make possible the detection and control of this pathogen in nursery stock where it may occur without exhibiting symptoms.

8,9. DURATION OF BASE PROJECT: Ongoing. The time period of this particular proposal is 1989.

10. BUDGET:

Research Assistant, (0.35 FTE)	$6,200
Employee benefits (OPE at 32%)	2,000
Supplies	800
Mandatory OSU 10% overhead on $9,000	900
TOTAL	$9,900

We suggest that this budget be made available to the U.S. Department of Agriculture, Agricultural Research Service for Trust Fund No. 58-91HZ-8-114. As noted above, there is now a mandatory 10% overhead charge by Oregon State University on all funds paid by USDA ARS to OSU for work of the kind specified in this proposal. The continuing ability of this research project to supply virus-tested raspberry stock to industry in the Pacific Northwest rests on the ability of the Washington Raspberry Commission and the Oregon Caneberry Commission to support the technical assistance needed to produce these plants.

1. SIGNATURES:

R H Converse — 10-17-88

R. H. Converse, Project Leader — Date

R G Linderman — 10-17-88

R. G. Linderman, Research Leader — Date
Horticultural Crops Research Unit, USDA-ARS

Stella Coakley — 10-17-88

Stella Coakley, Chairperson — Date
Dept. of Botany and Plant Pathology
Oregon State University

Approved, Washington Red Raspberry Commission — Date

Approved, USDA-ARS — Date
Authorized Departmental Officer

PROJECT NO.: New

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 winter, injury attributed to cold was again detected in some 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.

Cold damage following the early freeze in 1985 and the long, warm autumn of 1987 may be an indication that failure to cold acclimate is, in some years, a limiting factor for red raspberry cultivars grown in Washington. The results of our proposed research would provide information needed to follow 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 red raspberry cultivars.

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.

PROGRESS:

A preliminary test was done in February 1988 to adapt the laboratory freezing technique for use on red raspberry canes. The preliminary test gave us necessary information on sampling methods, and time required to perform laboratory cold hardiness tests on red raspberry. Results of the preliminary test indicated close agreement between visual browning and regrowth methods of sample viability determination and are being used to design the proposed experiment.

PROPOSED RESEARCH:

Standard laboratory freezing techniques will be used to determine the cold hardiness levels of stem and bud tissues from canes collected in the field at Puyallup, Washington. Five commercial cultivars, 'Willamette', 'Meeker', 'Skeena', 'Chilliwack' and 'Comox' will be freeze tested during the late fall, winter and early spring. Cane samples containing at least one bud will be subject to controlled freezing in a Forma Scientific Model 2425 low-temperature bath. Following freezing, tissue viability will be measured by the visual browning method. This information will help to determine the seasonal pattern of cold hardiness and differences in cold hardiness levels of the 5 cultivars tested.

TERMINAL DATE OF BASE PROJECTS:

June 30, 1990
June 30, 1991

DURATION OF THIS PROPOSAL:

1/3 First year of a three-year proposal

BUDGET FOR WINTER OF 1988-1989:

01 Temporary Employees	$2,100
03 Supplies and Services	50
07 Benefits (5% of 01)	105
Total	$2,255

PROJECT NO.: New

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.

PROPOSED RESEARCH:

Plants of cultivars and advanced selections will be planted Spring 1989 by Maberry Packing Inc., Lynden, WA. Cultivars to be included are 'Willamette', 'Meeker', 'Chilliwack', 'Comox' and 'Skeena'. Advanced selections to be included are WSU 892, BC 80-28-50 and BC 80-28-53. Each plot will consist of one post length (30 ft). A gap will be left between plots to clean out the machine. The study will be planted in a randomized block design with three replications for a total of 24 plots.

The plots will be harvested beginning in 1990. The number of canes per hill will be counted prior to harvest. Harvested yield will be recorded for each plot. The weight of a 50 berry sample for each plot will be

determined periodically through the season. After the end of the harvest season, twelve canes per plot will be selected and the number of fruiting sites counted. The potential yield will be estimated from the number of canes per hill, fruiting sites per cane and average berry size. This will be used to estimate the harvesting efficiency.

TERMINAL DATE OF BASE PROJECT: June 30, 1991

DURATION OF THIS PROPOSAL:

Four years, an updated proposal will be written for the third and fourth years.

BUDGET:

		1989-90
03	Goods and services	$140
04	Travel	60
	Total	$200

The costs for 1990-91 are anticipated to be approximately $1000. Expenses will include harvest, data collection, and travel.

PROJECT NO: New

TITLE: Detection of raspberry viruses

PERSONNEL: Robert R. Martin, Agriculture Canada, Research Station, 6660 N.W. Marine Drive, Vancouver, B.C., Canada, V6T 1X2

JUSTIFICATION:

The new material that is being developed in the raspberry breeding programs needs to be virus tested to ensure that the material is virus free.

OBJECTIVES:

Virus testing of breeding material in the breeding programs to ensure that the parent material is free of seed-borne viruses (raspberry bushy dwarf and tomato ringspot viruses). Testing of new cultivars for viruses including raspberry bushy dwarf, tomato ringspot, tobacco streak, and raspberry latent viruses.

PROGRESS:

During the past year we have cloned dsRNA specific for raspberry latent virus (formerly referred to as raspberry leafspot virus). We are developing methods for detecting this virus with these cDNA probes. This development will be finished as part of the funding from the commission last year. Early attempts have given good results, but more work is being carried out to provide a method which can be used routinely. A method for cloning small amounts of dsRNA templates has been developed which will be useful for cloning other viruses that are difficult to purify.

PROPOSED RESEARCH:

The work proposed here is to supplement the breeding programs by testing parent material and progeny for viruses. Virus tests will include ELISA (a sensitive serological method) for detecting RBDV and TomRSV, and cDNA probes for detecting raspberry latent virus. Before a variety can be tested on an equal basis for production potential it must be free of viruses so that a potential variety is not starting at a disadvantage. We will also test the raspberry latent virus probes on a large scale basis so that his test can be made available to any interested parties.

TERMINAL DATE OF BASE PROJECT: January 1, 1992

DURATION OF THIS PROPOSAL: 1/1

BUDGET:	1989/90
03 Goods and Services	500.00
04 Travel	400.00
TOTAL	900.00

1. PROJECT NO.: USDA ARS Trust Fund Agreement No.58-91H2-8-114

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

3. PERSONNEL: Dr. Richard H. Converse, Research Plant Pathologist, USDA, ARS.

4. JUSTIFICATION: This is a special equipment funding request for an automatic ELISA reader ($9,000). Much of the research done by this Project on Washington Red Raspberry Commission funding uses enzyme-linked immunosorbent assay (ELISA). The manual ELISA reader we now have is slow and does not provide computer-usable data. An automatic ELISA reader is needed in order to develop more accurate, computer-sortable data more rapidly than is possible with present equipment. Both the PNW red raspberry virus survey data currently being accumulated, and research now planned on red raspberry virus disease problems of the Pacific Northwest require the acquisition of updated automatic ELISA reader equipment.

5. OBJECTIVES:

a) Purchase a Titertek Multiskan automatic ELISA reader with accompanying software to interface with present IBMPC computer in the lab.

b) Use this equipment for research on the development and use of antisera specific for the detection of viruses causing important diseases of red raspberry in the Pacific Northwest.

6. PROGRESS: This is a new equipment request.

7. PROPOSED RESEARCH: This equipment will be used to improve the quality and the speed of data accumulation and analysis in research on red raspberry virus diseases important in the PNW.

8. DURATION OF BASE PROJECT: The base project is ongoing. This specific request is for one-time purchase of equipment, and should not be substituted for the accompanying, ongoing funding request to the Washington red Raspberry Commission for salary funding to assign a Research Assistant to the development and propagation of virus-tested red raspberry clones for the PNW.

9. BUDGET:

Salary	none
Employee benefits	none
Travel	none
Supplies and equipment	$9,000
Overhead costs	none
TOTAL	$9,000

We suggest that these funds be made available to USDA ARS Trust Fund Agreement No. 58-91H2-8-114.

Signature page for Washington Red Raspberry Commission Proposal

Submitted by:

Richard H. Converse 10/17/88

Richard H. Converse, Res. Pl. Pathologist, USDA ARS date

Approved by:

R.G. Linderman 10/20/88

R.G. Linderman, Res. Ldr. USDA ARS HCRL date

Area Director, USDA ARS date

Project No.: NEW

Title: Introduction and evaluation of a pesticide-resistant mite predator from Europe, *Ambylseius andersoni*, for enhanced spider mite control in red raspberry.

Personnel: Dr. Russell H. Messing and Dr. Brian A. Croft
Dept. of Entomology, Oregon State University
Corvallis, Oregon 97331 Tel: 503-754-2086

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 the 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 predators found in raspberry in Western Oregon and Washington (Table 1), and its resistance to pesticides has been well- documented.

Objectives: 1. determine genetic compatibility of native and European strains of *A. andersoni*.

2. confirm pesticide susceptibility in the native strain and resistance levels in the European strain.

3. analyze pesticide response in the inter-strain hybrids and backcrosses, to determine 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: Colleagues in Europe have documented the resistance of A. andersoni to numerous pesticides, including organophosphates, organochlorines, and carbamates. We have obtained a population of this predator from Switzerland, and are now maintaining it in good condition on a diet of two-spotted mites and pollen in the lab. Preliminary hybridization tests indicates that it readily cross-breeds with the native strain.

Proposed Research: Field research will be supplemented by some critical laboratory experiments. Standard rearing techniques are now being used to maintain both native and European colonies of A. andersoni (and also T. urticae) in the lab. In relation to objectives 1-5:

1. We will perform hybridization tests between the two strains to determine if they are conspecific (thus readily interbreeding) or related but separate species (not interbreeding). Female deutonymphs of each strain will be reared individually with males of the opposite strain, and the number of eggs produced, sex ratio, and egg viability will be examined. Each cross will be replicated 15-20 times, and intra-strain crosses will serve as controls. Female F_1 hybrids will be backcrossed with males of the maternal strain, and F_2 eggs reared in the same way as F_1's.

2. A modified slide-dip technique will measure the toxicity of organophosphate and carbamate insecticides to both strains at various concentrations. Log probit analysis will be used to establish dose response curves.

3. F_1 (hybrid) and F_2 (backcross) mites will also be tested with diagnostic doses of each insecticide. Shifts in dose response curves will be analyzed for evidence of the genetic features of the resistance, which is important in predicting stability of the resistance in the field.

4. Mass-rearing of predator colonies will take place in controlled temperature/photoperiod insectaries. Predators will be released

sequentially at defined rates in selected red raspberry fields, based on histories of spider mite infestation and insecticide usage.

5. Spider mites and predators will be sampled bi-weekly throughout the growing season. Pre- and post-spray samples and further assays will validate stability of resistance in the field, and predator/prey ratios correlated with spider mite infestation levels to examine predator efficacy.

Terminal Date of Base Project: July 31, 1992

Duration of this Project: Proposed for two years.

Schedule:	Objective: 1	2	3	4	5
1989					
spring/summer	X	X			
fall/winter		X	X	X	
1990					
spring/summer				X	X
fall/winter		X			X

Annual Budget:

00	Salaries.....0.2 FTE post-doc	$4600
01	Wages.....$5/hr x 1/2 time x 6 mo.	2600
04	Travel.....10 trips x 200 mi. x $.21/mi	420
06	Equipment ....rearing pans, foam, etc.	100
07	Benefits.....(.26 x 4800.) + (.12 x 2600.)	1560
	Total	$9280

Table 1. Abundance of phytoseiid species found in survey of Willamette Valley, Oreg., by commercial crops

Species	Crop													
	App	Pch	Per	Prn	Chr	Grp	Bkb	Rsb	Stb	Crn	Mnt	Fbt	Xtr	Total
T. pyri	144[a]	16	6	115[a]	32	144[a]	117[a]	31	8	0	0	3	0	616
T. occidentalis	83[a]	8	20	10	63[a]	4	5	7	3	1	6	2	0	212
A. aberrans	1	0	0	1	0	0	0	0	0	0	0	159	0	161
A. andersoni	7	1	2	1	22[a]	3	19[a]	33[a]	8	10	1	0	11	118
T. arboreus	38	0	0	9	0	0	1	0	0	0	0	2	0	50
A. fallacis	1	0	0	0	0	0	0	0	22	7	0	0	0	30
A. brevispinus	0	0	0	0	0	0	0	0	1	2	0	0	0	3
A. reticulatus	0	0	0	0	0	0	0	0	3	0	0	0	0	3
T. rhenanus	0	0	0	0	0	0	0	0	0	0	0	1	0	1
A. nr. zwoelferi	0	0	0	0	0	0	0	0	1	0	0	0	0	1
A. umbraticus	0	0	0	0	0	0	0	0	1	0	0	0	0	1
Unknown	9	1	0	0	0	0	2	0	0	0	0	1	0	13
Totals	283	26	28	136	117	151	144	71	47	20	7	168	11	1,209

App, apple; Pch, peach; Per, pear; Prn, prune-plum; Chr, cherry; Grp, grape; Bkb, blackberry; Rsb, raspberry; Stb, strawberry; Crn, corn; Mnt, mint; Fbt, filbert; Xtr, Christmas tree.

Note: An identical proposal will be given to the Strawberry Commission, as the mite occurs in both crops. We hope to obtain the necessary funding from a combination of sources.