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Laboratory Study of Steaming

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Idealite or similar inert media may replace soil in the Colorado carnation industry (Holley, 1967). Steaming of idealite seems to be no problem in practice, but questions have arisen concerning whether pathogens enter the pores of the stones and how much time is required to heat the particles through.

It was assumed that if an organism enters idealite particles, a large particle would take longer time to steam than a small one. Before the final idealite steaming was done, it was necessary to determine the killing time by steam of the pathogens in pure cultures and in tissue. Several experiments were done with infected inch-long stem pieces, pure cultures of the pathogens on wheat seeds, and on potato-dextrose agar (PDA). One experiment was done with infected roots of carnation.

The apparatus used for the experiments is shown in Figure 1. It consists of a bottle with boiling water, the neck of which contains a netting with the pathogens. The stopper was put in at the same time as the netting, but steam could escape at the sides of the stopper.

The pathogens, *Phialophora cinerescens*, *Fusarium oxysporum* f. sp. *dianthi*, *F. roseum*, *Rhizoctonia solani*, *Pythium ultimum* and *Phytophthora* sp. were grown in flasks for 1-2 weeks on sterile idealite stones of the following sizes 2-3, 5-6, 7-8, 10-12, and 14-16 mm. The sterile stones were moistened with nutrient broth to encourage growth of the organisms. *Pseudomonas caryophylli* was grown on PDA, and then some of the bacteria were suspended in water. Dry idealite stones were half submerged in the bacterial suspension. Water was sucked up by the stones and when they were wet on the top they were used in the experiment.

Stones from all five sizes were steamed together. After the steaming the particles were crushed and

spread on potato dextrose agar. The result of pure culture and tissue steaming appears in Table 1 and the result of idealite steaming in Table 2.

All pathogens in idealite were killed within 20 seconds, except *Ps. caryophylli*. Several further experiments were needed to establish the killing temperature for this organism. Since it was killed in 10 seconds on infested filter paper pieces, it was obvious that the bacteria entered the stones. Table 3 gives the final result of the experiments.

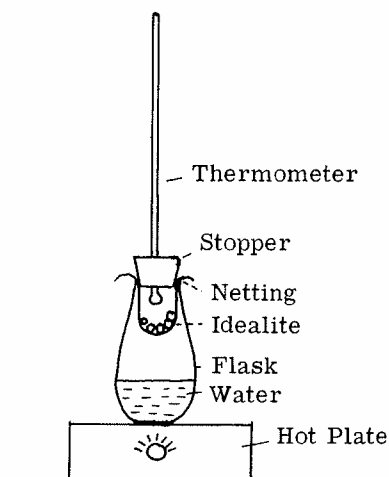


Fig. 1. Bottle used for laboratory study of steaming. The netting with the infested stones was placed in the bottle when the water was boiling.

Table 1. The time in seconds required to kill pathogenic organisms in various environments.

Pathogen	Environment				
	Stems	Leaves	Roots	Wheat	PDA
<i>Ph. cinerescens</i>	10				20
<i>F. oxysporum</i>	10*(40)	10	20**	10	10
<i>F. roseum</i>					20
<i>Rh. solani</i>				30***	10
<i>P. ultimum</i>					10
<i>Phytophthora</i> sp.					10
<i>Ps. caryophylli</i>					10****

*Only one section of a stem piece gave growth of *F. oxysporum* after 30 seconds steaming. In all the others, 10 seconds were enough.

**10 seconds were not tried.

***One seed gave growth at 20 seconds but normally *Rhizoctonia* was killed in 10-20 seconds.

****Pieces of filter paper wetted with the bacterial suspension.

Table 2. Effect of steam on 5 pathogens on idealite. The sign + indicates growth and - no growth. The signs represent the five sizes of idealite with the smallest size to the left.

Pathogens	Control not steamed	Steaming Time in Seconds			
		10	15	20	30
<i>Ph. cinerescens</i>	+++++	+++++		-----	-----
<i>F. oxysporum</i>	+++++		-----	-----	-----
<i>R. roseum</i>	+++++		+-----	-----	-----
<i>P. ultimum</i>	+++++		-----		-----
<i>Ps. caryophylli</i>	+++++	+++++		+++++	+++++

Table 3. Time required to kill *Pseudomonas caryophylli* in five sizes of idealite.

Steaming time in seconds	Sizes of idealite in mm				
	2-3	5-6	7-8	10-12	14-16
30	+	+	+	+	+
35	+	+	+	+	+
45	-	+	+	+	+
60	-	-	-	+	+
120	-	-	-	-	+
300	-	-	-	-	-

Discussion of Results

From the practical point of view, it is safe to steam until the temperature in the medium reaches 180 degrees F in the bottom of the bench, and to keep it there or higher for 30 minutes. If we were sure that we measured the temperature in the coolest place of the medium, 5 minutes would be enough, but we must take into account cool spots due to uneven moisture or steam distribution, and wooden construction of the benches, which need comparatively more heat.

Literature Cited

Holley, W. D. 1967. Inert media to replace soil? Col. Flw. Gro. Bull. 205.