

ERADICATION OF PHYTOPHTHORA CINNAMOMI IN AVOCADO SEED BY HOT WATER TREATMENT

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Phytophthora root rot has become the most important disease of avocado in southern California. Unofficial estimates in 1940 placed the number of affected acres at 500 (2), now some 3500 acres are involved (3). It is probable that this spread is primarily due to movement of infected nursery stock (3, 4, 5).

While fumigation by methyl bromide or chloropicrin can free nursery soil of Phytophthora, the problem of eliminating the fungus from infected seed or nursery stock still remains. Attempts to do this by means of chemical drenches or dips have not in general been satisfactory. Preliminary experiments have shown that avocado seed and seedlings can withstand immersion in hot water at 120°F. for 30 minutes (1). This fact, together with the relatively low thermal tolerance of Phytophthora spp., indicated that a hot-water seed treatment might be an effective and inexpensive way of eradicating the fungus from infected plant parts.

A series of seed treatments using hot water at various temperatures and for various lengths of time was tested. Seed of both Mexican and Guatemalan varieties, which had been stored for various time periods, were used. The results following a 30-minute treatment (table 1) showed that the seed would tolerate a temperature of 125°F. without germination being affected. At 130°F. decreased germination was evident, while all seed was killed at 135°F. and above. At 120°F. hot-water treatment even for 1¼ hours did not reduce germination percentages. These results held true for both Guatemalan and Mexican varieties and for seed stored up to eighteen months.

Table 1. Germination counts after a 30 minute hot-water treatment at various temperatures. Counts were taken 2 months after planting. The numerator indicates the number of seedlings, while the denominator refers to the total number of seeds used for the treatment.

68°F.	18/20
120°	118/122
125°	55/59
130°	18/35
135°	0/40
140°	0/40
No treatment	40/40

Seed which had been artificially inoculated with Phytophthora was also hot-water

treated. The presence of the fungus after the treatment was ascertained by both culturing and examination of planted seed. In some cases the fungus had killed the growing points before the heat treatment, so that the germination counts were not a reflection of the control achieved. However, in no case was the fungus recovered from 100 infected seed which had been treated at either 120°F. or 125°F. for 30 minutes or longer. Lower temperatures did not adequately control the disease. The plants from treated seed appeared healthy and showed no sign of root damage, even under periodic wet-soil conditions. All of the 50 infected seed which was not heat treated showed evidence of fungus activity.

The principle behind the use of moist heat for killing disease organisms is that the plant can stand more heat than can the organism. This method of disease control has been in use since 1882. The hot-water treatment used in this work is inexpensive, does an excellent job of eradicating internally-borne pathogens, and requires only a simple procedure. A 100-200 gallon tank for treatment is desirable because of greater ease of temperature control, but a sink or tub is adequate. A circulating pump or a wooden paddle should be utilized to agitate the water bath. A trickle of steam or water 20°-25°F. above that of the treatment is used to keep the temperature within 0.5°F. above or below that required. Such temperature control, although relatively easier to maintain in large containers, can be achieved in small units with a little practice. The thermometers must be accurate within the treatment range; they may be calibrated against precision thermometers or, as a second choice, against boiling water and a water ice mixture to define the boiling and freezing points, respectively.

Porous cloth bags or wire screen containers are used to hold the seeds during immersion. They should not be filled more than 2/3 full or the water circulation will be restricted. Introduction of too many seeds at one time into a small tank will excessively lower the water temperature. A larger bath or fewer seeds must then be used. After the required time the containers are removed from the water bath and promptly cooled by immersing in or spraying with clean, cold water. The material is then spread out to dry on a surface not in contact with the ground, and is then ready for planting. It is extremely important that the seeds be planted in soil freed of the pathogen by a chemical or steam treatment in order to avoid reinfection.

It has been recommended that since the *Phytophthora* fungus can enter wind-fallen fruit and grow into the seed, only seed which has been picked from the tree be used for planting. Using seed treated with hot water at 120°-125°F. for 30 minutes eliminates the possibility of introducing the pathogen into the nursery on seed, even though it might have been originally infected. This treatment coupled with a soil treatment, in the case of container-grown stock, or careful selection of a site when planting directly in the soil, should materially reduce the spread of the disease by means of infected nursery stock.

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