Acetic Acid Vapours For Controlling Tomato Root Rot Disease Under Greenhouse Conditions

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ABSTRACT

Effect of acetic acid vapours on tomato root rot fungi under laboratory and greenhouse conditions was studied. Acetic acid vapours at four concentrations i.e.0.0, 2, 4 and 6 μL were tested against linear growth of F. solani, R. solanii and S rolfsii. Results revealed that complete inhibition in linear growth was obtained with AA at 6 μL for all tested fungi. The most sensitive fungi to acetic acid vapours are F. solani and R. solanii which inhibited at 4 μL, while S rolfsii were more resistant to acetic acid vapours at 6 μL caused the complete inhibition of linear growth. Complete inhibition of chlamadospores of F. solani was obtained by AA vapour at 15 μL while, Sclerotia of S.rolfsii showed more resistance to acetic acid vapours as their germination was completely inhibited at 20 μL of acetic acid vapour. Under greenhouse conditions results indicated that complete reduction in total count of pathogenic fungi was obtained with AA at μL for F. solani & R. solanii and at 100 μL for S. rolfsii. The highest reduction was achieved with AA at 25 μL which reduced the population by 74.0, 84.0 and 53.0 % for F. solanii, R. solani and S. rolfsii respectively. All tested concentrations of AA significantly reduced the percentage of root rot incidence of tomato plants. The most effective concentration of acetic acid vapour was 100 μL which reduced the disease incidence by 92.9, 94.2 and 93.9 % for F. solanii, R. solani and S. rolfsii respectively. It could be suggested that acetic acid vapours might be safely used for controlling tomato root rot disease under greenhouse conditions.

Keywords: Tomato plants - Acetic acid vapours- Root rot disease-

INTRODUCTION

Tomato plants is the one of most important vegetable crops in Egypt and other countries. Root rot disease caused by Rhizoctonia solani Kuh.: Fusarium solani (Mart) Sacc. and Sclerotium rolfsii Sacc. is the most destructive disease of tomato [9,12,4,13]. Controlling such diseases mainly depend on fungicides treatments [19]. However, fungicidal applications cause hazards to human health and increase environmental pollution. Methyl bromide was extended to soil against fungi, nematodes, viruses and plant pathogenic bacteria, although too expensive for use in large field operation. It is used worldwide in most nurseries, greenhouse agriculture and other high-value plant production enterprises, [17]. This compound is expensive for use in large field conditions in spite of their hazards effect to the environment and human healthy [17]. Therefore, alternative treatments for control of plant diseases are needed [2,3,4].

Vapours of acetic acid (AA) were reported to be effective for controlling postharvest decay of apple, grapes, kiwifruit, pear, tomato, orange, apricot and stone fruit [20-24,14-16,3,5].

Abd-El-Kareem [5] reported that, acetic acid vapour at 75 μL caused complete reduction in population of cucumber root rot fungi and under greenhouse conditions it reduced the cucumber root rot disease more than 93.3 and 95.4 % for pre and post emergence respectively.

The present work aims to study the effect of acetic acid vapours on linear growth as well as spore germination tomato root rot fungi In vitro. It is effect on total count of fungi as well as its effect on tomato root rot disease under greenhouse conditions.

Materials and Methods

Effect of acetic acid fumigation on linear growth of tomato root rot fungi:

Fumigation:

Acetic acid fumigation was carried out in specially designed fumigation chamber 270 L in volume with fan to have closed circulated air current [14].

Soil-borne fungi:

All isolates were obtained from Plant Pathology Department, National Research Centre Egypt.
Effect of acetic acid fumigation on resting stage germination of tomato root rot fungi:

Acetic acid vapours at four concentrations i.e. 0.0, 5.0, 10.0, 15.0 and 20.0 μL (v/v in air) for 30 min in fumigation chamber. Fumigated disks were transferred to plates containing PDA medium. Unfumigated disks for each fungus served as control. Linear growth of fungi was measured when the control plates reached full growth and the average growth diameter was calculated. Twenty five disks as replicates were used for each particular treatment.

Effect of acetic acid fumigation on root rot incidence of tomato plants:

Artificially infested soils were fumigated with acetic acid vapours at concentrations 0.00, 12.5, 25.0 and 100 μL/L in air for 60 min in fumigation chamber. Unfumigated soil served as control. Total of tomato root rot fungi were counted using dilution methods. The reduction in percentage of total count of fungi referring to unfumigated soil was calculated.

Statistical analysis:

Tukey test for multiple comparisons among means was utilized [18].

Results:

Effect of acetic acid fumigation on linear growth of tomato root rot fungi In vitro:

Acetic acid vapours at four concentrations i.e. 0.0, 2.4 and 6 μL/L were tested against linear growth of F. solani, R. solani and S. rolfsii. Results in Table (1) indicate that all tested concentrations of acetic acid vapours inhibited the linear growth of all tested fungi. Complete inhibition in linear growth was obtained with AA at 6 μL/L for all tested fungi. The most sensitive fungi to acetic acid vapours are F. solani and R. solani which inhibited at 4 μL/L, while S. rolfsii were more resistant to acetic acid vapours as 6 μL/L caused the complete inhibition of linear growth.
Table 1: Linear growth (mm) of tomato root rot fungi as affected with different concentrations of acetic acid vapours.

<table>
<thead>
<tr>
<th>Acetic acid (μL/L)</th>
<th>F. solani</th>
<th>R. solani</th>
<th>S. rolfsii</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>90.0 a</td>
<td>90.0 a</td>
<td>90.0 a</td>
</tr>
<tr>
<td>2</td>
<td>20.3 b</td>
<td>12.0 b</td>
<td>22.0 b</td>
</tr>
<tr>
<td>4</td>
<td>10.0 c</td>
<td>0.0 b</td>
<td>8.0 c</td>
</tr>
<tr>
<td>6</td>
<td>0.0 d</td>
<td>0.0 b</td>
<td>0.0 c</td>
</tr>
</tbody>
</table>

1- Figures with the same letter are not significantly different (P=0.05).

Effect of acetic acid fumigation on resting stage germination of tomato root rot fungi:

Acetic acid vapours at four concentrations i.e. 0.0, 5, 10, 15 and 20 μL/L against chlamydospores of F. solani and sclerotia germination of R. solani and S. rolfsii were tested. Results in Table (2) illustrate that all tested concentrations of acetic acid vapours significantly reduced germination of resting stages of all tested fungi. Complete inhibition of chlamydospores of F. solani was obtained by AA vapour at 15 μL/L. Sclerotia of S. rolfsii showed more resistance to acetic acid vapours as their germination was completely inhibited at 20 μL/L of acetic acid vapour.

Table 2: Resting stage germination(%) of tomato root rot fungi as affected with different concentrations of acetic acid vapours.

<table>
<thead>
<tr>
<th>Acetic acid (μL/L)</th>
<th>Chlamydospores</th>
<th>Sclerotia</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F. solani</td>
<td>R. solani</td>
</tr>
<tr>
<td>0.0</td>
<td>90.0 a</td>
<td>85.0 a</td>
</tr>
<tr>
<td>5.0</td>
<td>18.0 b</td>
<td>38.0 b</td>
</tr>
<tr>
<td>10</td>
<td>8.0 c</td>
<td>14.0 c</td>
</tr>
<tr>
<td>15</td>
<td>0.0 d</td>
<td>0.0</td>
</tr>
<tr>
<td>20</td>
<td>0.0 d</td>
<td>0.0</td>
</tr>
</tbody>
</table>

1- Figures with the same letter are not significantly different (P=0.05).

Effect of acetic acid vapours on total count of tomato root rot fungi:

Artificially infested soils were fumigated with acetic acid vapours at concentrations 0.00, 12.5, 25, 50 and 100 μL/L in air for 60 min in fumigation chamber. Results in Tables (3) indicate that soil fungi response differently to acetic acid vapours. Complete reduction in total count of pathogenic fungi was obtained with AA at 50 μL/L for F. solani & R. solani and at 100 μL/L for S. rolfsii at μL/L. The highest reduction was achieved with AA at 25 μL/L which reduced the population by 74.0, 84.0 and 53.0 % for F. solani, R. solani and S. rolfsii respectively. Meanwhile, AA at 12.5 μL/L was less effective.

Table 3: Reduction in tomato root rot fungi population fumigated with acetic acid vapours.

<table>
<thead>
<tr>
<th>Acetic acid (μL/L)</th>
<th>Reduction in tomato root rot fungi populations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F. solani</td>
</tr>
<tr>
<td>12.5</td>
<td>65.0</td>
</tr>
<tr>
<td>25</td>
<td>74.0</td>
</tr>
<tr>
<td>50</td>
<td>100.0</td>
</tr>
<tr>
<td>100</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Incidence of root rot disease in tomato plants:

Results in Table (4) indicate that all tested concentrations significantly reduced the percentage of root rot incidence of tomato plants. As the concentration increases the effect increases too. The most effective concentration of acetic acid vapour was 100 μL/L which reduced the disease incidence by 92.9, 94.2 and 93.9 % for F. solani, R. solani and S. rolfsii respectively. Acetic acid vapour at 50 μL/L reduced the disease incidence more than 78.6 % for all tested fungi. Meanwhile, AA at 12.5 μL/L showed moderate effect.

Table 4: Percent of tomato root rot disease as affected with different concentrations of acetic acid vapours.

<table>
<thead>
<tr>
<th>Acetic acid (μL/L)</th>
<th>Disease incidence</th>
<th>Reduction %</th>
<th>Disease incidence</th>
<th>Reduction %</th>
<th>Disease incidence</th>
<th>Reduction %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F. solani</td>
<td>R. solani</td>
<td>S. rolfsii</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.00</td>
<td>38.0 a</td>
<td>52.0</td>
<td>66.0 a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.5</td>
<td>22.0 b</td>
<td>42.0</td>
<td>20.0 b</td>
<td>61.5</td>
<td>47.0 b</td>
<td>40.4</td>
</tr>
<tr>
<td>25</td>
<td>15.0,0 c</td>
<td>60.5</td>
<td>12.0 c</td>
<td>76.9</td>
<td>33.0 c</td>
<td>50.0</td>
</tr>
<tr>
<td>50</td>
<td>9.0 c</td>
<td>78.6</td>
<td>8.0 d</td>
<td>84.6</td>
<td>12.0 d</td>
<td>81.8</td>
</tr>
<tr>
<td>100</td>
<td>3.0 d</td>
<td>92.9</td>
<td>3.0 e</td>
<td>94.2</td>
<td>4.0 e</td>
<td>93.9</td>
</tr>
</tbody>
</table>

1- Figures with the same letter are not significantly different (P=0.05).
Discussion:

Tomato plants is the one of most important vegetable crops in Egypt and other countries. Root rot disease caused by Rhizoctonia solani Kuh.; Fusarium solani (Mart) Sacc. and Sclerotium rolfsii Sacc. is the most destructive disease of tomato [912,11]. Controlling such diseases mainly depend on fungicides treatments [19].

Soil treatment with specific chemical for reducing pathogen inoculum and disease incidence was first tried in the nineteenth century

Munnecke and Van Gundy, [17]. Methyl bromide, chloropropene, meta sodium, dizomet and dichloropropene are the most effective fumigants of soil for controlling soil-borne diseases.

These compounds are very expensive for use in large field conditions, in spite of their hazards effect to the environment and human health [17]. Alternatives, sheep, less toxic, more efficient of these compounds are needed [1,2].

Acetic acid vapors were extremely effective for controlling postharvest decay of several fruits, [20,21,14,15]. In the present study results revealed that complete inhibition in linear growth was obtained with AA at 6 μL/ for all tested fungi. The most sensitive fungi to acetic acid vapours are F. solani and R. solani which inhibited at 4 μL/L, while S. rolfsii were more resistant to acetic acid vapours at 6μl/l caused the complete inhibition of linear growth. On the other hand, acetic acid vapour at 20 μL/L caused complete inhibition of resting stages, complete inhibition of chlamedospores of F.solani was obtained by AA vapour at 15 μL/L while, Sclerotia of S.rolfsii showed more resistance to acetic acid vapours as their germination was completely inhibited at 20 μL/L of acetic acid vapour.

In this regard, killing of postharvest and common storage fungi with acetic acid vapors were reported by Sholberg and Gaunce [20]. In the present study, under greenhouse conditions results indicated that complete reduction in total count of pathogenic fungi was obtained with AA at 50 μL/L for F. solani & R. solani and at 100 μL/L for S. rolfsii. The highest reduction was achieved with AA at 25 μL/L which reduced the population by 74.0, 84.0 and 53.0 % for F. solani, R. solani and S. rolfsii respectively. All tested concentrations of AA significantly reduced the percentage of root rot incidence of tomato plants. The most effective concentration of acetic acid vapour was 100 μL/L which reduced the disease incidence by 92.9, 94.2 and 93.9 % for F. solani, R. solani and S. rolfsii respectively. These results open new area for the use of acetic acid in soil sterilization, avoiding other deleterious, dangerous effects of other fumigants. Acetic acid vapours is excellent biocide [20]. There are several advantages of using acetic acid vapours, it is a natural compound, had no residual hazard at low levels required to kill fungi, it is also generally-regarded-as-safe compound and it is inexpensive [24]. The inhibitory effect of acetic acid vapours on microorganisms is greater than that due to pH alone, and undissociated acetic acid as it can penetrate the microbial cell to exert its toxic effect [8]. The mechanisms of acetic acid inhibition of microorganisms is apparently to affect the cell membrane interfering with the transport of metabolites and maintenance of membrane potential [24].

On the other hand, there are several advantages of using acetic acid fumigation to control plant diseases:
It is a natural compound found throughout the biosphere posing little or no residual hazard at low levels required to kill fungal spores; it is also generally - regarded - as - safe compound in the United States and does not require rigorous registration procedures; it is inexpensive, Sholberg et al., [24]. It could be suggested that acetic acid vapours might be safely used commercially for controlling cucumber root rot disease under greenhouse conditions.

REFERENCES