Effect of Leachates from Peach Soil and Roots on Bacterial Canker and Growth of Peach Seedlings

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ABSTRACT

Peach seedlings were grown in water culture solutions containing leachates from old peach orchard soil, from soil in pots with an accumulation of peach roots, and from nonpeach soil. Old peach soil and "pot" soil leachates resulted in reduced growth of seedlings. After inoculation with *Pseudomonas syringae,* the longest cankers developed on plants growing in leachates from the pots and, after an extended period, the bacteria were reisolated from more of the seedlings in this treatment than from those in other treatments. It is postulated that when trees are replanted on old peach sites, an uptake of some water soluble substance from dead peach roots by the trees may predispose them to bacterial canker and contribute to peach tree short-life.

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The peach tree decline or "short-life" problem has become more severe in recent years due to successive plantings on the same land (2). Results suggesting that toxins in the soil, or in old roots, are involved have been reported (8, 11), but other workers have found no evidence of toxins (4, 9, 11). These reports, and others on this subject were reviewed by Koch (7) and Savory (13).

Reports from California (5, 10, 11) and Ontario (7, 8) describe stunting and chlorosis of peach trees on replanted land. In addition to these symptoms, we have observed discoloration of wood, gumming, and sour sap when peach trees were replanted on old land in Georgia.

Symptoms of bacterial canker, as described by Wilson (14) and Petersen and Dowler (9), include discoloration of wood, gumming, and sour sap. This suggests that bacterial canker of peach is part of the decline problem on replanted land in the southeastern USA.

In an accompanying paper (3), we report the results of inoculations with the bacterial canker pathogen, *Pseudomonas syringae,* on peach seedlings, *Prunus persica* L. (Batsch), grown in soil from old and new peach sites. When seedlings were exposed to different temp after inoculation, the canker extension was dependent on the temp, but not on the soil source. It appears possible that a leachable toxic substance in old peach soil might predispose peach trees to more severe bacterial canker infection.

We found no increase in severity of bacterial canker from growing peach seedlings in soil from old peach sites (3). Therefore, we initiated the tests reported here to determine the effect on bacterial canker of leachates from soils obtained from old peach sites, and from pots in which peach roots had been allowed to accumulate by growing trees in containers for several years.

MATERIALS AND METHODS.—Leachates from three soil sources were used. In preparation for the first treatment, peach trees were grown in sandy loam soil in 37.8-liter pots (4 trees per pot) for 3 yr in order to provide a dense root system in the pots. During this time, these plants died in the pots with typical decline symptoms including gumming and cankers. In March 1970, enough distilled water was washed through each pot to provide 4 liters of leachate. The soil which furnished this leachate is referred to in this report as "pot" soil. For the second treatment, Faceville sandy loam was obtained from an old peach site with a history of decline. For the third treatment, similar soil was obtained from a pecan grove. Leachates were collected from these soils as outlined for the "pot" soil treatment. Six 37.8-liter pots were used to provide the leachate for each treatment. Distilled water without added leachate was used as the fourth treatment for comparison. Nutrients were added to all treatments to to make 50% Hoagland's solutions (6).

Elberta peach seed with endocarps removed were stratified at 4 C, and germinated in peat pots. The seedlings were transferred after 5 wk into 3.8-liter glass containers covered with aluminum foil to exclude light. Each container, fitted with a polystyrene stopper, held one plant in one of the nutrient solutions prepared with leachates or distilled water as described above. Six plants were used for each of the four treatments and placed in the greenhouse at temp between 20 and 29 C. Solutions were renewed weekly and continuously aerated.

After 7 mo in water culture, seedlings were measured and pruned by removing approximately 30 cm from selected branches. Four plants in each treatment were inoculated by spraying onto three pruning cuts with a small hand sprayer. A virulent *P. syringae* isolate, B-3 (4), was grown on King's Medium B, and a 48-h culture of the bacteria was diluted to 10^7 cells/ml and used for inoculum. Moist cotton and masking tape were then applied around each inoculated site to delay drying. As a control, other seedlings in each treatment were inoculated with nonsterile deionized water. Resulting cankers were measured 11, 78, and 112 days after inoculation. Reisolations after 37 days were made 50 and 150 mm below the inoculation points, and at 150 mm after 73 and 160 days.

Reisolations of bacteria were from living tissue approximately 25 mm below the inoculated branch tips. In preparation for reisolation, we removed a strip of bark approximately 6 × 12 mm with a sterile scalpel. A rotary hand drill with a sterile 1.5-mm or 2.5-mm bit was then used to remove small chips which were caught in a test tube containing Kings Medium B. Resulting colonies of *P. syringae* were identified by a characteristic yellow-green pigment, and a negative oxidase test.

RESULTS AND DISCUSSION.—Inoculations with

TABLE 1. Effect of soil leachates on development of cankers in peach seedlings growing in water culture, and inoculated with *Pseudomonas syringae* or water

Source of leachate	Inoculum	Canker length (mm)		
		11 days[a,b]	78 days[a,b]	112 days[a,b]
"Pot" soil with peach roots[c]	*P. syringae*	5.1 A	16.0 A	20.6 A
Field soil (peach)[d]	*P. syringae*	6.1 A	9.2 B	13.0 B
Field soil (pecan)[e]	*P. syringae*	4.9 A	10.2 B	12.5 B
Distilled water (no leachate)	*P. syringae*	4.9 A	7.8 B	13.8 B
All leachates[f]	Deionized water	0.0 B	0.0 C	0.0 C

[a]Days after inoculation.
[b]Values in a column followed by the same letter do not differ significantly, $P = 0.05$.
[c]Leachate from soil in pots containing an accumulation of dead peach roots.
[d]Leachate from soil obtained from old peach site.
[e]Leachate from soil obtained from pecan grove in which peaches had not been grown.
[f]Used as a control, inoculated with deionized water only.

TABLE 2. Effect of soil leachates on recovery of *Pseudomonas syringae* from inoculated peach seedlings growing in water culture

Source of leachate	Inoculum	Seedlings from which *P. syringae* was reisolated (%)			
		50mm[a]	150 mm[a]		
		37 days[b]	37 days	73 days	160 days
"Pot" soil with peach roots[c]	*P. syringae*	100	25	50	50
Field soil (peach)[d]	*P. syringae*	100	0	50	25
Field soil (pecan)[e]	*P. syringae*	75	25	25	25
Distilled water (no leachate)	*P. syringae*	75	0	25	0
All leachates[f]	Deionized water	0	0	0	0

[a]Distance from point of inoculation.
[b]Time after inoculation.
[c]Leachate from soil in pots containing an accumulation of dead peach roots.
[d]Leachate from soil obtained from old peach site.
[e]Leachate from soil obtained from pecan grove in which peaches had not been grown.
[f]Used as a control, inoculated with deionized water only.

P. syringae resulted in infection of all plants as indicated by canker length and recovery of the bacteria (Tables 1 and 2). Gumming was also observed on branches inoculated with *P. syringae*, but not on those inoculated with water. Cankers and gumming were symptoms regularly observed by the authors on declining peach trees. In fact, we have isolated *P. syringae* from some trees in Georgia and one virulent local isolate of *P. syringae* was used along with B-3 in a test reported in an accompanying paper (3).

Our results with seedlings in water culture apparently differ from our results with peach seedlings grown in soil (3). In the test with soils, we found no adverse effects of old peach soil on either tree growth or on bacterial canker development. In the test reported here, however, the leachate from old peach soil and the "pot" soil leachate both reduced the growth of peach seedlings in water culture (Table 3). In addition, the "pot" soil leachate treatment resulted in more severe bacterial canker infection than other treatments, as shown by longer canker length 78 and 112 days after inoculation (Table 1).

Although the bacteria were recovered initially from all treatments where plants were inoculated with *P. syringae* (Table 2), 100% recovery was obtained only from the "pot" and peach soil leachate treatments after 37 days. At this time, however, *P. syringae* was not found in most of the seedlings 150 mm below the inoculation point. Additional movement of bacteria occurred as recovery of bacteria increased from 0 or 25% at 37 days to 50% at 73 days in the two peach leachate treatments. After 160 days, recovery from the "pot" treatment remained at 50%, showing more persistence of the pathogen in this treatment. It should be noted that in all reisolations, the bacteria were recovered from distances considerably greater than the maximum visible canker extension (Tables 1 and 2), indicating the systemic nature of the pathogen (1). No canker symptoms were observed, and no *P. syringae* was isolated at any time, from the control trees inoculated with water (Table 2).

The results of this test suggest that water-soluble substances from peach roots or from soil containing peach roots may be a part of the peach-tree-decline or peach-short-life problem. If this is true, the effect must be so subtle that it is necessary to concentrate the roots, as was done in the "pot" treatment, in order to measure it in greenhouse tests. Based on the results of this water culture test, we postulate that, when trees are replanted on old peach sites, an uptake of the soluble substance from dead peach roots by the trees may predispose them to bacterial canker and thus contribute to short-life. No effort was made in this test to identify the toxic agent involved, or the mechanisms by which it is produced.

The possible role of toxins in the "peach replant" problem has been investigated for some time. Prince, Havis, and Scott (10) and Havis (5) investigated the role of toxins in greenhouse tests, and Savage and Cowart (12) in a field test. They found no detrimental effects on growth. Their tests, however, involved the addition of peach root bark or whole roots to the soil before planting peach trees or seedlings.

Patrick (8) and Proebsting and Gilmore (11) found that under certain conditions peach root residues, or their water extracts, were injurious to peach seedlings. They observed similar injury when peach roots were exposed to amygdalin in the presence of emulsin. Patrick found that amygdalin and several microorganisms isolated from old

TABLE 3. Effect of soil leachates on growth of peach seedlings in water culture

Source of leachate	Diameter of trees[a,b] (mm)
"Pot" soil with peach roots[c]	12.83 A
Field soil (peach)[d]	13.16 A
Field soil (pecan)[e]	15.33 B
Distilled water (no leachate)	16.16 B

[a]Diameter of trees 15 cm from ground after 7 mo of growth.
[b]Values in a column followed by the same letter do not differ significantly, $P = 0.05$.
[c]Leachate from soil in pots containing an accumulation of dead peach roots.
[d]Leachate from soil obtained from old peach site.
[e]Leachate from soil obtained from pecan grove in which peaches had not been grown.

peach orchard soils produced the same type in injury. Amygdalin itself was not injurious, but the emulsin and the microorganisms, presumably by producing emulsin, decomposed amygdalin into hydrogen cyanide and benzaldehyde. Patrick also obtained root injury with each of these compounds separately.

Inoculation tests indicate that *P. syringae* is a rather weak pathogen (9). Evidently, one or more predisposing factors must be present before the disease complex including this organism results in tree death. One of the predisposing factors could be a toxic substance present in decomposing roots which are found in old peach soil.

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