

# Influence of Soil Water and Temperature on Root Necrosis of Peach Caused by *Pythium* spp.

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## ABSTRACT

Conditions of soil water and temp had a marked and differential influence on disease severity in peach induced by *Pythium vexans* and *P. irregulare*. Growth comparisons showed that stunting induced by *P. vexans* was most severe at periodically-saturated soil water regimes, but was unaffected by temp of 13, 21, and 29 C. By contrast, stunting induced by *P. irregulare* was most severe at 13 C, but was unaffected by either periodically-

saturated or nonsaturated soil water regimes.

Our evidence suggests that disease severity induced by *P. vexans* was correlated with the favorable influence of periodic excesses of water on zoospore productions. By contrast, disease severity induced by *P. irregulare* was correlated with temp and was unaffected by conditions of soil water because sporangia formed germ tubes. Phytopathology 60:880-882.

Abundant soil water favors diseases of seedlings and ornamentals caused by *Pythium* spp. (1, 3, 9, 10, 13). Information on the influence of soil water on root necrosis of orchard perennials caused by *Pythium* spp. is limited. Peach tree decline involving feeder root necrosis caused by *Pythium* spp. was most severe following winters of heavy rainfall and moderate soil temp (8, 12). Furthermore, greenhouse pathogenicity tests revealed that *P. vexans* d.By and *P. irregulare* Buis., two species associated with feeder root necrosis of peach, differ in their soil water and temp requirements for maximum disease development (2, 12). The purpose of this study was to quantitatively evaluate the combined influence of soil water and temp on disease severity in peach induced by *P. vexans* and *P. irregulare*. The influence of water on sporangial germination and the influence of temperature on mycelial growth of these two species was also investigated.

**MATERIALS AND METHODS.**—*Pathogenicity test.*—Elberta peach (*Prunus persica* [L.] Batsch) seedlings were germinated from seed obtained from commercial canneries, and were grown separately in 7.5-cm pots for 10 weeks. Seedlings of uniform size with pot-bound root systems and single, unbranched, quiescent shoots were selected for the test. Root systems of seedlings were bound with 10-mesh plastic screen and transplanted into 15-cm pots of infested and noninfested soil mixtures. The soil mixtures consisted of equal parts of sand, sandy-clay loam soil, and pine bark; had a pH of 5.5; and had a water saturation capacity of approximately 50% (4). Soil mixtures were treated with methyl bromide at a rate of 500 g/m<sup>3</sup>.

*Pythium vexans* and *P. irregulare* were grown separately in moist sterile sand-cornmeal (95%-5% v/v) for 6 weeks in the laboratory. These inocula were incorporated into the soil mixtures at a rate of 50-cc/1,250-cc. Infested soil mixtures were watered once and then allowed to dry at greenhouse temp for 4 weeks. Microscopic examination of developing colonies on soil dilu-

tion plates revealed that this time period was sufficient for the inocula to grow saprophytically, colonize organic fractions, and form dormant spores. Inoculum levels of the *Pythium* spp. were established at approximately 75 propagules/g of air-dry soil (7).

Treatments consisted of (i) noninfested soil or soil infested with *P. vexans* or *P. irregulare* separately; (ii) periodically-saturated or nonsaturated soil water regimes; and (iii) soil temp of 13, 21, and 29 C, in all possible combinations and with five individually potted seedlings/treatment. The potted seedlings were inserted into 3.8-liter containers, and the resulting double-walled units were placed in soil temp tanks filled with water maintained at appropriate temp. Periodically-saturated soil water regimes were accomplished at 5-day intervals by subirrigating the pot inside the 3.8-liter container for 8 hr before draining. Nonsaturated soil water regimes were accomplished by irrigating the exposed soil surface of the pot when visible drooping of leaves and succulent shoots occurred.

After 30 days, new growth of shoots and the roots extending through the plastic screen were cut and weighed. Fresh shoot and root wt were analyzed from a completely randomized design in a 3 × 3 × 2 factorial arrangement of the data. Factorial treatments were compared by Duncan's multiple range test at the 5% level of significance. Statistical inferences involving infected plants were restricted to comparisons with healthy check plants subjected to the same environmental influences.

*Sporangial germination.*—Cultures of *P. vexans* and *P. irregulare* were grown in petri dishes on hemp-seed agar (HSA) for 2 weeks. Dishes were flooded with a thin film of autoclaved tap water. Actively growing noninjured peach roots were excised and added to a sample of these dishes. After incubation for 30 min, the cultures were microscopically examined.

*Mycelial growth.*—Petri dishes of HSA were seeded with discs cut with a No. 1 cork-borer from the pe-

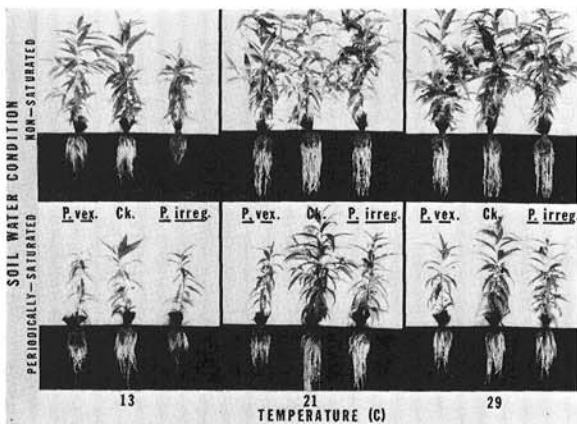
riphery of 3-day-old HSA cultures of *P. vexans* and *P. irregulare*. Cultures were grown in incubators at 5-degree intervals through the range of 5-35 C. Mean radial growth was calculated to the nearest 1 mm at three successive 24-hr intervals on three replicate dishes.

**RESULTS.—Pathogenicity test.**—*Pythium vexans* and *P. irregulare* were recovered from roots and soil of the respective infestation treatments. Final infestation levels approximated the initial 75 propagules/g levels. Shoot wt of seedlings generally paralleled root wt; however, they provided a less sensitive measure of disease severity (Fig. 1, 2). Root wt obtained from seedlings infected with *P. vexans* were severely reduced below those of healthy checks at the periodically-saturated soil water regimes, irrespective of 13-, 21-, and 29-C temp. By contrast, root wt obtained from seedlings infected with *P. irregulare* were most severely reduced below those of healthy checks at 13 C, irrespective of the periodically-saturated or nonsaturated soil water regimes.

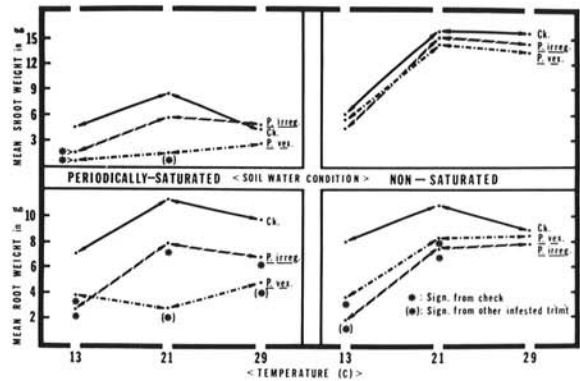
**Sporangial germination.**—Sporangia of *P. vexans* readily germinated to form zoospores in autoclaved tap water. In the presence of excised peach roots, zoospores were attracted to the zone of elongation and to breaks in the cortical tissues caused by emerging lateral roots (Fig. 3-A, B). Sporangia of *P. irregulare* did not germinate in autoclaved tap water. In the presence of excised peach roots, however, sporangia in the immediate proximity of the root surfaces formed germ-tubes (Fig. 3-C, D).

**Mycelial growth.**—Both *P. vexans* and *P. irregulare* grew fastest at 30 C. *Pythium vexans* was severely restricted in growth at 5 and 35 C, and grew slower than *P. irregulare* throughout the temp range of 5 to 35 C.

**DISCUSSION.**—The influences of environment on disease severity of woody perennials infected by *Pythium* are difficult to evaluate. Foliar symptoms of infected plants resemble those associated with any root injury that interferes with water and mineral absorption. Root



**Fig. 1.** Pathogen-temp-soil water influences on shoot and root growth of peach. Plants grown in soil infested with either *Pythium vexans* or *P. irregulare* are shown relative to check plants grown at the same environmental conditions but in noninfested soil.



**Fig. 2.** Pathogen-temp-soil water influences on shoot and root growth of peach. Mean shoot and root wt of plants grown in soil infested with either *Pythium vexans* or *P. irregulare* are shown relative to the mean shoot and root wt of check plants grown at the same environmental conditions but in noninfested soil (significant [Sign.] departures in shoot or root wt from that of checks [Ck.] are indicated by \*).

symptoms are not readily discernible, as infected cortical tissues appear similar to suberized tissues of healthy roots. However, since shoot and root systems of woody perennials infected by *Pythium* are restricted in growth, the influences of environment on disease severity can be objectively evaluated by shoot and root comparisons with healthy check plants.

Increased activity of pythiaceous fungi in wet soils is attributed to a dependency on water for zoospore production (5), and to an ability to tolerate conditions of poor gas exchange (6). Abundant soil water may further stimulate *Pythium* activity by increasing host exudates (9). With reference to our study, we suggest that abundant soil water and the capacity of *P. vexans* to produce zoospores provided this fungus with an intensified infection potential, either in the form of an increase in inoculum density or a greater mobility for finding infection sites. We further suggest that the infection potential of *P. irregulare* was unaltered, because abundant soil water is not a necessity for the extension of sporangial germ-tubes.

Diseases caused by *Pythium* spp. are reported to be most severe at temp unfavorable for growth of the host, irrespective of the optimum temp for growth of the fungus (10). This relationship was evident with *P. irregulare*; growth reductions induced by this fungus were most severe at 13 C, the optimum for growth of peach seedlings is reported as 18 C (11), and the optimum for mycelial growth of the fungus was 30 C. In the case of *P. vexans*, the temp relationship was obscured because disease severity induced by this fungus strongly reflected the influence of soil water. When the influence of temp on disease severity induced by each pathogen was summed over the influence of soil water, our results agreed with the findings of prior temp studies involving these two pathogens (8, 12). *Pythium irregulare* caused greater reductions of growth at lower soil temp, whereas *P. vexans* caused greater reductions of growth at higher temperatures.

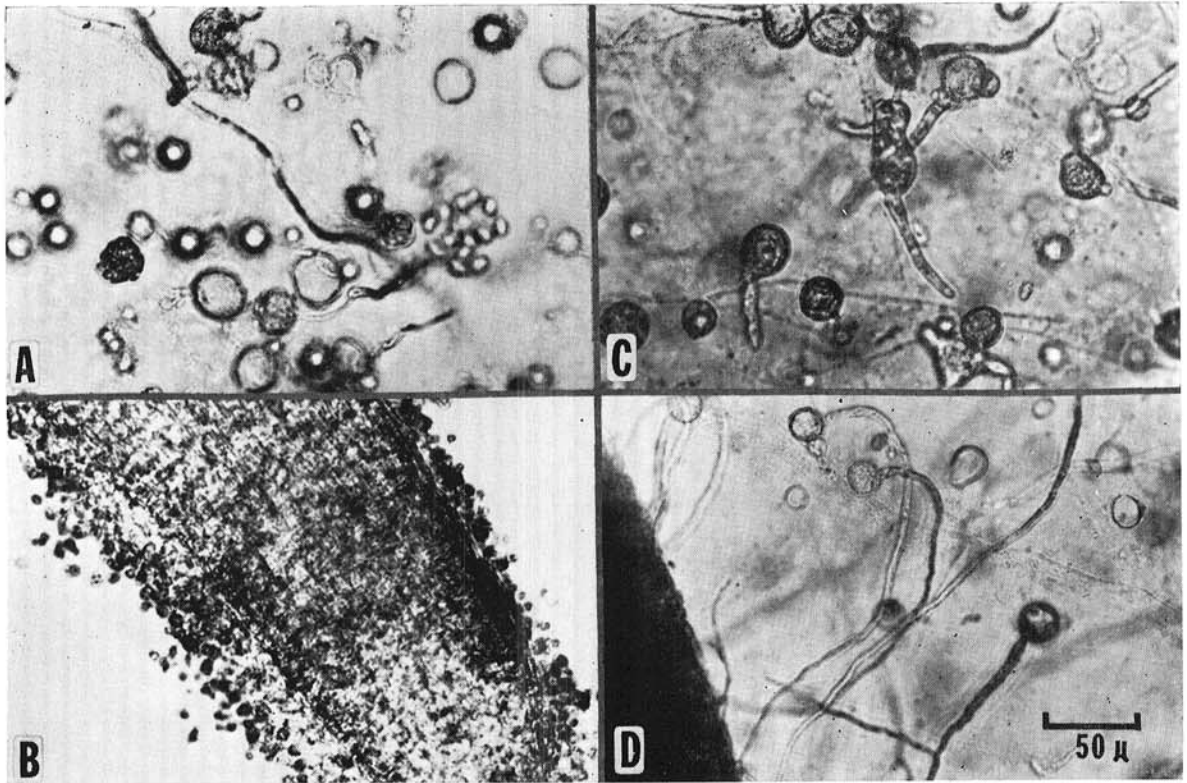


Fig. 3. Petri dish observations on sporangial germination. A, B) *Pythium vexans*; A) indirect germination; B) zoospore encystment on root. C, D) *Pythium irregulare*; C) direct germination; D) germ-tubes in proximity of root.

Findings of our study relate to orchard situations in the southeastern USA in the following manner. Winter and Spring rains produce periodically flooded and saturated conditions in the field. These conditions, together with moderately cold temp, favor build-up liberation, dispersal, and infection by *Pythium* inocula. Moreover, the flooded and saturated soils are slower to warm, thereby further retarding root growth of host plants. These factors acting and interacting together severely restrict root growth at a time when it is at a premium due to the demands of budbreak and the initiation of flower and leaf growth.

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