Effect of Temperature on Bacterial Canker in Peach Seedlings Grown in Old and New Peach Soil

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ABSTRACT

Peach seedlings were grown in soil from old and new peach sites for 7 mo in containers and then inoculated with either of two isolates of *Pseudomonas syringae* or water and held at 3, 8, 23 C, and variable (outdoor, −17 to 14 C) temp. Neither the soil source nor isolate source differentially affected the seedling growth, canker length, or seedling mortality. Canker length and seedling mortality were positively related to temp. Plants at variable temp with a mean of 3.3 C and a mean maximum of 8.5 C developed longer cankers than at a constant temp of 8 C. There was no infection or mortality of seedlings inoculated with water.

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Additional key words: tree-short-life complex, peach tree decline.

The death of peach trees from the tree-short-life complex, or peach-tree decline, has reached epidemic proportions in Georgia and other areas of the southeastern United States. Although the causes of peach tree short-life appear to be many, the disease complex has become more severe in recent years, due to successive planting of peach trees on the same land (5, 17). The involvement of bacterial canker caused by *Pseudomonas syringae* in the peach tree short-life complex in the southeastern USA has been shown by Dowler and coworkers (9, 10).

The effect of temp on bacterial canker development has been reported by several workers. However, most of the studies were with plum (18), prune (16), or cherry (3), in which the infection process differs somewhat from that of peach. Crosse and Garrett (4) reported varying results

with isolates of *Pseudomonas* obtained from different parts of the world as well as strains obtained from different hosts. They also stated that comparatively little is known about the effects of environmental factors on disease after infection. We, therefore, initated a study on the effects of temp on bacterial canker using a local isolate of *P. syringae* and an isolate from another area. We also compared soil from old peach land to soil from new peach land as to the effects on growth of seedlings and the development of bacterial canker when seedlings growing in these soils were inoculated with *P. syringae*.

MATERIALS AND METHODS.—To determine the effect of old peach soil on growth and survival of peach seedlings, Faceville sandy loam soil was collected from an old peach orchard with a history of the short-life complex. Similar soil was also collected from an adjacent pecan grove with no known history of a peach planting. Elberta peach seedlings, *Prunus persica* (L.) Batsch, were grown from seed in peat pots for 4 wk and, in March 1969, transferred into either old peach soil or new peach soil. Single seedlings were placed in 3.5-liter pots with 225 replications for each soil. No fertilizer was added, but the seedlings were watered as needed. Height of the seedlings and mortality were determined in October, after 7 mo of growth.

To determine the effects of temp on bacterial canker development and mortality after inoculation, 120 plants from each soil were selected for uniformity in December, and from these plants, 40 in each soil were inoculated with either: (i) isolate B-3 of *P. syringae* (obtained from California) which had been reported to be highly virulent (8); (ii) isolate FV-3 obtained by us from a peach orchard at Fort Valley, Georgia; or (iii) sterile deionized-water. Both isolates were grown on King's Medium B (14) and 48 h cultures of each isolate were used for inoculum, diluted to 10^7 cells/ml, and sprayed onto one freshly cut terminal branch per plant with a small hand sprayer. Moist cotton and masking tape were then applied around each inoculated site to delay drying. After inoculation, plants were placed in growth chambers or out-of-doors, using temp of 3 C, 8 C, 23 C, or variable (outside), resulting in 24 inoculation-temp treatments with ten replications. During the test, outside temp varied between −17 C and 14 C with a mean of 3.3 C. Final measurements of canker length and plant mortality were obtained on 18 March 1970.

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 King's Medium B. Resulting colonies of *P. syringae* were identified by a characteristic yellow-green pigment and a negative oxidase test (15).

RESULTS AND DISCUSSION.—In the field, we have observed that trees growing on old peach land, initially, do not have as much vigor and do not grow as fast as trees on new peach land. In the present test, no fertilizer was added to the pots to determine if a growth difference of seedlings could be observed where only old or new soil was used as pot media. The lack of growth differences and mortality between seedlings grown in old or new peach soil (Table 1) was not anticipated by us and differs from some of the results reported by Gilmore (12, 13). He found reduced growth in old peach soil, both in containers and in the field.

In an accompanying paper (1) we reported reduced growth of peach seedlings when grown in water culture containing leachates from old peach soil. We postulate that reduced growth from any toxic substance if present in the old peach soil or roots in the present study may have been leached from the soil during watering of plants during the growing season. Also, we found no differences between the two soils in their effects on bacterial canker development in seedlings (Table 1).

There was no consistent difference in response to inoculation with the two bacterial isolates used in this test (Tables 2, 3), but the temp after inoculation had a marked effect on the extension of bacterial canker. There was only limited canker extension and no mortality at 3 C. The maximum canker extension and also the maximum mortality occurred at 23 C. The seedlings had "leafed out" in this chamber at the time of canker measurement. Some plants collapsed after "leafing out" and thus exhibited typical decline symptoms as seen in Georgia, resulting in

TABLE 1. Growth and mortality of peach seedlings in soil from an old peach site and in soil from a new peach site; and canker length after inoculation of these seedlings with *Pseudomonas syringae*

Soil Source	Mean ht[a] of seedlings (cm)	Mortality (%)	Canker[b] length (mm)
Old peach site[d]	52.3 A[c]	9.8 A	53.6 A
New peach site[e]	50.3 A	8.9 A	54.4 A

[a]Measured after 7 mo growth.
[b]Mean canker length 89 days after inoculations with isolates of *P. syringae*.
[c]Values in a column followed by the same letter do not differ significantly, $P = 0.05$.
[d]Soil obtained from an old peach site where peaches had been grown for several decades.
[e]Soil obtained from pecan grove in which peaches had not been grown.

TABLE 2. Effect of temp on canker length in peach seedlings inoculated with two isolates of *Pseudomonas syringae*

	Mean canker length (mm)			
	Isolate B-3[a]		Isolate FV-3[b]	
Temp (C)	21 days[c]	89 days	21 days	89 days
23	15.9 A[e]	118.1 A	14.9 A	115.5 A
8	9.1 A	30.1 C	8.9 B	30.3 C
3	0.4 B	15.6 D	2.1 C	13.3 D
−17 to 14[d]	9.9 A	56.0 B	8.3 B	53.4 B

[a]A virulent California isolate of *P. syringae* from peach.
[b]A local isolate of *P. syringae* from peach.
[c]Time after inoculation.
[d]Outside temp range (19 December 1969 - 18 March 1970) with a mean of 3.3 C.
[e]Values in a column followed by the same letter do not differ significantly, $P = 0.01$.

TABLE 3. Effect of temp on mortality of peach seedlings inoculated with two isolates of *Pseudomonas syringae*

Temp (C)	Mortality after 89 days (%)	
	Isolate B-3[a]	Isolate FV-3[b]
23	15 A[c]	15 A
8	5 BC	5 BC
3	0 C	0 C
−17 to 14[d]	0 C	10 AB

[a]A virulent California isolate of *P. syringae* from peach.
[b]A local isolate of *P. syringae* from peach.
[c]Values in a column followed by the same letter do not differ significantly, $P = 0.05$.
[d]Outside temp range (19 December 1969 - 18 March 1970) with a mean of 3.3 C.

15% mortality after 89 days. Plants at variable (outdoor) temp with a mean of 3.3 C and a mean maximum temp of 8.5 C, developed longer cankers than those maintained at a constant temp of 8 C (Table 2). The variation in temp may be very important in natural bacterial canker development in middle Georgia. *P. syringae* was reisolated from inoculated seedlings after 28 days, and no bacteria which produced green pigment in King's Medium B were isolated from the control seedlings inoculated with water. Also these control seedlings exhibited no disease symptoms and no mortality.

Our results correspond closely to the results reported by Dye (11) in New Zealand, who found 18.3 C to be the optimum temp for stem infection by *P. syringae* in a greenhouse test. Davis and English (7) inoculated dormant peach trees in containers with *P. syringae* in November or December, and then held them for 2 mo at 15 C with no canker symptoms developing. Other trees left in the orchard did develop cankers. They suggested that since 15 C was found earlier to be a favorable temp, some factor or factors essential for infection or disease development were present in the orchard, but absent in the growth chamber. They did not determine what these factors were.

Since we obtained infection at temp both above and below 15 C, the difference between our test and that of Davis and English was probably due to plants being in a different physiological state, with ours having received more hours of chilling. Our seedlings "budded out" soon after they were placed in the 23 C chamber.

Although we did not determine the upper limiting temp, high summer temp may be detrimental to *P. syringae* as indicated by reported difficulty in recovering the bacteria after May (4, 18).

In this test, we found greater bacterial canker extension and seedling mortality at 23 C than at lower temp. In the Fort Valley area of Georgia, warm periods occur during winter mo (2). During 20 successive winters (December, January, and February) there were 14 times when the daily maximum temp exceeded 21 C for five or more consecutive days (6). Based on results of the present study, there are periods during the winter which are favorable for rapid expansion of bacterial canker in the Fort Valley area where the short-life problem is most severe and *P. syringae* can be readily isolated from many declining peach trees. These periods favoring bacterial canker may be the same as the warm periods which predispose trees to cold injury (6).

Because several plants which died in this test (Table 3) exhibited typical decline symptoms, we suggest that growing the plants in containers for almost a year before inoculation had predisposed them to bacterial canker. Root restriction by the pots might be analogous to restriction of the root system in the field by compacted soil, root diseases, or cultural practices such as harrowing.

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