Distribution of Root-Rotting Fungi In Citrus Orchards As Affected by Soil Oxygen Supply

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THE SUPPLY OF OXYGEN in the soil is one important factor restricting the parasitism of root rotting fungi on citrus. The relationships of oxygen (in two types of soil) to several citrus root parasites as well as germination and growth of three of the fungi in pure culture were determined in recent experimentation.

Isolations

Isolations made from 94 soil samples in the surface foot in one orchard yielded 35 isolates of *Thielaviopsis basicola*, but 94 samples from the second foot produced only one culture of that fungus—suggesting a relationship to soil oxygen. To learn more about the distribution of root rotting fungi at several depths in an orchard, the soil profile was exposed and samples of soil were obtained at depths of 24, 21, 18, 15, 12, 9, 6, and 3 inches, and at the surface, for six tree sites. Oxygen diffusion rates also were measured at one site. Of 18 samples from the top 6 inches of soil, 15 yielded the fungus; while only four of 36 samples from below 6 inches yielded the organism. Oxygen diffusion rates were found to be progressively less with depth, indicating that oxygen supply limits the distribution of the fungus.

Distribution

Phytophthora spp. differed in distribution from *T. basicola* in that they were recovered in nine of 18 samples from the top 6 inches of soil and from 33 of 36 samples taken below 6 inches. Only one recovery was obtained from six surface samples—indicating destruction of *Phytophthora* spp. (the so-called water molds) by drying.

At 12-, 15-, 18-, 21-, and 24-inch depths, 29 of 30 samples yielded *Phytophthora* spp. These fungi apparently thrive at the oxygen concentrations found in these orchard soils. Closely related fungi, *Pythium* spp., some species of which cause damping-off of citrus seedlings, were found throughout the profile, indicating a low oxygen requirement.

Some species of Mucorales fungi (which cause citrus fruit decay) were found to have a high oxygen requirement. None was recovered below the 3-inch level.

Germination

Studies of the effects of several oxygen concentrations on the germination of the zoospores of *Phytophthora citrophthora* and *P. parasitica* and on the endoconidia of *Thielaviopsis basicola* also were made. Zoospores of *P. parasitica* germinated well at all oxygen concentrations used, from 40 parts per billion (ppb) to 40 parts per million (ppm); but concentrations of 40 to 160 ppb markedly delayed germination of *P. citrophthora* zoospores.

Endoconidia of *T. basicola* did not germinate at 630 ppb or 1260 ppb and only very slowly at 2.4 ppm. Under the conditions of the period of these experiments, the dark colored chlamydospores of *T. basicola* did not germinate at any oxygen concentration used.

An oxygen concentration of 40 ppm greatly retarded germination of *P. citrophthora* zoospores, slightly retarded those of *P. parasitica* and greatly stimulated the germination of endoconidia of *T. basicola*.

Damage

The data indicate the influence of oxygen concentration on the distribution in soil of citrus root rotting fungi and thus the number of fibrous feeder roots they can destroy. In pot cultures in the greenhouse, *T. basicola* made small discrete lesions on feeder roots but did not attack the main and lateral roots. The importance of its activity, if any, in the orchard is apparently confined to roots in the upper soil layers because of its dependence on high oxygen concentrations. However, examination of feeder roots from some orchard soils having abundant *T. basicola* failed to reveal a consistent relationship of the fungus with any lesions.

The two *Phytophthora* spp. thrive in the presence of oxygen concentrations found in the citrus orchards investigated and can destroy the feeder root system under soil moisture conditions that favor these water molds.

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