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Temperature and dosage dependent suppression of damping-off caused by *Rhizoctonia solani* in vermicompost amended nurseries of white pumpkin

(with 3 tables & 2 figures)

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Abstract. It is generally accepted that composts have the potential to provide biological control of plant diseases. However, there has been little research on the use of vermicomposts for the same purpose. The aim of this paper was to evaluate a vermicompost suppressiveness in nurseries of white pumpkin infested with *Rhizoctonia solani*. Two assays were carried out at 22 ± 2 °C and 15 ± 3 °C, with increasing proportions of compost in the substratum. Seedlings with damping-off or incipient crown rot, as well as those that did not emerge as expected for the germination power, were considered diseased. Vermicompost's effectiveness in suppressing the disease depended on dosage and temperature.

Additional key words: *Benincasa hispida,* Cucurbitaceae, disease control, soilborne pathogen.

Composts have the potential to provide biological control of plant diseases (5). One of the beneficial properties of compost-amended plant growth media is the microbially induced suppression of soilborne plant pathogens (7, 12, 4, 8). They can have enough quality to be successfully used in disease management of horticultural crops, particularly in potted plants substrates (6). A number of factors may affect suppression of diseases in compost-amended growth media. It is likely that temperature, moisture, compost dosage and target pathogen can contribute to variations in the degree of suppress (1).

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Rhizoctonia solani Kühn is an ubiquitous soil-borne fungus that combines strong saprophytic capabilities with facultative parasitism of a wide range of host plant species (16). In sustainable plant production, composts are a viable alternative for the control of soilborne fungal pathogens as *R. solani* (11, 3, 18, 2, 17). However, there has been little research on the use of vermicomposts for the same purpose (19, 14, 13). This work evaluates a vermicompost suppression in nurseries of white pumpkin (*Benincasa hispida* (Thunb.) Cogn., Cucurbitaceae) infested with *R. solani*, at two temperatures.

MATERIALS & METHODS

Trials were carried out at 22 ± 2 °C and 15 ± 3 °C, in randomized complete blocks with 16 repetitions. Experimental units were plastic trays of 15.5 cm x 6.5 cm x 4.5 cm. Treatments were defined by the proportion of compost in the substratum. A one year old vermicompost (pH: 6.8) obtained from residues of cattle slaughtherhouse, was used in mixtures with soil as substratum. This compost suppressed damping-off caused by *Rhizoctonia solani* on winter squash (*Cucurbita maxima* Duch.) (19).

The pathogen was cultivated in sterilized mineral soil (pH: 6.5). Isolate R 81 of *R. solani* AG-4 (virulence grade: 5), isolated from soybean *(Glycine max* (L.) Merrill) and proved to be pathogenic on *B. hispida*, was used. Inoculum was obtained from growth on potato dextrose agar (PDA) 2% pH: 7 and multiplied by inoculation of sterilized oat grains. The soil, previously autoclaved, was inoculated with grains colonized by the pathogen (0,1% v/v) and incubated in humid chambers at 21-24 °C during 10 days.

After preparing substrate mixtures, the trays were kept in humid chambers for 10 days before sowing. Two hundreed seeds of white pumpkin (80% of germination) were sown in each container. The trays were daily irrigated so as to avoid water stress, and remained in humid chambers with a 12-h photoperiod for 10 more days, when evaluation was done. Seedlings with damping off or incipient crown rot, as well as those that did not emerge as expected from the germination power, were considered diseased. Our hypothesis were that the average number of healthy seedlings per tray depends on the interaction of temperature and the proportion of compost in the mixture.

Analysis of variance was done to study the group of experiments. Heterocedasticity was detected by Levene Test (10). Residuals were examined for the model with transformed data using $arcsin\sqrt{p+1}$ and ranks, where *p* is the proportion of healthy seedlings per tray. With the former transformation it was not possible to correct the departure of the assumed model ($p<0.0001$) so, the tranformation by ranks was finally the choice for the analysis. Ryan test was used to compare treatment means.

The relationship between proportion of compost and percentage of healthy seedlings was explored by regression analysis (15).

RESULTS & DISCUSSION

At both temperatures, interaction between dosage and temperature was significant ($F= 117.07$, $p< 0.0001$), so treatments were compared within each experiment. Disease control significantly increased with the amendment of compost. Dead seedlings were not observed when 100% compost was used as substrate.

At 22 ± 2 °C, differences were detected among all treatment means. The proportion of healthy seedlings increased with increasing vermicompost doses (Table 1). In spite of this, disease control was low, even with 75% of compost. The relation between the proportion of compost and percentage means of healthy seedlings can be described by a parabola (Table 3 and Figure 1).

At 15 ± 3 °C, percentage means of healthy seedlings increased with the addition of compost and all treatment means were significantly different (Table 2). This relation can be described by a linear function (Table 3 & figure 2). In this case, an acceptable efficiency in disease control was obtained with 75% of compost, as this dose duplicated the number of healthy seedlings of control treatments.

Transformed means of the two experiments were compared for each level of compost. Significant differences were found in every comparison. For treatments with 25 to 75% of compost, the efficiency in the disease control was markedly higher at temperatures of 15 ± 3 °C. These results can be partially attributed to a decrease in the pathogen's aggressiveness, as it is shown in control treatments with 0% of compost (100% infested soil). Among inoculated treatments, the mixture with 75% of compost presented a percentage of diseased seedlings significantly smaller than the others, at both temperatures.

The analysis of these results provides an evidence of distinct temperature-dependent compost activity. In a previous work (19), this vermicompost's suppressive ability was evaluated in nurseries of winter squash (*C. maxima* Duchesne, Cucurbitaceae) infested with *R. solani* at 21-24 °C. A linear response was observed in disease control.

To our knowledge, there is only one published work related to the effect of temperature on compost suppressiveness (1). According to the authors, despite reported succeses, variability in suppression and a poor understanding of factors affecting this variability continue to hamper the widespread adoption of compost-amended growth media. Understanding how an amendment controls plant disease and what soil factors regulate its activity is critical for reducing the rates needed and improving efficacy (9). Our results have shown that dosage and temperature influence

Table 1.– Means of healthy seedlings in experiment 1 at 22 ± 2 ºC

% infected soil (vol.)	% compost (vol.)	Mean of healthy seedlings (%) 80% germination	Significance (*)
100	0	0.38	A
75	25	0.88	B
50	50	7.50	C
25	75	17.59	D
0	100	80.38	E

F= 879.00 p<0.0001
(*) Different letters indicate significant differences
Data were transformed for analysis.

Table 2.– Means of healthy seedlings in experiment 2 at 15 ± 3 ºC

% infected soil (vol.)	% compost (vol.)	Mean of healthy seedlings (%) 80% germination	Significance (*)
100	0	28.63	A
75	25	41.06	B
50	50	49.94	C
25	75	59.13	D
0	100	73.13	E

F= 67.98 p<0.0001
(*) Different letters indicate significant differences.
Data were transformed for analysis.

Table 3.– Relation between means of healthy seedlings and percentage of compost

Experiment 1(22 + 2 ºC)		
Variable	Coefficient	p-value
Intercept 4.2928	0.019	
Linear Component of % compost	-0.7568	<0.0001
Cuadratic component of % compost	0.0146	<0.0001

R^2= 0.94

Experiment 2 (15 + 3 ºC)		
Variable	Coefficient	p-value
Intercept	28.9625	<0.0001
Linear Component of % compost	0.4283	<0.0001

R^2= 0.75

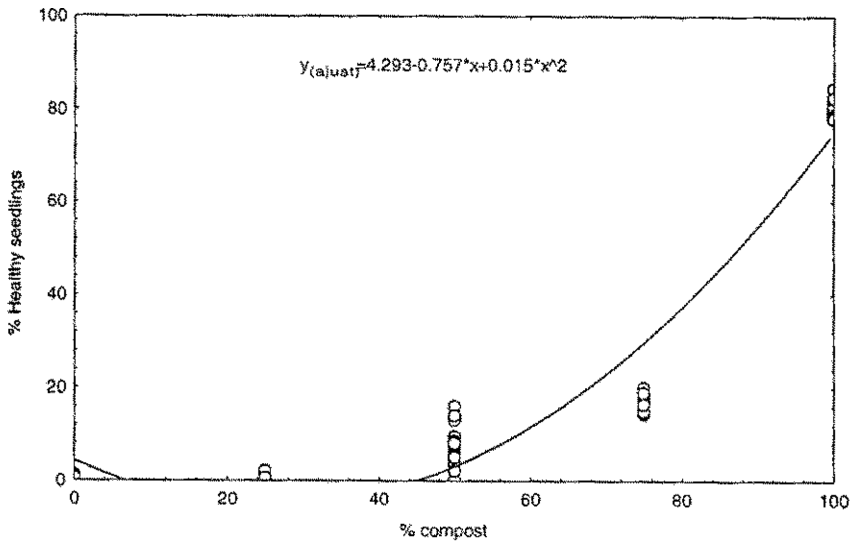

Fig. 1.– Relation between percentage of healthy seedlings and percentage of compost at 22 ± 2 °C

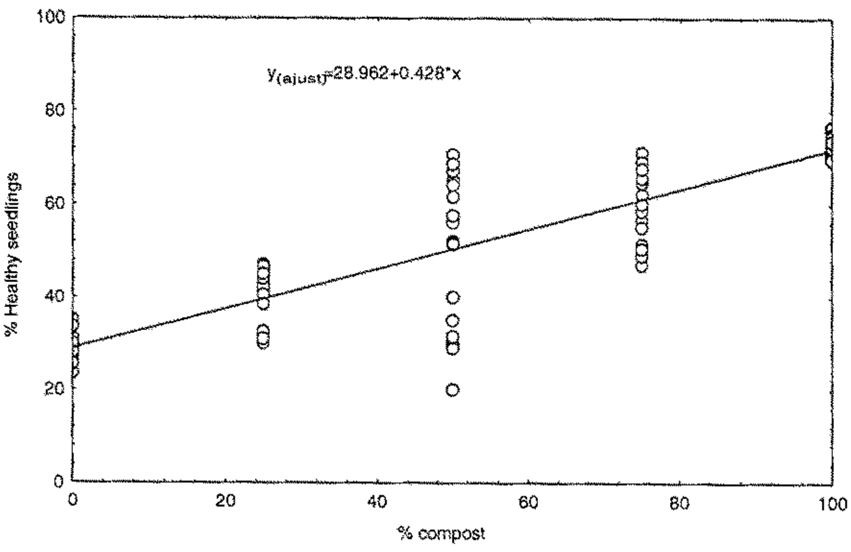

Fig. 2.– Relation between percentage of healthy seedlings and percentage of compost at 15 ± 3 °C

the effectiveness of amendments with vermicompost as a tool in the management of *Rhizoctonia solani* damping-off of white pumpkin. Further assays are needed to determine the temperature at which the response to the addition of compost turns from linear to parabolic, and if other environmental factors contribute to the response. Whether these differential temperature responses are due to different microbial activities has also to be estudied.

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