Fruit Varieties Journal 42(1):14-19 1988

Status of Virus-tested *Rubus* Cultivars in the USDA Research Collection

R. H. CONVERSE[1]

Abstract

The status of the *Rubus* cultivars in the USDA Agricultural Research Service research collection at Corvallis, Oregon was evaluated in 1987 with respect to virus and viruslike disease. Thirty-four of 35 blackberry cultivars; 9 of 111 black raspberry cultivars and 44 of 57 red and purple raspberry cultivars were found to be free of recognized virus and viruslike diseases when tested by a combination of sap inoculation, leaf grafting and serology.

In 1981 a list of the virus-tested *Rubus* cultivars in the collection of the United States Department of Agriculture, Agricultural Research Service (USDA ARS) in Corvallis, OR appeared in this Journal (5). Since that time several new *Rubus* cultivars have been added to this collection, and additional heat treatment, shoot-apex culturing (11), and virus indexing have been done on some of the clones listed in the earlier report. Virus and viruslike diseases of *Rubus* mentioned in this report have recently been reviewed (7). The methods used in the present report to detect the virus and viruslike diseases have been described (3, 4, 10).

Selected clones of the cultivars studied were potted in pasteurized soil mix, held deflowered in screened enclosures, and treated periodically with systemic insecticides to reduce the possibilities of infection by nematode-, pollen- and insect-borne virus and viruslike agents. Indexing was done from young, vigorous, triturated leaves by sap inoculation to young *Chenopodium quinoa* Willd. and *Cucumis sativus* L. cv. 'National Pickling' plants using a polyvinylpyrrolidone-phosphate buffer system (10). All clones were also indexed by petiole insert leaflet grafting to vigorously growing plants of *R. occidentali* L. cv. 'Munger' black raspberry, *R. idaeus* L. cvs. 'Malling Landmark' and 'Norfolk Giant' red raspberry (7), and *Fragaria vesca* L. var. *semperflorens* (Duch.) Ser. cv. 'Alpine' strawberry (6). The results of graft indexing to *R. henryi* Hemsl. & Kuntze [an alternative to *R. occidentalis* as an indicator (1)] were retained from earlier studies (5) though *R. henryi* is no longer routinely used in our laboratory. In some cases clones were further evaluated for virus content by use of enzyme-linked immunosorbent assay (ELISA) (3).

The results of the indexings are presented in a series of 3 tables dealing with healthy blackberry, healthy and virus-infected black, red, and purple raspberry. In each table a number or letter immediately following the cultivar name denotes the year in which that virus tested clone was released for commercial use by USDA ARS or (for letters) another releasing organization. The letter H following the year of release number indicates that the clone was subjected to heat therapy at 38°C followed by standard shoot propagation (2); the letter M in that position indicates the clone was developed from a regime of heat therapy at or above 38°C followed by excision and

[1]Research Plant Pathologist, USDA, Agricultural Research Service, Department of Botany and Plant Pathology, Oregon State University, Corvallis, OR 97331. Cooperative research between USDA Agricultural Research Service and the Oregon Agricultural Research Service, Technical Paper No. 8232 of the latter. I acknowledge the excellent assistance of Katherine L. Kowalczyk in growing and indexing these Rubus cultivars.

This project was accomplished through partial funding provided by the Oregon Caneberry Commission and the Washington Raspberry Commission.

Table 1. Blackberry cultivars in the USDA research collection, Department of Botany and Plant Pathology, Oregon State University, Corvallis, OR, January 1987, tested for recognized virus and viruslike diseases on the indicator plants shown.

Cultivar testing free from viruses[b]	Source	Results on indicator plants[a]							Notes[c]
		Cq	Cuc	Mun	Rh	ML	NG	Alp	
Auroroa-65-H	ARS—OSU	OK	OK	OK	OK	OK	OK	OK	E^-
Bailey-65	ARS Beltsv.	OK	OK	OK	NT	OK	OK	OK	
Black Satin-79	ARS Beltsv.	OK	OK	OK	NT	OK	OK	OK	
Boysen-72-M	ARS-OSU	OK	OK	OK	OK	OK	OK	OK	E^-
Brazos-76	TX AES	OK	OK	OK	NT	OK	OK	OK	
Brison-80	TX AES	OK	OK	OK	NT	OK	OK	OK	
Carolina-65	ARS Beltsv.	OK	OK	OK	OK	OK	OK	OK	E^-
Cascade-65	ARS-OSU	OK	OK	OK	OK	OK	OK	OK	
Chehalem-84	OR comm.	OK	OK	OK	NT	OK	OK	OK	E^-, CF
Cherokee-79	ARK AES	OK	OK	OK	NT	OK	OK	OK	
Chester Thornless-86	ILL AES	OK	OK	OK	NT	OK	OK	OK	
Cheyenne-78	ARK AES	OK	OK	OK	NT	OK	OK	OK	
Comanche-75	ARK AES	OK	OK	OK	NT	OK	OK	OK	
Darrow-65	ARS Beltsv.	OK	OK	OK	OK	OK	OK	OK	
Dirksen Thornless-79	ARS Beltsv.	OK	OK	OK	NT	OK	OK	OK	E^-
Early Harvest-78	ILL AES	OK	OK	OK	NT	OK	OK	OK	
Ebony King-78	ILL AES	OK	OK	OK	NT	OK	OK	OK	
Eldorado-65	ARS Beltsv.	OK	OK	OK	OK	OK	OK	OK	
Hull Thornless-81	ARS Beltsv.	OK	OK	OK	NT	OK	OK	OK	
Kotata-86-M	ARS-OSU	OK	OK	OK	NT	OK	OK	OK	
Lucretia-65	ARS Beltsv.	OK	OK	OK	OK	OK	OK	OK	
Marion-81-M	ARS-OSU	OK	OK	OK	NT	OK	OK	OK	E^-
Olallie UCB-M	CAL AES	OK	OK	OK	NT	OK	OK	OK	E^-
Philadelphia-78	W. Germany	OK	OK	OK	NT	OK	OK	OK	
Raven-67	ARS Beltsv.	OK	OK	OK	OK	OK	OK	OK	
Rosborough-80	TX AES	OK	OK	OK	NT	OK	OK	OK	
Santiam-75-H	ARS-OSU	OK	OK	OK	NT	OK	OK	OK	
Shawnee-86	ARK AES	OK	OK	OK	NT	OK	OK	OK	
Smoothstem-66	ARS Beltsv.	OK	OK	OK	OK	OK	OK	OK	
Thornfree-66	ARS Beltsv.	OK	OK	OK	OK	OK	OK	OK	
Thornless Logan AC-M	Ag. Canada	OK	OK	OK	NT	OK	OK	OK	E^-, CF
Thornless Oregon Evergreen-81-M	ARS-OSU	OK	OK	OK	NT	OK	OK	OK	E^-
Womack-80	TX AES	OK	OK	OK	NT	OK	OK	OK	
Young-65	ARS-OSU	OK	OK	OK	OK	OK	OK	OK	
Cultivar testing positive for virus[b]									
Snyder-70	ILL-AES	OK	OK	RM	NO	OK	OK	OK	

[a]Virus detection was attempted by means of mechanical inoculation of buffered (10) sap to Cq (*Chenopodium quinoa* Willd.), cuc (*Cucumis sativus* L. cv 'National Pickling'); leaflet insert grafting into petioles of the following list of indicator plants; Mun, (*Rubus occidentalis* L. cv 'Munger' or 'Munger' op seedlings); Rh (*R. henryi* Hemsl. & Kuntze); ML (*R. idaeus* L. cv 'Malling Landmark'); NG (*R. idaeus* cv 'Norfolk Giant'); and Alp [*Fragaria vesca* L. var. *semperflorens* (Duch.) Ser. cv 'Alpine' seedlings]. OK = symptomless when tested on that indicator plant. NT = not tested.

[b]Numbers following cultivar denote year of release of this tested clone by USDA-ARS, while AC indicates that the clone was released by agriculture Canada and UCB by the University of California, Berkeley. H denotes that the clone was derived from a plant that had undergone heat therapy (38°C for 4 or more weeks) followed by shoot propagation. M denotes that the clone was derived by shoot apex tissue culture and regeneration from a plant that had undergone heat therapy (38°C for 4 or more weeks).

[c]E^- signifies that the clone was evaluated by enzyme-linked immunosorbent assay (ELISA) (3) for one or more of the following viruses (7): raspberry bushy dwarf (RBDV), tobacco streak (TSV), tomato ringspot (TmRSV). Cultivars marked CF were found by field test to be free of calico disease (8).

growth of a small shoot apex in tissue culture (11). No letter following the year of release number indicates that the clone was propagated by standard methods only.

Table 1 lists clones of 34 blackberry cultivars that are free from recognized virus and viruslike agents and one infected blackberry cultivar ('Snyder-70'), based upon the indicated bioassays and serology tests. Several of these clones are derived by selection, heat therapy and/or shoot-apex culture from cultivars previously listed (5) as virus-infected stock. Others are clones of recently released cultivars. The 'Snyder-70' blackberry clone (from Illinois AES) is infected with what is probably a virus of the raspberry mosaic complex (7). Interestingly, this clone, although indexing negative on 'Malling Landmark' and 'Norfolk Giant' red raspberries, indexed positive with necrosis and mottling on Munger black raspberry, making it difficult to classify into the currently recognized members of the raspberry mosaic virus group (7).

Table 2 lists nine black raspberry cultivars that indexed free of recognized virus and viruslike diseases by sap inoculation and leaflet graft indexing to standard indicators, and two black raspberry cultivars that indexed positive for sap- or graft-transmissible agents during indexing and serological testing.

Table 3 lists 44 red and purple raspberry cultivars that indexed negative by sap inoculation and leaflet grafting to the listed indicator plants, and in some instances tested negative by ELISA for raspberry bushy dwarf, tobacco streak and tomato ringspot viruses (7). Nine of these red raspberry cultivars recently released or widely grown on the U.S. Pacific Coast were obtained after heat therapy and shoot-apex culture. Five other cultivars were subjected to heat therapy only, followed by macropropagation. Among these latter, 'August Red-85-H,' 'Fallred-65-H' and 'Latham-62-H' came from source plants that were uniformly infected with black raspberry necrosis virus (7) and were freed of this virus by heat therapy.

Table 2. Blackberry cultivars in the USDA research collection, Department of Botany and Plant Pathology, Oregon State University, Corvallis, OR, January 1987, tested for recognized virus and viruslike diseases on the indicator plants shown.

Cultivar testing free from viruses[b]	Source	Results on indicator plants[a]							Notes[c]
		Cq	Cuc	Mun	Rh	ML	NG	Alp	
Allen-65	NY AES	OK	OK	OK	OK	OK	OK	OK	
Black Hawk-64-H	Iowa AES	OK	OK	OK	OK	OK	OK	OK	
Bristol-69-H	Ohio AES	OK	OK	OK	OK	OK	OK	OK	
Cumberland-69-H	Ohio AES	OK	OK	OK	OK	OK	OK	OK	
Huron-71	NY AES	OK	OK	OK	NT	OK	OK	OK	
Jewel-76	NY AES	OK	OK	OK	NT	OK	OK	OK	
Munger-81-M	ARS-OSU	OK	OK	OK	OK	OK	OK	OK	E^-
New Logan-69-H	Penna comm.	OK	OK	OK	OK	OK	OK	OK	
Plum Farmer-69-H	ARS-OSU	OK	OK	OK	OK	OK	OK	OK	
Cultivars testing positive for viruses[b]									
Allegheny-71	MD AES	LL[d]	M	OK	NT	OK	OK	DW, VC	$RBDV^-$, TSV^+/E
Shuttleworth-64	NY comm.	OK	OK	OK	OK	OK	DS	VB, DS	$RBDV^+$, TSV^-/E

[a,b,c]See Table 1 for explanation of these footnotes. $RBDV^-$ and TSV^+/E indicates the absence and presence of these two viruses, respectively by ELISA.

[d]DS = distortion; DW = dwarf; LL = local lesions; M = mottling; VB = vein banding; VC = vein clearing.

Table 3. Red and purple raspberry cultivars in the USDA research collection, Department of Botany and Plant Pathology, Oregon State University, Corvallis, OR, January 1987, tested for recognized virus and viruslike diseases on the indicator plants listed.

Cultivar testing free from viruses[b]	Source	Results on indicator plants[a]							Notes[c]
		Cq	Cuc	Mum	Rh	ML	NG	Alp	
Amity-85-M	ARS-OSU	OK	OK	OK	NT	OK	OK	OK	E⁻
August Red-85-H	Mich. comm.	OK	OK	OK	NT	OK	OK	OK	E⁻
Boyne-65	Ag. Canada	OK	OK	OK	OK	OK	OK	OK	
Brandywine-80	NY AES	OK	OK	OK	NT	OK	OK	OK	E⁻
Canby-81-M	ARS-OSU	OK	OK	OK	NT	OK	OK	OK	E⁻
Chilcotin-86-M	ARS-OSU	OK	OK	OK	NT	OK	OK	OK	E⁻
Chilliwack-87	WA AES	OK	OK	OK	NT	OK	OK	OK	E⁻
Citadel-66	MD AES	OK	OK	OK	OK	OK	OK	OK	
Clyde-64	NY AES	OK	OK	OK	OK	OK	OK	OK	
Comox-87	WA AES	OK	OK	OK	NT	OK	OK	OK	E⁻
Cuthbert-64	Ag. Canada	OK	OK	OK	OK	OK	OK	OK	
Dormanred-73	Miss. AES	OK	OK	OK	NT	OK	OK	OK	
Durham-61	MN comm.	OK	OK	OK	OK	OK	OK	OK	
Fairview-81-M	ARS-OSU	OK	OK	OK	OK	OK	OK	OK	E⁻
Fallred-65-H	NH AES	OK	OK	OK	OK	OK	OK	OK	
Haida-79	Ag. Canada	OK	OK	OK	NT	OK	OK	OK	
Heritage-86-M	ARS-OSU	OK	OK	OK	NT	OK	OK	OK	E⁻
Indian Summr-65-H	NY comm.	OK	OK	OK	OK	OK	OK	OK	
Latham-62-H	Mich. AES	OK	OK	OK	OK	OK	OK	OK	
Liberty-80	Iowa AES	OK	OK	OK	NT	OK	OK	OK	
Lloyd George	SCRI[d]	OK	OK	OK	NT	OK	OK	OK	
Madawaska-68	Ag. Canada	OK	OK	OK	NT	OK	OK	OK	
Malling Jewel	WA AES	OK	OK	OK	NT	OK	OK	OK	E⁻
Malling Landmark-62	SCRI	OK	OK	OK	OK	OK	OK	OK	E⁻
Meeker-81-M	ARS-OSU	OK	OK	OK	OK	OK	OK	OK	E⁻
Newburgh-61	Ag. Canada	OK	OK	OK	OK	OK	OK	OK	
Nootka-79	Ag. Canada	OK	OK	OK	NT	OK	OK	OK	E⁻
Norfolk Giant	SCRI	OK	OK	OK	OK	OK	OK	OK	
Pathfinder-78	ARS WYO	OK	OK	OK	NT	OK	OK	OK	
Prestige-79	NH AES	OK	OK	OK	NT	OK	OK	OK	
Puyallup-81-M	ARS-OSU	OK	OK	OK	OK	OK	OK	OK	E⁻
Scepter-66	MD AES	OK	OK	OK	OK	OK	OK	OK	
Sentinel-66	MD AES	OK	OK	OK	OK	OK	OK	OK	
Sentry-78-H	MD AES	OK	OK	OK	OK	OK	OK	OK	E⁻
September-64	NY comm.	OK	OK	OK	OK	OK	OK	OK	
Skeena-79	Ag. Canada	OK	OK	OK	NT	OK	OK	OK	E⁻
Southland-79	NC AES	OK	OK	OK	OK	OK	OK	OK	
St. Regis-64	OR comm.	OK	OK	OK	OK	OK	OK	OK	
Success-65	NH AES	OK	OK	OK	OK	OK	OK	OK	E⁻
Sumner-85-M	ARS-OSU	OK	OK	OK	OK	OK	OK	OK	E⁻
Trailblazer-78	ARS Beltsv.	OK	OK	OK	NT	OK	OK	OK	
Viking-78	VT Dept. Ag.	OK	OK	OK	NT	OK	OK	OK	
Washington-62	WA comm.	OK	OK	OK	OK	OK	OK	OK	
Willamette-80-M	ARS-OSU	OK	OK	OK	OK	OK	OK	OK	E⁻

Table 3. (Cont'd)

Cultivar testing positive for viruses[b]	Source	Results on indicator plants[a]							Notes[c]
		Cq	Cuc	Mum	Rh	ML	NG	Alp	
Amber	NY comm.	OK	OK	OK	NT	OK	DS	OK	$RBDV^+$, TSV^-/E
Amethyst-78	Iowa AES	SN[d]	LL	OK	NT	OK	OK	OK	TSV^+, $RBDV^-$/E
Baumforth Seedling A	SCRI	OK	OK	RM	NT	RM	OK	OK	
Baumforth Seedling B	SCRI	OK	OK	RM	NT	RM	M, DS	M	
Fallgold	WA comm.	OK	OK	OK	NT	OK	DS, DW	OK	
Glen Clova	Ag. Canada	OK	OK	OK	NT	OK	OK	OK	TSV^+/E
Hilton-65	NY AES	OK	OK	OK	OK	OK	OK	VC, RS	
Marcy-64	Ag. Canada	YS	OK	OK	OK	OK	OK	OK	$RBDV^+$/E
Milton-63	NY comm.	OK	OK	OK	RM	OK	OK	M, RS	
Miranda-64	Ag. Canada	OK	OK	OK	RM	RM	RM	OK	
Newman-64	ARS Beltsv.	OK	OK	RM	NT	RM	RM	OK	
Reveille-66	MD AES	OK	OK	OK	OK	OK	OK	OK	$RBDV^+$, TSV^+
Trent-65	Mass. comm.	OK	OK	RM	NT	RM	RM	M, DW	

[a,b,c]See Table 1 for explanation of these footnotes.
[d]SCRI = Scottish Crop Research Institute (Dundee, Scotland). SN = systemic necrosis, YS = yellow lear spots, RM = raspberry mosaic symptons (shoot tip necrosis and/or leaf mottling), RS = ringspots and/or oakleaf patterns on leaves.

The 13 red and purple raspberry cultivars listed in the second part of Table 3 all indexed positive for sap- or graft-transmissible agents. 'Amethyst-78' and 'Glen Clova' infected by tobacco streak virus and 'Amber,' 'Marcy-64,' and 'Reveille-66' are infected by raspberry bushy dwarf virus as determined by ELISA. The remaining 8 cultivars appear to be infected with viruses in the raspberry mosaic complex (7) or other unidentified virus or viruslike agents.

As in the previous report (5), *F. vesca semperflorens* cv. 'Alpine' was found in this study to be a useful leaf-graft indicator, exhibiting symptoms in some cases when indicator plants of the various *Rubus* sp. used failed to do so. However, the reactions of graft-infected 'Alpine' were not diagnostic and did not enable us to identify any of the virus or viruslike agents that were found. Currently, many viruses for which specific antisera have been prepared and which infect cultivated *Rubus* in the United States can be rapidly and accurately detected by ELISA, as noted.

Several viruses infecting *Rubus* for which specific antisera are presently lacking have been readily identified by means of the characteristic electrophoretic profiles of their double-stranded ribonucleic acids (dsRNA) (9). In the near future rapid laboratory detection of a number of graft-transmissible agents in *Rubus*, now recognized only by means of time-consuming, relatively insensitive, costly bioassays may become possible by use of dsRNA techniques. Such disease agents include raspberry leaf spot, and possibly raspberry leaf mottle, and *Rubus* yellow net viruses, raspberry vein chlorois virus (7), blackberry calico agents (8), Alpine mosaic agent and other poorly characterized graft-transmissible agents infecting *Rubus* (6).

Propagations of all *Rubus* cultivar clones listed in this report have been

placed in the USDA-ARS Northwest Clonal Germplasm Repository at Oregon State University, Corvallis, OR 97333.

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U.S. POSTAL SERVICE STATEMENT OF OWNERSHIP, MANAGEMENT AND CIRCULATION

Fruit Varieties Journal is owned and published by the American Pomological Society, with publication and business offices located at: 103 Tyson Building, University Park, PA 16802. Frequency of issue: quarterly. Publication number: 0091-3642. Annual subscription price: $12.00. Editor: David C. Ferree, Dept. Horticulture, OARDC, Wooster, Ohio 44691. Business Manager: L. D. Tukey, 103 Tyson Building, University Park, PA 16802.

The average number of copies of each issue printed during the preceding 12 months was 1,100; total paid circulation, 894; total distribution, 894; office use and left over, 206. The actual number of copies of a single issue published nearest to filing date was 1,100; total paid circulation, 932; total distribution, 932; office use and left over, 168.

I certify that the statements made by me above are correct and complete. L. D. Tukey, Business Manager. September 30, 1987.