Effect of Cultivar and Rootstock on Incidence of Viral and Nonviral Symptoms in PRSV-Infected Prunus domestica

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ABSTRACT

Virus-free Richards Early Italian and standard Italian prune (*Prunus domestica*) trees growing on various rootstocks were infected in their second year with PRSV (*Prunus* ringspot virus) isolates of differing severity and observed through their sixth year for PRSV and other symptoms. Incidence of nonvirus symptoms (primarily leafspot-complex and fruit-gummosis) varied with rootstock and season. A mild PRSV strain seldom induced symptoms, but other isolates produced characteristic symptoms in most scion/root combinations. Incidence of PRSV symptoms was greatest the year following inoculation with typical latency ensuing thereafter. No general correlation was observed in the incidence of leafspot-complex, fruit-gummosis, and PRSV symptoms, nor of PRSV infection with rootstock-suckering or wind-resistance. The various conditions under study generally were more severe in Richards trees than in standard Italian trees. With all factors considered, the best trees for both varieties were produced on the CEA-2 Myrobalan plum (*P. cerasifera*) rootstock.

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Additional key words: genetic disorders, compatibility, PRSV incubation, leaf-curl, gum-spotting, leafspot-complex, wind-resistance.

Prunus ringspot virus commonly produces chlorotic rings and spots in the foliage of Italian prune trees (*P. domestica* L.) shortly after invasion then assumes a latent condition in which virus effects are less obvious (2); detection of virus presence thereafter requires use of suitable indicator plants (5, 6). Italian prune trees also are commonly affected by various abnormalities which are nontransmissible with standard grafting procedures used to transfer stem-invading viruses such as PRSV (*Prunus* ringspot virus) (3, 4). Symptomatology and interrelationships of the viral and nonviral conditions have not previously been defined.

MATERIALS AND METHODS.—Richards Early Italian (*P. domestica* L.) and standard Italian (*P. domestica* L.) prune trees were selected as the test cultivars. In cooperation with personnel of the Washington Agricultural Experiment Station, virus-free budwood of both varieties was used to produce trees on the following six rootstocks: Bitter Almond (*P. amygdalus* Batsch.), the California selection CEA-2 and the Washington selection Myro-100 of Myrobalan plum (*P. cerasifera* Ehrh.), Lovell peach (*P. persica* L. Batsch), Tilton apricot (*P. armeniaca* L.), and Bush Cherry (*P. tomentosa* Thunb.). In addition, Richards trees were produced on Bessey Cherry (Western Sand Cherry; *P. besseyi* Bailey) and Sand Cherry (*P. pumila* L.), and standard Italian prune trees were produced on Chickasaw plum (*P. angustifolia* Marsh), Hortulan plum (*P. hortulana* Bailey), Blackthorn (*P. spinosa* L.), and St. Julian-A plum (*P. insititia* L. Bullace). European Bird Cherry (*P. padus* L.) was tried for both cultivars, but all trees died during the first two years.

During their first year, all trees were indexed on Shirofugen flowering cherry (*P. serrulata* Lindl.) to verify their freedom from PRSV infection. During the second year, all trees were bud-grafted using three buds infected with the appropriate PRSV strain for those to be infected, or three virus-free buds for the controls. Year two therefore is the first year for which data are recorded.

Eighty trees of each cultivar on each rootstock were randomly arranged with respect to rootstock in each of four randomly arranged blocks. Treatments (control and four virus strains) were randomly arranged with respect to each other within scion/stock combinations in each block for each cultivar. This resulted in 16 trees for each cultivar/rootstock/treatment combination.

PRSV cultures used were mild (Idaho code PI-11), moderate (PI-15), or severe (PI-19) and were so classed according to overall effects on Buttercup squash (*Cucurbita maxima* L.) plants in a greenhouse, Lovell and Muir peach (*P. persica* L. Batsch) seedlings in a greenhouse and in a field plot, Shirofugen flowering

cherry trees, and standard Italian prune trees of various age. The fourth PRSV culture used (PI-108) was a field-run strain from standard Italian prune characterized by severe chlorotic ringspotting in the foliage following initial invasion.

Symptoms of virus infection were recorded for those trees showing chlorotic ringspotting and chlorotic mottling characteristic of PRSV infection of Italian prune (2, 6) prior to establishment of the latent (nonsymptomatic) condition. Symptoms of the leafspot-complex condition were recorded for those trees showing any one of the several previously defined (3, 4) chlorotic-to-necrotic spotting conditions which are bud-perpetuated but nontransmissible. Principal components of the leafspot-complex which developed during the study were bulls-eye, random-brown, random-black, mottle, and yellow-leaf symptoms, occurring individually or in combinations. The frequently associated fruit-gummosis (gum-spotting) condition in which globules or tendrils of gum are extruded from depressed necrotic spots in the fruit surface was recorded separately. This symptom has been associated with various stress conditions in prune trees in Idaho, including the leafspot-complex. A green-leaf-curl condition sometimes is associated with it also, but will be treated separately in the Results section.

Other information such as tree survival, tendency of the rootstock to sucker, and wind resistance were recorded as well. Suckers were removed each year in September; the recorded information on suckering therefore reflects suckering activity during each separate year of the study.

A severe westerly wind struck the plot in the spring of the second year, affording an opportunity to evaluate the sturdiness of each scion/root combination in terms of permanent displacement from the vertical. The sixth year of the study proved to be an extremely severe fruit-gummosis year, and afforded an opportunity to evaluate all scion/stock combinations under severe test conditions for that disorder.

RESULTS AND DISCUSSION.—*Wind tipping.*—The wind-tipping observations indicate that sturdiest trees for both cultivars were obtained on Bitter Almond, CEA-2 plum, and Myro-100 plum rootstocks. Equally sturdy standard Italian trees were produced on Tilton root, but Richards trees on that root remained mildly tipped (1-5 degrees from the vertical). Both cultivars remained mildly tipped on Lovell peach, and standard trees were mildly tipped also on Blackthorn, Bush Cherry, Hortulan plum, and St. Julian-A plum. Moderate tipping (6-15 degrees) of Richards trees occurred on Bush Cherry and Sand Cherry, and for standard trees on Chickasaw plum. No severe tipping (16-25 degrees) of standard trees was observed, but Richards trees on Bessey Cherry remained severely tipped. The commonly used peach rootstocks (Lovell) were not severely affected by the wind, but were less resistant to it than the Myrobalan plum rootstocks that also are frequently used, which indicates that the plum roots would be a better choice for orchards located in exposed sites. These results support the evidence of Parry and Rogers (7) which showed that anchorage of apple trees is governed by rootstock.

Tree survival.—Tree losses generally occurred in the first two years and seemed to be associated with compatibility problems. From the standpoint of tree survival, trees on CEA-2 proved best (no losses; all trees on Bird Cherry died), though in the case of standard Italian trees Hortulan plum and Lovell peach were equally good. One to two Richards trees on Bush Cherry, Lovell peach, and Sand Cherry were lost; one to two standard trees on Myro-100 plum and St. Julian-A were lost. Losses were higher on other rootstocks for both varieties. The wind-sturdiness of trees on Bitter Almond was negated in terms of practical value by the fact that tree loss was severe on that root for both varieties.

Suckering.—Freedom from suckering was evident for both varieties when grown on Bitter Almond, Lovell peach, or Tilton apricot. No suckering was observed for Hortulan plum either, but this root was tested only under standard Italian trees. Despite the stresses of the Bush Cherry dwarfing effect, only traces of suckering occurred with that rootstock. The performance of Bitter Almond again was negated by the severe tree loss sustained on that root. Blackthorn (tested only under standard Italian) suckered so severely that it is of no practical value. Again these results with Italian prune trees support the results of Parry and Rogers (7) in that suckering varies with rootstock. However, virus effects on suckering via their effects on compatibility (1) cannot be ruled out.

Non-viral symptoms.—Foliage and fruit symptomatology varied, but each symptom-category remained identifiable throughout the period of the study when that symptom was in evidence. Virtually all symptom types proved to be more severe in Richards trees than in standard Italian trees on the same rootstock. One exception was that symptoms of the leafspot-complex failed to develop in Richards trees on CEA-2 plum root, but for standard Italian trees the low incidence of symptoms on that root and on Myro-100 plum and Hortulan plum make any of the three acceptable. High incidence of symptoms (five or more trees affected out of 16) was recorded for Richards trees on Bessey Cherry, Myro-100 plum, and Sand Cherry. High incidence of symptoms in standard trees occurred on Bitter Almond, Blackthorn, Chickasaw plum, and St. Julian-A rootstocks. Incidence was high in both cultivars when growing on Bush Cherry, Lovell peach, or Tilton apricot.

Symptoms of the leafspot-complex increased in incidence when the fruit-gummosis (gum-spotting) and green-leaf-curl (not mite-induced; generally associated with fruit production, and probably a manifestation of water stress–plot not irrigated) conditions were severe. The gummosis and curl conditions again were more severe in Richards than in standard Italian trees. No direct association of fruit-gummosis and green-leaf-curl was observed, but fluctuations in incidence of the two conditions tended to parallel each other. Trees on the dwarfing Bush Cherry developed more continuing fruit-gummosis symptoms than trees on any other rootstock. The sixth (final) year of the study proved to be one of very high incidence and severity of fruit-gummosis for most stock/scion combinations, accompanied by increased incidence and severity of green-leaf-curl. Unusually high temperatures (maxima and means) were recorded for May (32.2 and 22.2 C) and September (34.4 and 26.7 C) of the sixth year, and the highs of May were preceded by unusually low (minima) temperatures in April (−11.1 and 0.6 C). Also, the minima for September (40 and 47 C) were unusually high. Precipitation had fallen off

continuously in October for years 2-5 (3.4, 2.3, and 0.9 cm respectively), and this late-season decline was followed the sixth year by unusually low precipitation in the spring period April-May (1.1 and 1.8 cm, respectively) and in the fruit-maturation period August-September (1.0 and 0.1 cm, respectively). Thus it seems likely that incidence and severity of the nonviral conditions are associated with adverse climatic conditions.

Viral symptoms.—All virus cultures tended to produce characteristic foliar symptoms in both cultivars on most rootstocks, except for the mild strain PI-11 which seldom induced symptoms in Richards trees, and failed entirely to do so in standard Italian trees on Bitter Almond, CEA-2 plum, and Bush Cherry. Individual differences for various scion/root combinations were manifested during the study; e.g. no symptoms developed in Richards trees on Bitter Almond either for PI-11 or for the severe strain PI-19; and, therefore, it would appear that in this case Bitter Almond inhibits symptom expression even in the early "shock" stages of infection. On the other hand, standard Italian trees on Chickasaw plum developed abundant characteristic symptoms (more than trees on all other roots combined), suggesting that standard trees on that rootstock are more sensitive to that culture than trees on other rootstocks, and therefore that Chickasaw plum might enhance the value of Italian trees as visual indicators of PRSV. Since deficiencies in performance in various measurement categories were noted for Bitter Almond and Bush Cherry, CEA-2 plum again emerged as the best rootstock choice.

No symptoms of virus infection were observed in control trees throughout the course of the study, and periodic indexing on Shirofugen flowering cherry (*Prunus serrulata* Lindl.) verified their continuing condition of PRSV-freedom.

Virus symptoms occasionally were evident the year of inoculation (second year of the study), but definitely peaked in incidence the following year, and seldom were evident thereafter. This was true of both cultivars, and virtually all rootstocks. No correlation was observed between severity of virus strain and development of foliar symptoms, except for the mild culture (PI-11) which developed symptoms only rarely and generally in combination with symptoms of the leafspot-complex when it did. Except for this tendency of PI-11 to induce PRSV symptoms only when trees were otherwise stressed, as indicated by presence of the leafspot-complex, no relationship between incidence of leafspot-complex, fruit-gummosis, and PRSV infection was observed. Also, there was no apparent relationship between virus infection and suckering.

CONCLUSIONS.—For the conditions of the study, the following conclusions are in order: (i) Incidence of nonvirus conditions in Richards Early Italian and standard Italian prune trees is affected by rootstock and fluctuates within each scion/root combination with annual weather conditions. (ii) *Prunus* ringspot symptoms occasionally appear the year of infection, but commonly develop in greatest abundance the year following infection, and the latent condition tends to become established in nearly all cases by the third year. (iii) Symptoms produced by PRSV isolates of differing virulence tend to be the same in appearance and severity in Richards Early and standard Italian prune trees, but very mild strains (in this case PI-11) rarely induce symptoms in Richards trees, and often fail to do so in standard Italian trees as well. (iv) The various conditions under study generally were more severe in Richards trees than in standard Italian trees. (v) There is no general correlation between presence of PRSV and development of leafspot-complex symptoms, fruit-gummosis, and/or suckering of rootstocks. (vi) All factors considered, best standard-size trees of both cultivars were produced on CEA-2 plum rootstock, and when dwarfing effects are not required this root is recommended.

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