In conclusion, fertilization termination times and an additional soil fungicide drench did not alter harvest or postharvest characteristics of poinsettias. However, growing poinsettia plants under different temperatures and light levels can greatly influence both growth and postharvest qualities.

Literature Cited

1. Ecke, P., Jr. and O. A. Matkin. 1976. The poinsettia manual.
2. Farnham, R. B. 1936. Results of studies with poinsettias grown in sand. *Flor. Rev.* 78 (2007):19-20.
3. Gartner, J. B. and M. L. McIntyre. 1957. Effect of day length and temperature on time of flowering of *Euphorbia pulcherrima* (poinsettia). *Proc. Amer. Soc. Hort. Sci.* 69:492-497.
4. Hobbs, E. E. and W. E. Waters. 1964. Influence of nitrogen and potassium on susceptibility of *Chrysanthemum morifolium* to *Botrytis cinerea*. *Phytopathology* 54:674-676.
5. Kiplinger, D. C. and H. K. Tayama. 1970. Foliar analysis information for floral crops. *Ohio Florists' Assoc. Bul.* 493:2-9.
6. Leananton, J. H. 1969. Interveinal chlorosis of poinsettias. M. S. Thesis, Univ. Calif., Davis.
7. Leopold, A. C., E. Niedergang-Kamien, and J. Janick. 1959. Experimental modification of plant senescence. *Plant Physiol.* 34:570-573.
8. Marousky, F. J. and J. B. Shanks. 1966. Effects of environmental factors and plant maturity on bract and leaf abscission in *Euphorbia pulcherrima* Willd. *Proc. Amer. Soc. Hort. Sci.* 88:662-670.
9. Shanks, J. B. 1975. Poinsettias and their greenhouse culture. *Maryland Florist* 197:1-31.
10. Smith, T. C. 1960. The effects of varying levels of nitrogen and potassium on the growth, yield, keeping quality, intensity of flower color and foliar composition of *Chrysanthemum morifolium* 'Bluechip'. MS Thesis, Univ. of Florida, Gainesville.
11. Waters, W. E. and S. S. Woltz. 1968. Influence of pre-harvest nitrogen nutrition and postharvest storage conditions on chrysanthemum cut flowers. *Sunshine State Agr.* 13:12-13.
12. Witte, W. T. and H. N. Miller. 1976. Relative susceptibility of poinsettia cultivars to *Botrytis* flower blight. *Florida Flower Grower.* 13:3.

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Breeding for Root Rot Resistance in Red Raspberry[1]

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Additional index words. Rubus idaeus, Phytophthora erythroseptica, heritability, red raspberry decline

Abstract. **Red raspberry (*Rubus idaeus* L.) clones and seedlings were evaluated in infested field soils for resistance to a root rot. Disease symptoms were root necrosis and wilting of first and second year canes. Of 41 clones examined 'Latham', 'Newburgh', 'Durham', 'Chief' and 'WSU 458' were the most resistant. 'Lloyd George' and its derivatives were generally the most susceptible. Evaluation of seedlings from 25 crosses showed that 'Latham' and 'Newburgh' produced the highest percentage of resistant seedlings and the seedlings with the highest level of resistance; 'Glen Clova' and 'Meeker' produced the fewest seedlings with resistance. Heritability estimates based on parent/offspring regression were 0.85 for the percentage of seedlings infected and 0.92 for the mean seedling injury rating.**

Root rot of red raspberry in the Pacific Northwest is characterized by root necrosis and the wilting, beginning in May, of new primocanes (2,3,7). The leaves die but remain attached to the cane. Gray water-soaked lesions at or just below the soil line occur on wilting canes. Very few feeder roots are present and the older roots which support the new canes are necrotic. Although generally more common on heavier and wetter soils it is also found on well drained soils. Converse and Schwartze (4) isolated *Phytophthora erythroseptica* Pethyb. from 'Canby' roots. In greenhouse pathogenicity studies with this fungus 'Canby' plants died, 'Sumner' and 'Washington' plants were weakened and 'Newburgh' plants remained vigorous. In a field inoculation study with *P. erythroseptica* carried out in fumigated soil, symptoms were most severe in 'Canby' and 'Willamette', moderate with 'Sumner' and slight with 'Newburgh' (3). Soil fumigation made it possible to establish red raspberries on root rot infested soils but 1-4 years after fumigation wilting symptoms characteristic of root rot reappeared (7).

In British Columbia high nematode populations have been associated with declining plants on both heavy and light soils (8,9).

The objectives of this study were to screen 41 advanced selections and cultivars (subsequently referred to as clones) and to evaluate seedling populations for resistance to root rot under field conditions.

Materials and Methods

In May, 1972, a planting of 41 clones was established in a field at the Southwestern Washington Research Unit, Vancouver, which had a 20-year history of root rot. Each clone was replicated in 10-30 single hills in a completely random design. Above ground symptoms did not show during the summer of planting but during the second summer beginning in May and continuing into September many primocanes showed wilt symptoms and died. On September 26, 1973 each hill was evaluated on a 0-9 scale with 0 being no primocane wilting symptoms and 9 being death of all canes in a hill. Intermediate ratings were

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based on the proportion of primocanes showing wilting symptoms. Only the most resistant 25 clones were evaluated on August 21, 1974. Ratings were again based on primocane symptoms although many fruiting canes either failed to produce fruiting laterals or during lateral development wilting and death occurred.

In May 1974, at the Southwestern Washington Research Unit 13-15 seedlings from each of 8 crosses and in 1975, 35-40 seedlings from each of 17 crosses were established on root rot-infested soils as individual hills in a completely random design. In each planting 4 or 5 hills of the parent clones were randomly dispersed among the seedlings. The same injury rating scale used for clones was used for the seedlings. Progeny means and parent means for the 1975 planting were used in a parent/offspring regression analysis to determine heritability (1).

Results

For the 41 clones examined in 1973 the percentage of individual hills showing root rot varied from 0 for 'Latham' to 100 for 'Skeena' and the mean root rot rating varied from 0 for 'Latham' to 7 for 'Lloyd George' (Table 1). By 1974, both the percentage of hills showing symptoms and the mean rating had increased substantially but again 'Latham' with 33% of its hills showing symptoms and an injury rating of 0.3 was the most resistant. 'Newburgh', 'Durham', 'Chief' and 'WSU 458' also showed some resistance with injury ratings of 1.5 or less.

Of the 1974 planted seedlings the percentage of seedlings which showed symptoms ranged from 7 for the 'Latham' x 'Haida' cross to 79 for the 'Haida' x 'Glen Clova' cross (Table 2). For the same two crosses the mean injury ratings were 1.1 and 6.2, respectively. When 'Latham', 'Newburgh' and 'Sumner' were each crossed with 'Haida' and 'BC 64-9-81', 'Latham' and 'Newburgh' transmitted a higher level of resistance than 'Sumner'. 'Haida' transmitted more resistance to its seedlings than did 'BC 64-9-81'. 'Canby' and 'Glen Clova' which were extremely susceptible when evaluated as clones produced a high proportion of susceptible seedlings.

In the 1975 planted seedlings the 'Latham' x 'Newburgh' progeny had the lowest % infection, 25, and the lowest mean injury rating, 0.5 (Table 3). When all crosses are considered, 'Latham' as a parent had the lowest percentage of seedlings showing symptoms and the lowest injury ratings, while 'Glen Clova' had the highest percentage of seedlings showing symptoms and the highest mean injury ratings. Seventy selections were made with root rot resistance and desirable horticultural traits.

Heritability estimates were .85 ± .05 for % infection and .92 ± .08 for mean injury rating.

Discussion

The relative susceptibility of 'Newburgh', 'Sumner', 'Washington', 'Willamette' and 'Canby' in this study agree closely with their rankings in greenhouse pathogenicity tests for *P. erythroseptica* (4) and field inoculation studies (3). The present ranking of clones also agrees with commercial field observations in the Pacific Northwest which rank the following clones in order of increasing susceptibility to root rot: 'Newburgh', 'Sumner', 'Puyallup', 'Willamette', 'Washington' and 'Canby' (3). Although *P. erythroseptica* has not been isolated from roots of infected plants in this study the differential cv. reactions plus symptomatology strongly implicate *P. erythroseptica* as the causal agent of the root rot in this study. The original isolation of *P. erythroseptica* was made from a nearby field at the Southwestern Washington Research Unit (4). The wilting of primocanes and ground level lesions were not typical of the British Columbia raspberry decline situation where nematodes were the primary causal agent (9) nor were they symptoms where tomato ringspot virus was the cause of raspberry decline (5).

Table 1. Mean root rot ratings and percentage of hills showing symptoms for 41 red raspberry clones planted in 1972 at Vancouver, Washington and evaluated in 1973 and 1974.

Clone[z]	No. replications	Root rot ratings[y] Sept. 26, 1973 Rating	%	Aug. 21, 1974 Rating	%
Latham	30	0 a[x]	0	0.3 a	33
Newburgh	30	0 a	3	0.8 ab	40
Durham	10	0.1 a	10	1.0 abc	60
Chief	15	0.1 a	13	1.5 abc	27
WSU 458	10	0.2 a	20	0.7 ab	60
Taylor	15	0.2 a	13	1.4 abc	73
Sumner	20	0.6 a	40	1.5 abc	70
WSU 411	15	0.5 a	40	2.1 abcd	73
BC 64-10-198	10	1.5 abc	50	2.4 abcde	90
BC 61-1-122	15	0.3 a	27	2.5 bcde	80
OR-US 1438	15	0.9 abc	47	3.2 cdef	80
WSU 455	15	0.7 ab	40	3.3 cdefg	87
Puyallup	15	1.1 abc	67	3.3 cdefg	87
Cuthbert	15	1.2 abc	40	3.4 cdefg	100
Carnival	15	1.5 abc	40	4.0 defgh	87
BC 64-6-169	10	0.6 a	40	4.4 defghi	70
Haida	15	1.5 abc	60	4.3 efghi	93
WSU 404	30	1.3 abc	43	5.0 fghij	83
Fairview	20	0.6 a	25	5.3 ghij	80
Matsqui	15	0.9 abc	60	6.0 hijk	93
WSU 535	15	0.9 abc	53	6.4 ijk	93
WSU 460	15	0.5 a	13	6.4 ijk	87
WSU 387	15	1.1 abc	53	6.9 jk	93
Glen Esk	10	1.2 abc	50	7.8 k	100
Chilcotin	15	1.7 abcd	53	7.8 k	100
Washington	15	1.3 abc	67		
Rideau	15	2.7 bcde	67		
Meeker	15	2.7 bcde	53		
Madawaska	15	2.8 cde	53		
WSU 553	15	2.9 cde	67		
SHRI 6531/84	15	3.1 cde	67		
WSU 550	13	3.1 cde	53		
Willamette	20	3.5 def	80		
WSU 546	15	4.0 efg	60		
SHRI 6626/41	15	4.2 efgh	67		
SHRI 6531/42	15	4.5 efgh	73		
OR-US 1531	15	4.6 efgh	80		
Canby	30	5.6 ghi	90		
Skeena	15	6.1 hi	100		
Glen Clova	15	6.1 hi	93		
Lloyd George	15	7.0 i	93		

[z]WSU, BC, OR-US and SHRI selections originated from the Washington State University, British Columbia, Oregon State University-USDA and Scottish Horticultural Research Institute breeding programs, respectively.

[y]0-9 rating scale, 0 = no symptoms, 9 = death; % refers to % hills showing symptoms.

[x]Mean separation by Duncan's multiple range test, 5% level.

Table 2. Mean seedling root rot injury rating and percentage of seedlings showing symptoms for 8 red raspberry progenies planted in 1974 at Vancouver, Washington on June 15, 1976.

Seed parents	Pollen parents: Haida Rating[x]	%	BC 64-9-81[z] Rating	%	Canby[y] Rating	%
Latham	1.1 a[w]	7	2.2 a	46	–	–
Newburgh	1.1 a	8	2.5 a	36	4.7 b	73
Sumner	2.7 a	36	5.0 b	69	–	–
Glen Clova[y]	6.2 b	79	–	–	–	–

[z]A 'Creston' x 'Willamette' selection from the British Columbia breeding program.

[y]Reciprocal cross data.

[x]0-9 rating scale, 0 = no symptoms, 9 = death; % refers to % hills showing symptoms.

[w]Mean separation by Duncan's multiple range test, 5% level.

Table 3. Mean seedling root rot ratings and percentage of seedlings showing symptoms for 17 red raspberry progenies planted in 1975 and rated in 1977.

Seed parent	Pollen parent: Newburgh Rating[z]	%	WSU 458[x] Rating	%	WSU 460[x] Rating	%	Glen Clova Rating	%
Latham	0.5 a[y]	25	0.5 a	29	0.5 a	30	1.6 abc	50
Newburgh			1.1 ab	40	2.4 bcd	55	4.4 ef	83
WSU 458[x]					2.9 cd	62	5.1 fg	92
Sumner			2.1 bcd	49	2.9 cd	61	5.2 fg	90
WSU 460[x]							5.8 g	80
Meeker	2.0 bcd	63	2.1 bcd	53	3.2de	73	6.3 g	90

[z]0-9 rating scale, 0 = no symptoms, 9 = death; % refers to % hills showing symptoms.

[y]Mean separation by Duncan's multiple range test, 5% level.

[x]'Newburgh' x 'Sumner' seedlings from the Washington State University breeding program.

Although it is not possible to trace the original source of resistance exhibited by 'Latham', its parent, 'King', was known for its ability to thrive on poorly drained clay soils (6). 'Latham' is the source of resistance found in 'Chief' and 'Sumner'. 'Taylor', a 'Newman' x 'Lloyd George' seedling, probably received its resistance from 'Newman' because 'Lloyd George' is extremely susceptible. 'Newman' originated from mixed open-pollinated seed of 'Herbert', 'King', 'Louden', 'Cuthbert' and 'Eaton' (6). 'WSU 458' may have derived its resistance from both its parents, 'Newburgh' and 'Sumner'.

The high heritability estimates for root rot resistance suggest that considerable additive genetic variance exists and that the mating of parents based on their phenotypes will result in rapid genetic gain.

Literature Cited

1. Bohren, B. B., H. E. McKean and Y. Yamada. 1961. Relative efficiencies of heritability estimates based on regression of offspring on parent. *Biometrics* 17:481-491.
2. Bristow, P. R. 1977. Some observations on a root rot of red raspberry. *Proc. West. Wash. Hort. Assoc.* 67:120-122.
3. Converse, R. H. 1973. Tomato ringsport virus and *Phytophthora* root rot in relation to decline disease in red raspberry. *Proc. West. Wash. Hort. Assoc.* 63:156-159.
4. Converse, R. H. and C. D. Schwartze. 1968. A root rot of red raspberry caused by *Phytophthora erythroseptica*. *Phytopathology* 58:56-59.
5. Freeman, J. A., R. Stace-Smith and H. A. Daubeny. 1975. Effects of tomato ringspot virus on the growth and yield of red raspberry. *Can. J. Plant Sci.* 55:749-754.
6. Hedrick, U. P. 1925. The Small Fruits of New York. Rpt. N.Y. State Agricultural Expt. Sta. for 1925.
7. Johnson, F., P. C. Crandall and J. R. Fisher. 1972. Soil fumigation and its effect on raspberry root rot. *Plant Dis. Rptr.* 56:467-470.
8. McElroy, F. D. 1973. Nematodes and red raspberry decline. *Proc. West. Wash. Hort. Assoc.* 63:160-161.
9. McElroy, F. D. 1977. Effect of two nematode species on establishment, growth and yield of raspberry. *Plant Dis. Rptr.* 61:277-279.

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Variation in Stability of Cytoplasmic-genic Male Sterility in *Capsicum annuum* L.[1]

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Additional index words. cytoplasmic male sterility, hybrid seeds, pepper

Abstract. **Several cytoplasmic-genic male-sterile (partially fertile) cultivars were developed in pepper. Three cultivars demonstrated different levels of male sterility; male sterility stability of 'Bikura' was reliable for hybrid seed production.**

Cytoplasmic-genic male sterility in *Capsicum annuum* was originally documented by Peterson (6). Inheritance was suggested primarily due to a single recessive gene interracting with S-type cytoplasm. In his material, Peterson demonstrated variation in anther morphology and in production of pollen grains which could be related to the different cultivars used in the crosses. In addition, the character was found to be highly sensitive to fluctuating growth conditions, particularly temperatures. Novak et al. (5), working with Peterson's source of male sterility and broader genetic material, found digenic inheritance; they also noted variable degrees of sterility from complete male-sterility to partial fertility. According to Pochard (7), Novak (5), Hirose (3) and Horner (4), abnormal development in Peterson's source of male sterility occurs in premeiotic stages, but the final breakdown stage is postmeiotic. Shifriss and Frankel (8) found S-type cytoplasm following intraspecific crosses in *C. annuum,* probably identical to that found by Peterson (6). Since these previous studies indicated lack of stability of cytoplasmic genic male sterility, the character was not utilized in breeding F_1 hybrids, while genic male sterility is already in commercial use (2). The present paper reports variation in level of male sterility among and within male sterile cultivars and its bearing on future F_1 seed production, utilizing cytoplasmic-

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