SOIL STERILIZATION BY MICROWAVE HEATING

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The process of soil sterilization is an important procedure for any greenhouse operation concerned with the control of soil-borne plant pathogens. Common problems such as damping off, root rot, and wilt can be controlled if the soil used for potting was sterilized. On the commercial scale most soil is steam sterilized, a process that is both laborious and time consuming, but without which severe economic losses could be suffered.

To most people, the microwave oven is a convenient and time-saving appliance in the kitchen. Although microwave energy is used quite extensively for food preparation both privately and commercially, no evidence was found that the microwave principle has been used to sterilize soil to eliminate plant pathogenic microorganisms. The "quick-heating" feature of microwave energy has been shown to be of value in preparing media for the culture of fungi and bacteria as opposed to the use of an autoclave which operates by pressurized steam (1). With the use of a kitchen-size microwave oven on loan from a commercial flower grower, studies were initiated to determine the extent to which it could be utilized to eliminate plant pathogenic fungi from small samples of soil.

Methods

Cultures of five soil-inhabiting, plant pathogenic fungi (Rhizoctonia, Pythium, Fusarium, Verticillium, and Thielaviopsis) were grown on sterilized wheat seed in separate flasks to provide inoculum. To test the viability of these fungi in wheat seeds or soil before or after exposure in the oven, samples of the seeds or soil were placed on nutrient-rich media (potato dextrose agar) contained in sterile petri plates and incubated at room temperature for 3-6 days. If the microwave was effective in sterilizing the seeds or soil, no fungi would grow on the media.

Seeds from each of the five cultures were exposed in the oven for 15 and 30 minute intervals; an equal amount from each culture was left unexposed. The seeds were then transferred to the culture plates and incubated for three days, then the size of the fungal colony around each wheat seed was measured.

The affect of a moist soil environment around the infected wheat seeds was examined by burying samples of each of the five cultures in a two inch deep pan filled with sterilized soil. Three samples of each of the five cultures (four seeds per sample) were buried to a depth of one inch with a spacing of one inch between samples. One sample of each of the five cultures was removed after 15, 30, and 45 minutes exposure in the microwave oven. A fourth sample was not exposed and was used as a control. The four seeds in each sample were then evenly spaced on culture media in a petri dish and incubated at room temperature for 6 days. This procedure was repeated using moist field soil, sand, and a 2:1:1 (soil:sand:peat) potting mix.

To determine if heavily infested soil could be sterilized by microwave energy, wheat seeds from three of the fungal cultures (Fusarium, Verticillium, and Thielaviopsis) were placed in a glass beaker containing moist 2:1:1 soil mix, covered, and allowed to stand for 10 days. The beaker was approximately 3.5 inches in diameter and 4.5 inches deep. This provided a greater depth to which the microwave energy had to penetrate in order to have a sterilizing affect. After exposure times of 0, 15, and 30 minutes, small samples of soil were taken from various depths in the beaker and placed on culture media. These plates were incubated at room temperature for 6 days and then examined for fungal growth.

Results

As can be seen from Table 1, there was a decrease in amount of fungal growth from infected wheat seeds with greater exposure intervals. However, when this test was repeated and the plates were allowed to incubate for two weeks, the difference in fungal growth was not evident even at exposure times of up to 60 minutes.

We found that when a moist environment such as soil is provided for the infected wheat seeds, they are sterilized in as short a time as 15 minutes (Table 2). This held true for all three soil types. It was noted that at longer exposure times, the seeds and other organic matter in the soil were charred.

When the beaker of soil was exposed to the microwaves, it took no longer than 15 minutes to sterilize it throughout the depth of the beaker (Table 3).

Discussion

Provided there was adequate moisture available, the microwave oven was capable of sterilizing wheat seeds infected with fungal pathogens and infested soil in less than 15 minutes. When infected weeds were exposed to microwave energy without any soil, the fungal population was reduced, but was not eliminated even at exposure times of 60 minutes. Apparently the seeds alone did not have enough moisture available to provide the heat transfer needed for sterilization.

Although these experiments do not show that sterilizing soil by microwave energy is superior to other methods, they do indicate that an alternate method other than steam is possible and warrants further investigation.

Table 1. Effect of microwave heating on wheat seeds infected with five different fungi.

	Exposure Times		
Fungus	0 min. (check)	15 minutes	30 minutes
Pythium	1.4 cm [1/]	1.0	0.8
Fusarium	2.9 cm	2.6	2.5
Rhizoctonia	-- [2/]	--	--
Verticillium	1.1	0.7	0.0
Thielaviopsis	1.6	1.2	0.0

1/ Values are the average diameter of colonies growing from four wheat seeds.
2/ Fungal culture contaminated -- reading discarded.

Table 2. Effect of microwave heating on infected wheat seed in different soils.

		Exposure Times					
Fungus	Soil Type	0 (control)	15	30	45	60	90
Fusarium	Sand	4.8cm [1/]		0.0		0.0	0.0
	Field Soil	5.0	0.0	0.0	0.0		
	2:1:1 Mix	4.8	0.0	0.0	0.0		
Verticillium	Sand	1.8		0.0		0.0	0.0
	Field Soil	2.2	0.0	0.0	0.0		
	2:1:1	2.1 [2/]		0.0		0.0	0.0
Rhizoctonia	Sand	--		0.0		0.0	0.0
	Field Soil	--	0.0	0.0	0.0		
	2:1:1 Mix	--	0.0	0.0	0.0		
Pythium	Sand	--		0.0		0.0	0.0
	Field Soil	--	0.0	0.0	0.0		
	2:1:1	--	0.0	0.0	0.0		
Thielaviopsis	Sand	2.5		0.0		0.0	0.0
	Field Soil	2.9	0.0	0.0	0.0		
	2:1:1 Mix	2.9	0.0	0.0	0.0		

1/ Values are average diameter of colonies growing from four wheat seeds.
2/ Stock fungal culture contaminated.

Table 3. *Effect of* microwave heating on soil infested with Verticillium, Fusarium and Thielaviopsis.

Sample	Exposure Times		
#	0 (check)	15	30
1	Abundant growth	No growth	No growth
2	Abundant growth	No growth	No growth
3	Abundant growth	No growth	No growth
4	Abundant growth	No growth	No growth

Literature Cited

1. Guthrie, J. W. and J. Anderegg. 1975. Fast, convenient media preparation via microwave oven. Turtox News 52:2. pp. 2-3.

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