Brownline of Prune Trees, a Disease Associated with Tomato Ringspot Virus Infection of Myrobalan and Peach Rootstocks

Srecko M. Mircetich and J. W. Hoy

Research plant pathologist and graduate student, respectively, Agricultural Research, Science and Education Administration, U. S. Department of Agriculture; Department of Plant Pathology, University of California, Davis 95616.
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ABSTRACT

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Surveys of declining prune orchards revealed a widespread incidence of prune brownline disease (PBL) associated with declining prune (*Prunus domestica*) trees on Myrobalan plum (*Prunus cerasifera*) or peach (*Prunus persica*) rootstocks in several California prune-growing areas. A narrow strip of dark brown and necrotic cambial phloem tissues (brownline = BL) at the graft union of the scion and rootstock was the diagnostic symptom of the disease. Annual surveys of commercial prune orchards revealed natural spread of PBL from diseased to adjacent healthy trees. A virus (TomRSV-P) serologically identical to the peach yellow bud (PYB) strain of tomato ringspot virus (TomRSV) was isolated from and consistently detected by enzyme-linked immunosorbent assay test (ELISA) in Myrobalan plum or peach rootstocks, but never in the prune scions of orchard trees naturally affected by PBL. TomRSV-PYB was readily graft-transmitted from naturally infected peach trees to Myrobalan plum seedlings. The causal agent of PBL and TomRSV-P was graft-transmitted by root chips from Myrobalan or peach rootstock of orchard-grown PBL-affected prune trees to healthy prunes (cultivar French) on Myrobalan or peach rootstock only when the inoculum was applied to the rootstock of the indicators. Indicators inoculated in this manner developed typical BL at the union within 2 yr. Transmission of TomRSV-P or BL symptom induction was not achieved when root chips from either Myrobalan or peach rootstock of PBL-affected prune trees were applied to the French prune scion of the indicators. Negative results also were obtained when buds from French scion of PBL-affected orchard trees served as inoculum and were applied either to the rootstock or French prune scion of the indicators. Apparently, TomRSV-P is present only in the Myrobalan or peach rootstocks of naturally PBL-affected prune trees. The development of BL at the graft union of prune trees on Myrobalan or peach rootstock seems to be due to a hypersensitive reaction of the prune scion to TomRSV-P.

Additional key words: European plum, incompatibility, virous disease, soilborne virus, NEPO virus, hypersensitive reaction.

During the last 6 yr, an increasing incidence of general decline symptoms of prune (*Prunus domestica* 'French') trees on Myrobalan rootstock have been observed in commercial orchards in a number of California prune-producing areas. Prune cultivar French accounts for 79% of the total California prune acreage of over 83,000 acres. Although the general aboveground symptoms of these declining prune trees are similar to those caused by various soilborne pathogens, improper cultural practices, nutrient deficiencies (5,18), winter injury (10), and incompatability between scion and rootstock (1,3,16), we found no evidence that any of these causes are implicated in the disorder. In 1973, however, we observed a consistent association of a narrow strip of dead and dark-brown cambial and phloem tissues (brownline = BL) at the junction of the French prune scion and Myrobalan rootstock of declining trees in a commercial orchard with a high incidence of dead or dying trees in Yolo County. Subsequent careful examination of declining prune trees in numerous geographically separated orchards revealed that the presence of BL at the union is the most consistent diagnostic symptom of this prune decline disorder, which will be referred to as prune brownline (PBL).

The BL symptom at the union of declining French prunes on Myrobalan rootstock resembles cambial necrosis at the union of apricot scions on plum or peach rootstocks affected with stem pitting (14) and apple union necrosis (20) which are associated with certain strains of tomato ringspot virus and the blackline symptom of English walnuts on *Juglans hindsii* or Paradox rootstock affected with the walnut blackline disease which is associated with a strain of cherry leafroll virus (15). Furthermore, the occurrence of affected prune trees in groups of several trees and the apparent spread of the disease from an infected to an adjacent healthy tree suggests that the disease is caused by an infectious agent. The occurrence of groups of BL-affected prune trees in commercial orchards and a high incidence of diseased prune trees in certain areas where tomato ringspot virus (TomRSV) is known to occur in other stone fruits (9,14,17,21,24,26) prompted experiments to investigate a possible association of TomRSV with BL-affected prune trees.

The present paper reports the occurrence of PBL and its BL symptoms and graft transmission of the causal agent. The relationship between certain strains of tomato ringspot virus and PBL also was studied.

MATERIALS AND METHODS

Field observations and survey of orchards. To determine specific field symptoms of prune (*Prunus domestica* L.) trees affected with PBL, we observed development of symptoms from incipient infection through death of trees in several orchards. Positive diagnosis of the disease in all trees was based on the presence of BL at the union (Fig. 1).

Numerous commercial prune orchards were surveyed for 6 yr to determine the incidence and pattern of occurrence of BL-affected trees and possible natural spread of the disease within such orchards.

Detection of viruses in BL-affected trees. Naturally and experimentally BL-infected and symptomless prune trees propagated on peach (*Prunus persica*[L.] Batsch.) seedlings, on clones or seedlings of Myrobalan plum (*P. cerasifera* Ehrh.), and on clonal Marianna 2624 plum (*P. cerasifera* × *P. munsoniana* [?] Wight & Hedr.) rootstock were assayed for the presence of TomRSV by infectivity and serological assays. Leaf, cambial, and inner bark tissues from both rootstock and scion portions of prune trees were triturated in nicotine: phosphate buffer mixture (1.5 volume of 5% aqueous solution of nicotine and 1.0 volume of

phosphate buffer 0.1 M, pH 7.2) and the extract was inoculated to cucumber (*Cucumis sativus* L. 'National Pickling'), cowpea (*Vigna ungiculata* [L.] Walp. 'Ramshorn'), bean (*Phaseolus vulgaris* L. 'Bountiful'), and tobacco (*Nicotiana tabacum* L. 'Havana 425') plants as previously described (15). Enzyme-linked immunosorbent assay (ELISA) (2) was used for detection of TomRSV in prune trees by testing the same tissues as those used for mechanical transmission tests. The viruses recovered from prune tree rootstocks in bioassay tests were compared serologically with peach isolates of TomRSV (4,12) and with an isolate of cherry leafroll virus (CLRV) (15), in both gel double-diffusion and ELISA tests. Antigen sources were expressed sap from cucumber, cowpea, or tobacco plants. The serological tests employed antiserum (PVAS #239, American Type Culture Collection [ATCC]), prepared to the prunus stem pitting (PSP) and antiserum (PVAS #174 ATCC) prepared to the grape yellow vein (GYV) strains of TomRSV, antiserum prepared to tobacco ringspot virus (TobRSV) (PVAS #157, ATCC), and antiserum prepared to the golden elderberry strain of CLRV (supplied by R. Stace-Smith, Canada Agric. Res. Station, 6660 N.W. Marine Dr., Vancouver, B.C., Canada V6T 1X2).

Graft-transmission experiments. Graft-transmission experiments were conducted under greenhouse and lathhouse conditions. PBL-affected and TomRSV-infected orchard prune trees of cultivar French (French prune, Agen) propagated on peach and Myrobalan rootstocks (French/peach and French/Myrobalan) or peach trees affected with yellow bud mosaic (17), served as inoculum sources.

Because there are conflicting data in the literature on the ability of TomRSV to infect Myrobalan plum (17,23) (the predominant rootstock for prunes in California) and because TomRSV is repeatedly detected in Myrobalan rootstocks of BL-affected trees, graft-transmission of the peach yellow bud (PYB) strain of TomRSV (4,9) from naturally infected peach to healthy Myrobalan seedlings was attempted. Ten 6-mo-old Myrobalan and peach seedlings growing in steam-pasteurized soil in 3.7-L cans were inoculated with root chips or buds from two orchard peach trees infected with TomRSV-PYB as described previously (13). Controls were inoculated in the same manner with buds and root chips from healthy trees. The inoculated indicators were observed for symptom development for 2 yr in the greenhouse. Infection of the graft-inoculated indicators was based on mechanical transmission of TomRSV-PYB from the indicators to herbaceous plants and on detection of TomRSV in the indicators by ELISA.

In a similar experiment under lathhouse conditions we attempted to graft-transmit the causal agent of PBL and TomRSV from BL-affected orchard French/peach trees to healthy 1-yr-old trees of French/Lovell peach. The indicators were inoculated in June 1974 with buds from French prune scions or with root chips from peach rootstocks of BL-affected orchard trees as described previously (13). Three buds from the French prune scion or three root chips from the peach rootstock of donor trees were placed into the French scion portion or the Lovell rootstock portion of the indicators. Twenty indicators were inoculated using five indicators for each set of four inoculum-indicator combinations (Table 1). The final data in this experiment were collected in October 1976, when the experiment was terminated.

In another experiment we used inoculum from BL-affected orchard trees of French/Myrobalan to inoculate healthy 1-yr-old French/Myrobalan or Lovell peach. The indicators were inoculated with buds from French scion or root chips from Myrobalan rootstock of the donor tree in the same four inoculum-indicator combinations as in the previous experiment (Table 1). Controls consisted of the indicators that received inoculum from healthy prune trees and from indicators that received no inoculum (Table 1). The indicators were observed for the development of PBL disease symptoms for 2 yr before the experiment was terminated. Transmission of the brownline agent was based on the presence of BL at the union of the scion and rootstock of indicator plants—whereas transmission of TomRSV-P was based on its mechanical transmission from indicators to herbaceous plants and/or detection in the indicators by ELISA. TomRSV isolates recovered from graft-inoculated indicators were compared by gel diffusion or ELISA to known strains of TomRSV and CLRV and to the TomRSV-P isolates recovered from BL-affected trees that served as the inoculum sources.

RESULTS

Field symptoms, incidence, and natural spread. General aboveground symptoms of BL-affected prune trees resembled those induced by several other different causes which induce partial or total girdling of trees. The first initial symptoms of BL-affected trees were yellowing of leaf margins and interveinal chlorosis accompanied by drooping and upward rolling of leaves followed by marginal necrosis of leaf lamina. The affected trees developed fall color in the leaves and become defoliated much earlier, particularly in the terminal growth, than did comparable healthy trees (Figs. 1A,B). The affected trees usually had a very heavy set of small-sized, poor quality fruits which dropped prematurely. In older prune trees poor growth of terminal shoots usually preceded leaf symptoms, whereas younger (3- to 5-yr-old), vigorous trees suddenly showed premature defoliation and leaf symptoms on the most vigorous terminal shoots (Fig. 1B). As the disease progressed, affected trees showed dieback in terminal shoots, general decline and they subsequently died. However, the presence of a narrow strip of brown to dark-brown cambial tissue (brownline) at the junction of the scion and rootstock was the diagnostic symptom of this disease (Figs. 1A,a, B,b). In the early stage of the disease the brownline symptom is limited to the cambium and it was not continuous around the union, but it gradually extends into the bark from the cambium, girdling the union (Figs. 1B, b) and resulting in death of the tree within 1- to 5-yr after the girdling is completed. Younger and smaller vigorous trees are usually subject to quicker decline and death than larger and nonvigorous trees. Brownline-affected trees usually develop an overgrowth ("inverted shoulder") of the scion at the union (Figs. 1B, b) although occasionally younger trees die before the overgrowth has developed.

Brownline was observed in California commercial prune orchards on the following cultivars: French, President, and Empress propagated on Myrobalan and peach seedlings or clonal Myrobalan 29C rootstocks. We haven't observed BL in orchard prune trees on clonal Marianna 2624 plum rootstock even in orchards with prune trees of the same age on both Marianna 2624 and Myrobalan rootstocks and where a high incidence of brownline was observed in trees on Myrobalan rootstock.

The root systems of BL-affected trees generally were weaker and had smaller lateral and fewer feeder roots compared to the root system of the same rootstocks of healthy prune trees. In addition, Myrobalan seedling rootstocks of prune trees in an advanced stage of PBL often exhibited discoloration and necrosis of the cambium followed by bark canker below the graft union. This condition usually resulted in sudden collapse of the trees. The clonal Myrobalan 29C rootstock in BL-affected trees usually developed numerous sprouts with viruslike symptoms (mottling, chlorotic spots, and rings) in the leaves.

Surveys of commercial orchards revealed that PBL disease was commonly associated with declining prune trees in Yolo, Solano, Yuba, Sutter, El Dorado, and Placer counties, which account for approximately 40% of the total prune acreage in California. The incidence of BL-affected trees in surveyed orchards ranged from a few to more than 25%. BL-affected trees commonly occurred in groups of few to more than 50 trees within individual orchards. We occasionally observed a single tree affected with brownline at considerable distance from a group of affected trees, but subsequent spread from these single trees was almost invariably to immediately adjacent healthy trees.

The rate and pattern of natural spread of the disease was studied in one orchard. This orchard had 6-yr-old trees (French prune/Myrobalan seedlings and French prune/Marianna 2624 clonal rootstocks) planted 6.7 m apart in a square grid pattern; trees in every three rows were on different rootstocks. In 1975 we noted several isolated trees with incipient brownline symptoms on Myrobalan rootstock, beside a row of healthy trees on Marianna 2624 rootstock. During 4 subsequent years we annually examined

adjacent trees on both rootstocks to assess the rate of spread of PBL disease from the single focus of infection. Natural spread of PBL occurred readily from infected to adjacent trees on Myrobalan rootstock. Radial spread from individual trees occurred commonly at the rate of one tree per year in any direction. TomRSV was readily detected in newly infected trees by ELISA. By 1979 no French prune tree on Marianna 2624 clonal rootstock adjacent to diseased trees on Myrobalan rootstock showed BL at the graft union. Likewise, no TomRSV was detected in any of the trees on Marianna 2624 by either bioassay or ELISA. Apparently natural spread of brownline disease commonly was from diseased to healthy French prune trees propagated on Myrobalan rootstock but not to those propagated on Marianna 2624.

Detection of tomato ringspot virus in brownline-affected trees. A strain of TomRSV (TomRSV-P) was detected in Myrobalan and peach rootstocks, but not in prune scions of trees either naturally or experimentally infected with the PBL causal agent. Mechanical transmission of TomRSV-P from cambial and inner bark tissues to cucumber, bean, tobacco, and cowpea was erratic whereas we readily transmitted the virus to these herbaceous plants from leaves

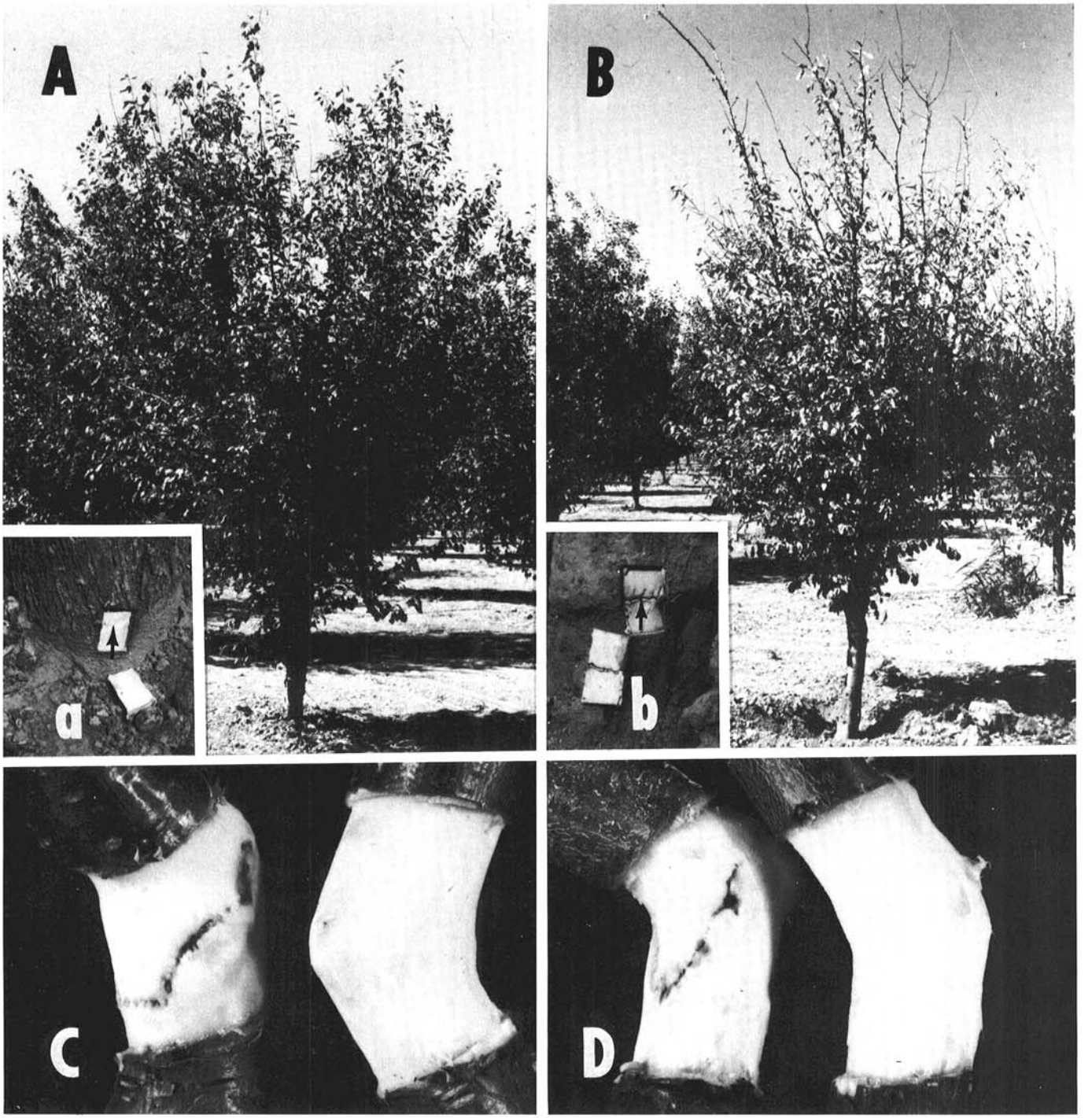

Fig. 1. Symptoms of prune brownline (PBL) disease in naturally and experimentally infected prune trees. A) Five-year-old healthy orchard prune tree on Myrobalan seedling rootstock; a, graft union of tree in A with bark removed to show the absence of brownline at the junction of the scion and rootstock (arrow). B) Five-year-old brownline-infected orchard prune tree on Myrobalan seedling rootstock with chlorotic leaves and premature defoliation of terminal shoots; b, overgrowth "inverted shoulder" above graft union, brownline in the woody cylinder at the junction of the scion and rootstock (arrow) and corresponding brownline in the inner bark removed from the graft union of tree in B. C-D) Graft unions of 2-yr-old French prunes on Lovell peach rootstock (C) and French prunes on Myrobalan seedling rootstock (D) that were inoculated with root chips from naturally PBL-affected (left) and healthy, symptomless (right) prune trees. Note brownline at union of the indicators which received root chips from PBL-affected prune tree.

of sucker shoots from Myrobalan or peach rootstock from both naturally and experimentally infected prune trees. ELISA was more reliable than mechanical transmission to herbaceous plants for detecting TomRSV-P in cambium and inner bark tissue from the rootstock of BL-affected prune trees. TomRSV-P was detected by ELISA in trees from which it was not mechanically transmitted as well as in those from which it was. The efficiency of TomRSV-P detection by ELISA was low (30–50%) in cambial and bark tissues from rootstocks of dormant or dying trees but it was much higher (90–100%) in leaves, cambium and bark tissues from rootstocks of trees in the early stages of disease. TomRSV-P consistently was detected by ELISA in Myrobalan and peach rootstocks of 45 PBL-affected prune trees, but it was never detected in the French, Empress, and President prune scions of the same trees. The virus was not detected in either rootstock or scion portions of healthy and symptomless prune trees concurrently tested with the PBL-affected trees.

The local and systemic symptoms in cucumber, cowpea, and beans induced by six TomRSV-P isolates from BL-affected prune trees were similar to those reported for various isolates of TomRSV (7,9,19,22). However, the TomRSV-P isolates failed to infect tobacco plants systemically and consistently induced small concentric rings or solid local lesions in inoculated leaves of Havana 425 tobacco depending on the isolate (Fig. 2). The symptoms induced in tobacco plants by the TomRSV-P isolates were similar to those induced by various strains of peach yellow bud mosaic virus (PYB) (7,9), a strain of TomRSV (4).

Six selected TomRSV-P isolates from BL-affected prune trees reacted positively in ELISA against antiserum to the prunus stem pitting (PSP) strain of TomRSV (12). In gel diffusion tests, two selected PBL isolates (TomRSV-P #1 and TomRSV-P #4) in leaf extracts from cucumber reacted positively with antisera to the PSP strain and the grape yellow vein (GYV) strain of TomRSV. Heterologous precipitin spurs developed between the two TomRSV-P isolates and the PSP isolate of TomRSV, whereas precipitin lines were confluent between the TomRSV-P isolates and a TomRSV-PYB isolate. Thus, TomRSV-P isolates appear to be serologically identical with TomRSV-PYB and related, but not identical to, TomRSV-PSP. There was no reaction between the two TomRSV-P isolates with antisera prepared to a known TobRSV isolate (PVAS #157) and the golden elderberry strain of CLRV. Apparently, the virus from BL-affected prunes is a strain of TomRSV (19).

Graft transmission experiments. Although the literature contains conflicting information on the capability of peach yellow bud mosaic virus (PYB) a strain of TomRSV (4) to infect Myrobalan plum, we readily transmitted this virus with buds and root chips from PYB-infected orchard peach trees to healthy Myrobalan plum and Lovell peach seedlings in greenhouse tests. Seven of 10 Myrobalan plum and 10 of 10 Lovell peach seedlings became infected when they were graft-inoculated with buds from PYB-infected orchard trees. Similarly, five of 10 Myrobalan plum and six of 10 Lovell peach seedlings became infected with PYB when inoculated with root chips from the same naturally infected orchard peach trees.

The Lovell peach seedlings experimentally infected with PYB developed leaf symptoms of the disease (17) within 5 mo and they were severely stunted and exhibited dieback in terminal shoots within 1 yr compared to controls that received inoculum from healthy peach orchard trees. In contrast none of the experimentally infected Myrobalan seedlings showed stunting or any visible viruslike leaf symptoms within 1 yr. However, 18 mo after inoculation we observed chlorotic spots and rings and mosaic symptoms in a few leaves of the Myrobalan seedlings that had received the inoculum from PYB-infected orchard peach trees, whereas no leaf symptoms were observed in controls inoculated with the inoculum from healthy orchard peach trees. The general vigor and growth rate of inoculated Myrobalan seedlings was comparable to that of controls within the experimental period. Viruses from the Myrobalan plum and Lovell peach indicators were serologically identical to each other and with the PYB isolate recovered from orchard peach trees. Apparently the PYB strain of TomRSV is capable of readily infecting Myrobalan plum which is the major rootstock for prune trees in California.

The PBL causal agent and TomRSV-P were readily graft-transmitted to healthy French prune trees in two different experiments when root chips from Myrobalan or peach rootstocks of naturally infected prune trees were applied to the Myrobalan or peach rootstock of indicator prune trees (Table 1). In contrast, no graft transmission of the PBL causal agent or TomRSV-P was achieved when the same inoculum was applied to French prune scion portions of the indicators (Table 1). Likewise, buds from the scions of French prune orchard trees affected with BL applied to the French prune scions or Myrobalan and peach rootstocks of the indicators, failed to induce either brownline at the union or to transmit TomRSV-P to the indicators (Table 1).

Fig. 2. Solid necrotic lesions and necrotic concentric rings in inoculated leaves of tobacco, Havana 425 induced by the TomRSV-P #1 (left) and TomRSV-P #4 (right) isolates recovered from orchard BL-affected prune trees.

Nineteen of 21 experimentally inoculated French prune indicators on Myrobalan or Lovell rootstock inoculated on the rootstock portion with root chips from donor trees developed brownline at the union within 2 yr (Table 1). The cambial and phloem necrosis-brownline at the junction of the French prune scion and Myrobalan or peach rootstock of the indicators was identical to that in orchard trees naturally affected by PBL (Figs. 1B, C, D). In addition, no viruslike leaf symptoms were observed in the French scion, but sucker shoots of the Myrobalan and Lovell rootstock of the indicators with brownline at the union showed chlorotic spots, rings, and distortion of leaves. The leaf symptoms of the Myrobalan rootstock of the indicators were identical to those of the Myrobalan 29C rootstock of PBL-affected orchard trees. However, we observed no small yellow buds or tufts of small pale-yellow leaves, the most characteristic symptoms usually induced in peach by TomRSV-PYB, in suckers of the Lovell rootstock of the indicators within 2 yr of observation.

TomRSV-P was readily transmitted and recovered from the rootstock portion of the indicators that developed brownline at the union. The virus recovered from the indicators was serologically identical to the TomRSV-P from orchard trees naturally affected by PBL. The virus was detected in rootstocks of all indicators with BL at the union whereas no TomRSV-P was detected in French prune scions of any indicator or in the rootstock of indicators free from brownline at the union (Table 1).

DISCUSSION

The high incidence and adverse effects of PBL were noted in certain commercial prune orchards in California. Our investigation showed for the first time that PBL is a specific disease caused by a graft-transmissible agent which spreads readily from diseased to healthy orchard trees. The constant association of TomRSV-P with both naturally and experimentally PBL-affected prune trees, strongly indicates that TomRSV-P is the causal agent of PBL in prune trees propagated on Myrobalan or peach rootstocks.

Apparently the virus is present only in the Myrobalan and peach rootstocks of BL-affected French prune trees. Thus, it appears French prune is resistant to TomRSV-P, and that the necrosis of cambium and phloem (brownline) at the union of French prune on Myrobalan and peach rootstock is due to a hypersensitive reaction of French prune scion to the TomRSV-P.

The symptoms induced in cucumber, cowpea, beans, and tobacco by the PBL-associated virus are very similar to those reported for TomRSV-PYB (7,9). Although it was related to the prunus stem pitting and grape yellow vein strains of TomRSV it appears to be identical to TomRSV-PYB in gel diffusion tests. Apparently the PBL-associated virus is an isolate of TomRSV-PYB (19). Although several strains of TomRSV are reported to infect *Prunus* spp. (9,12,14,17,23,24,26), the literature lacks conclusive data on the ability of TomRSV to infect Myrobalan plum (17,24). This investigation showed that TomRSV-PYB and TomRSV-P can both naturally and experimentally readily infect Myrobalan plum which is the most widely used rootstock (approximately 75%) for prunes in California commercial orchards (6).

Although we observed natural spread of PBL from diseased to adjacent healthy orchard prune trees on Myrobalan or peach rootstock, the vector of its causal agent is unknown. However, we found that the American dagger nematode (*Xiphinema americanum* Cobb.) (which is commonly found in prune orchards [11] and is an efficient vector of TomRSV-PYB [23]) often is associated with PBL-affected orchard prune trees affected with PBL disease.

Marianna 2624 clonal rootstock is second in importance to Myrobalan as a rootstock for prune trees in California. As yet, we have observed no orchard prune tree on Marianna 2624 to be affected with PBL. French prune trees on Marianna 2624 rootstock adjacent to BL-affected prune trees on Myrobalan rootstock have remained free of PBL disease and TomRSV-P for 5 yr, even though the natural spread of BL and TomRSV-P from the same infection foci in the same orchard occurred readily to French prune trees on Myrobalan seedling rootstock within the same period. These observations suggest that Marianna 2624 may be more resistant than Myrobalan rootstock to PBL and TomRSV-P under orchard conditions.

Several disorders of prunes on Myrobalan resembling the PBL disease have been reported in the literature (1,2,5,6,8,10,16,18). The symptoms of the "pinch root" or "carrot root" disorders affecting French and Sergeant prune on Myrobalan rootstock in California (8) and the pattern of occurrence and geographical location for the "pinch root" disorder (6,8) are identical to those of PBL of French prunes in California, but the presence of BL at the union of pinch root-affected trees was not reported (6,8). The symptoms of decline of Stanley prune on Myrobalan rootstock occurring in New York (3,10,16), including the presence of BL at the union (Figs. 2, 4, in reference 3; and Fig. 130 in reference 16), are strikingly similar to those of PBL disease, but its etiology remains undetermined. However the occurrence of different TomRSV strains in New York has been reported (25). A similar disorder of Green Gage (Reine Claude) prune on Myrobalan and peach rootstock occurs in France (1).

The PBL disease is caused by a graft-transmissible and probably soilborne agent, presumably TomRSV. Thus, control measures for

TABLE 1. Efficiency of buds from French prune scions and root chips from Myrobalan plum and peach seedling rootstocks of naturally plum brownline (PBL)-affected trees in transmitting the causal agent of PBL disease to healthy French prune on Myrobalan or peach seedling rootstock in lathhouse tests

Indicator (scion/rootstock seedling)	Type of inoculum	Part of indicator inoculated	Fraction of indicators with brownline at union[a]	Detection of TomRSV in indicators[b]	
				Scion	Rootstock
French prune/Lovell peach	Buds[c]	Scion	0/11	−	−
French prune/Lovell peach	Buds[c]	Rootstock	0/10	−	−
French prune/Lovell peach	Root chips[c]	Scion	0/10	−	−
French prune/Lovell peach	Root chips[c]	Rootstock	11/11	−	+
French prune/Myrobalan plum	Buds[c]	Scion	0/8	−	−
French prune/Myrobalan plum	Buds[c]	Rootstock	0/10	−	−
French prune/Myrobalan plum	Root Chips[c]	Scion	0/8	−	−
French prune/Myrobalan plum	Root chips[c]	Rootstock	8/10	−	+
French prune/Lovell peach	Buds[d]	Rootstock	0/6	−	−
French prune/Lovell peach	Root chips[d]	Rootstock	0/8	−	−
French prune/Myrobalan plum	Buds[d]	Rootstock	0/5	−	−
French prune/Myrobalan plum	Root chips[d]	Rootstock	0/5	−	−
French prune/Lovell peach	None	None	0/6	−	−
French prune/Myrobalan plum	None	None	0/7	−	−

[a] Number of indicators with brownline per number inoculated in two different experiments.
[b] Virus isolates serologically related to TomRSV; + = detected; − = not detected.
[c] Inoculum from orchard trees with brownline at the union from which TomRSV-P was recovered from the rootstock only.
[d] Inoculum from symptomless, healthy orchard trees from which attempts to recover virus from either scion or rootstock failed.

this disease should include the use of propagation materials: budwood, graftwood and cuttings for clonal rootstock, from TomRSV-free and healthy trees. ELISA appears to be efficient and reliable technique for detecting TomRSV-P in infected trees. Nursery stock should be produced and heeled on soil sites free from TomRSV and dagger nematodes. Infected prune trees in orchards should be removed, and any movement of soil from infested to healthy areas should be avoided. Before replanting, the infested soil sites should be fumigated with a nematicide, then fallowed and kept free from weeds for at least two growing seasons. Prunes on Marianna 2624 clonal rootstock rather than on Myrobalan plum or peach rootstock should be used for prune sites with a history of, or threatened by, PBL disease.

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