Effects of Prunus Ringspot Virus on Growth and Productivity of Richards Early Italian Prune Trees

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Published with the approval of the Director Idaho Agricultural Experiment Station as Research Paper No. 74:71.
Accepted for publication 9 April 1974.

ABSTRACT

Virus-free prune trees growing on eight different rootstocks were infected during their second year with four PRSV (*Prunus* ringspot virus) strains of differing virulence. The results indicated that: i) PRSV infection tends to stimulate growth of Richards trees (*P. domestica*), both in trunk size and tree height, but increases in one category do not occur at the expense of the other; ii) fruit yields tend to be enhanced by PRSV infection in general and by mild-strain infection in particular, and production on the commonly used peach and plum rootstocks is significantly enhanced; iii) effects of a given PRSV strain are influenced markedly by rootstock and tree age; and iv) fruit casting is not correlated with production of marketable fruits.

Phytopathology 64:1179-1181

Additional key words: Prunus domestica, PRSV, fruit yields, fruit casting, rootstocks.

Prunus ringspot virus (PRSV) is virtually omnipresent in stonefruit orchards. There are many recognizable strains, of varying severity, but characteristic symptoms generally are not evident following initial invasion of the host. In order to measure the more subtle effects of strains of differing virulence on prune (*P. domestica* L. 'Richards Early Italian'), 2-yr-old trees on various rootstocks were inoculated with strains representative of the spectrum of PRSV severity as it is found in Idaho and the infected trees observed for 8 yr.

MATERIALS AND METHODS.—Virus-free budwood of Richards Early Italian prune was used to produce trees on Bessey Cherry (Western Sand Cherry; *P. besseyi* Bailey), Bitter Almond (*P. amygdalus* Batsch), Bush Cherry (*P. tomentosa* Thunb.), the California selection (CEA-2) and the Washington selection (Myro-100) of Myrobalan plum (*P. cerasifera* Ehrh.), Lovell peach (*P. persica* L. Batsch), Sand Cherry (*P. pumila* L.), and Tilton apricot (*P. armeniaca* L.) rootstocks. Eighty trees on each rootstock were randomly arranged with respect to rootstock, and five treatments (controls and four PRSV strains) were randomly arranged with respect to each other in each rootstock-group. PRSV cultures used were of mild (Idaho code PI-11), moderate (PI-15), or severe (PI-19) virulence. This classification is based on their effects on squash (*Cucurbita maxima* L., 'Buttercup') plants in a greenhouse, peach (*P. persica* L. Batsch 'Lovell' and 'Muir') seedlings in a greenhouse and in a field plot, Shirofugen flowering cherry (*P. serrulata* Lindl.) trees, and standard Italian prune (*P. domestica* L.) trees. The fourth PRSV culture (PI-108) was a field-run strain from standard Italian prune characterized by severe chlorotic ringspotting in the foliage of Italian trees following initial infection.

Trees remained unpruned and unirrigated (dry-land growth conditions of the Moscow area) throughout the study.

Annual measurements of trunk diam (at a painted reference ring) and tree height were recorded, and the numbers of fruits matured on the tree and the number cast were counted. Fruit weights were obtained during the final year of the study, but since no significant differences in individual fruit size were found, yields and casting are represented in Tables 1 and 2 by fruit numbers. Table 1 presents data only for those rootstocks for which significant differences were found in one or more of the four measurement categories.

All trees were re-indexed on Shirofugen for PRSV during the final year of the study; controls were negative and inoculated trees were positive in all cases.

RESULTS AND DISCUSSION.—No significant differences in trunk diam were observed after four years, but virus strain PI-11 was associated with larger trunk diam for trees on all rootstocks except Bitter Almond and Bessey Cherry. After 8 yr, all infected trees on Bitter Almond were larger than the controls (Table 1), which suggests that PRSV is stimulatory to trunk expansion on that rootstock, whatever the infecting strain. Also after 8 yr, trees on Bush Cherry infected with PI-19 were larger than trees in all other treatments, indicating that while other test strains showed no such effect on Bush Cherry, PI-19 was stimulatory to trunk expansion on that root. Taken collectively, these results suggest that PRSV infection tends to stimulate trunk expansion rates, that effects of a given virus strain are strongly influenced by rootstock, and that generalized conclusions regarding behavior of infected cultivars cannot be reliable without due consideration being given to the rootstock.

No significant differences in tree ht were observed after 4 yr, but PI-11 was associated with largest trees on CEA-2 plum and Lovell peach rootstocks (Table 1). After 8 yr, all infected trees on Bitter Almond and Bush Cherry were taller than control trees. When this effect is compared with effects on trunk diam, it seems that trunk-expansion is not accelerated at the expense of vertical growth on these rootstocks and therefore PRSV must be stimulatory to growth in general on these roots. Also after 8 yr, PI-19 was responsible for significantly less vertical growth of trees on Myro-100 plum, than occurred in trees of other treatments on that root. This growth-suppression effect is directly opposite to the effect of PI-19 on trunk diam in trees growing on Bush Cherry, which shows that performance of infected trees on a given rootstock is determined as much by rootstock as by virus strain.

Greater fruit production after 4 yr was observed on control trees than on infected trees growing on Bessey Cherry, CEA-2 plum, and Bush Cherry, with most fruit production occurring on PI-11 trees on Tilton root, but

TABLE 1. Effects of four Prunus ringspot virus (PRSV) strains on growth and productivity of Richards Early Italian prune trees growing on eight rootstocks[a]

Rootstock[b]	PRSV strain	Growth		Productivity	
		Trunk diam (cm)[c]	Tree ht (m)	Fruits matured on tree[d] (no.)	Fruits cast (no.)
		After four years			
CEA-2 Plum	Control	7.9 x	3.8 x	200.7 x	19.2 y
	PI-11	8.1 x	3.9 x	195.0 x	27.2 x
	PI-15	8.0 x	3.8 x	131.5 y	12.5 y
	PI-19	7.8 x	3.8 x	161.7 xy	19.2 y
	PI-108	7.7 x	3.8 x	142.5 xy	16.0 y
Lovell Peach	Control	7.7 x	3.7 x	190.2 x	13.5 y
	PI-11	7.9 x	3.8 x	210.2 x	22.2 x
	PI-15	7.7 x	3.7 x	143.5 yz	19.5 xy
	PI-19	7.8 x	3.7 x	168.2 xy	16.2 xy
	PI-108	7.4 x	3.7 x	95.0 z	11.7 y
		After eight years			
Bitter Almond	Control	8.4 y	2.7 y	116.8 x	62.9 x
	PI-11	12.3 x	3.8 x	178.7 x	79.9 x
	PI-15	11.3 x	3.8 x	240.0 x	56.9 x
	PI-19	11.9 x	3.9 x	96.5 x	64.2 x
	PI-108	12.1 x	3.9 x	197.4 x	58.8 x
Bush Cherry	Control	8.2 y	2.3 y	216.2 y	56.7 x
	PI-11	9.3 xy	2.5 x	373.2 xy	65.5 x
	PI-15	9.3 xy	2.8 x	387.7 xy	59.0 x
	PI-19	10.2 x	3.0 x	630.7 x	76.0 x
	PI-108	9.4 xy	2.6 x	498.7 xy	71.0 x
CEA-2 Plum	Control	13.7 x	4.1 x	444.2 y	105.7 x
	PI-11	14.1 x	4.3 x	614.7 x	118.7 x
	PI-15	13.8 x	4.2 x	568.7 x	97.5 x
	PI-19	14.2 x	4.1 x	817.7 x	108.7 x
	PI-108	14.3 x	4.4 x	795.5 x	108.5 x
Lovell	PeachControl	13.2 x	4.4 x	273.0 y	114.2 x
	PI-11	13.4 x	4.2 x	765.7 x	121.7 x
	PI-15	13.2 x	4.0 x	773.2 x	102.7 x
	PI-19	13.5 x	4.1 x	895.5 x	119.0 x
	PI-108	13.4 x	4.1 x	722.7 x	112.2 x
Myro-100 Plum	Control	12.6 x	4.1 x	190.0 y	78.2 x
	PI-11	12.7 x	3.8 xy	589.7 x	71.5 x
	PI-15	12.8 x	3.9 xy	711.5 x	66.7 x
	PI-19	12.1 x	3.5 y	641.5 x	73.7 x
	PI-108	12.5 x	3.7 xy	688.5 x	67.2 x

[a]Virus-free trees bud-graft infected in the spring of their second year, 16 trees in each rootstock/strain combination randomized among four randomized blocks; mild (PI-11), moderate (PI-15), and severe (PI-19) PRSV strains classified according to effects on squash, peach seedlings, Shirofugen flowering cherry, and standard Italian prune; severe field-run strain (PI-108) included because of strong symptoms in Shirofugen and standard Italian. Values represent the averages for 16 trees. Following letters indicate significant differences within columns ($P = 0.05$) determined via Duncan's multiple range test.

[b]Data presented only for those rootstocks showing significant differences in growth or productivity.

[c]Average of two diam measurements/tree, taken 90° apart at a painted reference mark.

[d]Fruits were weighed in the eighth year, but since no significant differences in individual fruit weights were found these data are not presented.

these differences were not significant. Infection generally reduced production significantly for trees on CEA-2 plum and Lovell peach, and on Lovell the severe field-run strain (PI-108) caused a significantly greater reduction than other strains except PI-15 (Table 1). Larger-than-control yields were observed only in PI-11 trees on Lovell peach, Tilton apricot, and Sand Cherry, but these differences were not significant. After 8 yr, all infected trees on Lovell, CEA-2 plum, and Myro-100 plum were producing 1.5 to 4.0 times as many fruits as corresponding control trees, which clearly shows that yield was better in trees on the standard peach and plum roots when the trees were infected. Also after 8 yr, trees on Sand Cherry produced best when infected with PI-11; this production was greater than for all other treatments. Production on PI-11 trees on Bessey Cherry was numerically greater than for trees of other treatments. Taken collectively, these data show that yields tend to be enhanced by PRSV infection in general, and by PI-11 in particular.

Significant differences among treatments in fruit casting were common after 4 yr but occurred without any real pattern except for the fact that the mild strain (PI-11)

TABLE 2. Summary of effects of Prunus ringspot virus (PRSV) on growth and productivity of Richards Early Italian prune trees growing on various rootstocks after 8 yr[a]

Rootstock[b]	Treatment	Growth		Productivity	
		Trunk diam (cm)[c]	Tree ht (m)	Fruits matured on tree (no.)	Fruits cast (no.)
Bitter Almond	Control	8.4 x	2.7 x	116.8 x	62.9 x
	PRSV	11.9 y	3.9 y	178.2 x	65.0 x
Bush Cherry	Control	8.2 x	2.3 x	216.2 x	56.7 x
	PRSV	9.6 x	2.7 x	472.6 y	68.4 x
CEA-2 Plum	Control	13.7 x	4.1 x	444.2 x	105.7 x
	PRSV	14.1 x	4.3 x	699.2 y	108.4 x
Lovell Peach	Control	13.2 x	4.4 x	273.0 x	114.2 x
	PRSV	13.4 x	4.1 x	789.3 y	113.9 x
Myro-100 Plum	Control	12.6 x	4.1 x	190.0 x	78.2 x
	PRSV	12.5 x	3.7 x	657.8 y	69.8 x

[a]PRSV figures represent the averages of the four virus strains PI-11, PI-15, PI-19 and PI-108. Following letters indicate significant differences within columns ($P = 0.05$) determined via Duncan's multiple range test. Data not shown for the 4-yr interval because no significant differences were apparent at that time for any measurement-category.

[b]Data presented only for those rootstocks showing significant differences in one or more measurement categories.

was associated with highest numbers of fruits cast in most cases (Table 1). Fluctuations in fruit casting did not match fluctuations in production-on-the-tree except for trees on Tilton apricot, where fluctuations in casting paralleled those of fruit maturation. (Four-year data for Tilton are not presented in Table 1 because significant differences were not observed on growth or production-on-the-tree. Bessey Cherry and Bush Cherry also failed to produce significant differences at the 4-yr interval except in fruit-casting, and are omitted from the 4-yr presentation in Table 1. For Bessey Cherry, PI-15 trees cast significantly fewer fruits than the controls or PI-11 trees, but not PI-19 or PI-108 trees. For Bush Cherry, PI-11 trees cast more fruits than trees of all other treatments, but other treatments were not significantly different from each other.) After 8 yr, no significant differences were found in numbers of fruits cast among treatments for a given rootstock, again showing no correlation with production-on-the-tree, and suggesting that fruit casting, particularly in very young trees, provides no indication of performance to be expected at maturity.

When virus effects were pooled and compared collectively with controls (Table 2), no significant differences were found for any data category after 4 yr. After 8 yr, significant differences between trunk-expansion rates for infected and healthy trees were found for trees growing on Bitter Almond, and in that case infected trees grew more rapidly than control trees. This was true also for tree ht, again a definite growth stimulation.

Significant differences in fruit production were found (8 yr) for trees on CEA-2 plum, Myro-100 plum, Lovell peach, and Bush Cherry; i.e. even when virus data were pooled, infected trees still obviously produced from 1.5 to 4.0 times as many fruits as noninfected control trees (Table 2). Production was greater (not statistically significant) in the infected trees on all other rootstocks except Bessey Cherry. Obviously, PRSV improves production of Richards Early Italian prune trees, at least at the age of 8 yr.

No significant differences in fruit casting were found after 8 yr, and even the numerical differences were small in all cases. Again, casting appears to be unrelated to production of harvestable fruits.

For the conditions of the study, the following conclusions are in order: i) PRSV infection tends to stimulate trunk expansion rates for Richards Early Italian prune trees, and the effects of a given virus strain are markedly influenced by rootstock. ii) When the rootstock is Bitter Almond, PRSV infection consistently produces trees that are larger (trunk diam and tree ht) than uninfected control trees, which demonstrates that PRSV stimulation of trunk-expansion does not occur at the expense of tree ht or vice versa. iii) Depending on rootstock and tree age, PRSV infection can reduce or enhance production of Richards trees. iv) After 8 yr, yields tend to be enhanced by PRSV infection in general and by mild-strain infection (PI-11) in particular, and production on the commonly used peach and plum rootstocks is significantly enhanced. v) Mild PRSV infection (as exemplified by PI-11) tends to increase fruit casting as well as production-on-the-tree, which demonstrates that PRSV-induced increases in fruit drop do not occur at the expense of fruit production or vice versa. vi) Fruit casting, particularly in young trees, is not correlated with production of harvestable fruits, nor is it an indicator of production performance to be expected at maturity. vii) Averaging (pooling) of virus effects eliminates significant differences in all four measurement categories for young trees (4 yr) but not for older trees (8 yr); i.e., differences in the four measurement categories tend to be larger in older trees. viii) Generally speaking, PRSV infection tends to improve both growth and production of 8-yr-old Richards Early Italian prune trees, and since production on the commonly used peach and plum roots was 1.5 to 4.0 times as great as on uninfected control trees, it is evident that PRSV is not necessarily a bad thing for the orchardist, at least within the first 8 yr, and recent expenditures of state and federal funds for control of PRSV may not be justifiable in all cases.