Effect of Oxygen Tension on the Growth of Phytophthora cactorum

Ronald P. Covey, Jr.

Assistant Plant Pathologist, Tree Fruit Research Center, Wenatchee, Washington 98801.
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ABSTRACT

When three cultures of *Phytophthora cactorum* were grown at O_2 levels ranging from 21% to 0.2%, maximum dry wt of each culture was obtained at 21% O_2, and wt decreased with each decrease of percentage O_2. Phytopathology 60:358-359.

Phytophthora cactorum (Leb. & Cohn) Schroet., the causal organism of collar or crown rot of many deciduous fruit trees, is a soil-borne organism favored by high soil moisture. In Washington, symptoms of the disease are seldom found on roots more than 46 cm from the trunk. Greenhouse studies by McIntosh & O'Reilly (3) proved that *P. cactorum* is a much more efficient pathogen of pears when excess water is applied by dripping rather than by flooding. These observations indicated that air exchange could be important to the development of *P. cactorum* in soil. The following study was undertaken to determine the effect of oxygen tension on *P. cactorum*.

MATERIALS AND METHODS.—Various oxygen concentrations (0.2, 5.0, 10.5, and 21%) were obtained by mixing compressed nitrogen and oxygen (Fig. 1). The nitrogen source contained 0.2% oxygen; thus, oxygen concentrations below this level were not studied. Rate of gaseous exchange in the liquid media was controlled by adjusting screw clamps on the rubber tubing connecting the flask and the mixing chamber. Oxygen content was determined with a Beckman oxygen analyzer.

The medium, potato-dextrose broth (PDB), was made from the filtered broth obtained from 22 g instant potato flakes plus 10 g dextrose, and brought to 1 liter with distilled water. Sixteen 125-ml flasks, each containing 30 ml of PDB, were inoculated with 5-mm plugs of *P. cactorum* cut from the advancing edge of cultures grown on potato-dextrose agar. Since the gaseous mixture was bubbled through the medium, no other agitation was required.

One of the three cultures, 118-10, was isolated from water in an irrigation ditch near Wenatchee, Washington, and two others (237 and 239) were from the Oregon State University *P. cactorum* collection of H. Ronald Cameron. Each culture was tested twice, and each treatment replicated eight times. Although constant temperature facilities were not available, laboratory temperature varied only from 22-24 C during the course of this experiment. Data on the three cultures are, therefore, somewhat comparable.

RESULTS.—Growth was determined on the basis of mycelial dry wt 7 days after inoculation (Fig. 2). Maximum growth of all cultures occurred at 21% oxygen; minimum growth at 0.2% oxygen.

The relationship between oxygen content and mycelial wt of cultures 118-10 and 237 was nearly linear between 5 and 21% O_2, but it dropped off rapidly below 5% O_2. Dry wt of culture 239 decreased slightly from 21% and 10.5%, then fell off rapidly as the oxygen content decreased to 0.2%; however, the wt was equal to or greater than that of the other two cultures at each oxygen concentration.

Since all three cultures grew at 0.2% oxygen, the question arose as to equilibration time for the media. Placing the oxygen electrode directly into the medium showed that less than 1 hr was required for equilibration.

DISCUSSION.—Since each culture made restricted growth at low (0.2%) oxygen levels, *P. cactorum* development in soil is probably not limited by lack of oxygen per se. The possibility that low oxygen concentration and other factors, i.e., CO_2 and low concentration of toxic substances, are additive should be explored.

Klotz et al. (2) found that growth of *Phytophthora parasitica* and *P. citrophthora* were directly proportional to the concentration of oxygen (between 21 and 0.04%), with maximum growth occurring at 21% oxygen. However, Dukes & Apple (1), studying *P. parasitica* var. *nicotianae,* and Sherwood & Hagedorn (4), studying *Aphanomyces euteiches,* found that maximum growth of these fungi occurred at about 5% oxygen. The growth patterns found in the current study and those reported by Klotz et al. (2) are similar. They differ considerably from those reported by Dukes & Apple (1) and Sherwood & Hagedorn (4). It should be noted that the latter two studies were made under static conditions (a sealed container with an initial but decreasing concentration of oxygen), while Klotz et al. (2) used a flowing gas system similar to mine. Whether the different responses noted were due to difference in organisms or differences in tech-

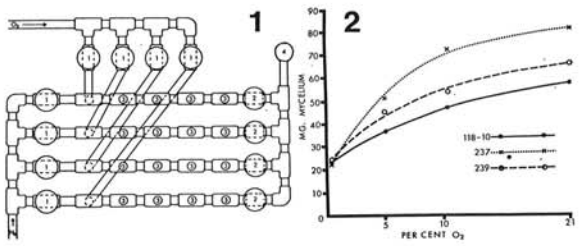

Fig. 1-2. **1)** Schematic drawing of oxygen and nitrogen mixturing apparatus. 1 = Needle valves; 2 = gate valves; 3 = nipples for tubing attachment; 4 = sensing chamber. Quarter-inch pipe and fittings were used in constructing the apparatus. **2)** Growth in mg of three cultures (118-10, 237, 239) of *Phytophthora cactorum* after 7 days' exposure to various concentrations of gaseous oxygen.

nique should be determined. It is difficult to conceive that the differences are due to technique, since the flowing gas system should be able to demonstrate the lower oxygen requirement at least as effectively as the static system.

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