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ORIGINAL ARTICLES

Evaluation of Hot Water Soil Treatment Against Cucumber Root Rot Disease under Greenhouse Conditions

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ABSTRACT

The effect of hot water on viability of pathogenic fungi under laboratory conditions, in addition to evaluate its effect as soil treatment on cucumber root rot disease in pot experiments was studied. The purified isolates, of *Rhizoctonia solani, Fusarium solani, Sclerotium rolfsii* and *Pythium ultimum* were tested for pathogenic ability on cucumber plants in pot experiments. Results indicate that the most aggressive fungi are *S. rolfsii* and *P. ultimum*, they caused disease incidence as 59.4 & 50.0 % at pre-emergence and 80.7 & 75.0 % at post-emergence stages, respectively. Meanwhile, *R. solani* and *F. solani* showed moderate effect against cucumber plants. Agar disks with mycelia and growth suspension of *R. solani, F. solani, S. rolfsii* and *P. ultimum* were exposed to different hot water temperatures and exposure times under laboratory conditions. Results indicate that growth suspension more sensitive than agar disks with mycelia to temperature and exposure times. The lethal temperatures to *R. solani, F. solani, S. rolfsii* and *P. ultimum* are 54.0, 58.0, 56 or 58.0 ºC and 52.0, 56.0, 54.0 or 56.0 ºC when exposed to hot water temperatures for one minutes as agar disks with mycelia or growth suspension respectively. Complete reduction in total count of all tested fungi was obtained with boiling water as soil treatments at 0.4 & 0.5 l / kg soil and hot water at 90.0 & 100 °C at rate 0.5 l / kg soil. As for the disease incidence the highest reduction in root rot disease was obtained with boiling water at rate 0.4 & 0.5 l / kg soil and hot water at 90.0 & 100 °C (0.5 L / kg soil) which reduced the disease incidence more than 88.4 and 92.9 % for pre and post emergence respectively. It could be suggested that hot water as soil treatments might be safely used commercially as a new approach for controlling root rot disease of cucumber plants under greenhouse conditions.

Key words: Hot water - Soil sterilization - root rot disease - cucumber plants - *Rhizoctonia solani- Fusarium solani- Sclerotium rolfsii- Pythium ultimum*

Introduction

Cucumber (*Cucumis sativus* L.) is one of the most important vegetable crops. The cultivated area in Egypt was 70680 feddans in 2008 which yielded 530000 tons. It is grown in plastic houses in two main growing seasons *i.e.* autumn and winter in about 20769 greenhouses which yielded 137000 tons (Anonymous, 2008). Cucumber plants suffer from many fungal, bacterial and viral diseases that effect fruit yield. Root rot, wilt and root knot nematode are the most important diseases affecting the crop specially in plastic houses (Kiewnick, *et al*., 2008; Abd El Kareem, 2009 and Morsy *et al.,* 2009).

Soil borne pathogens, *Rhizoctonia solani* Khun, *Pythuim ultimum* DAOM, *Fusarium* spp. Greek, *Sclerotium rolfsii* Sacc. and *Fusarium solani*(Mart.) App. & Wr. can cause severe economic losses in field and greenhouse grown cucumber plants (Roberts *et al*., 2005; Haikal, 2007 and JingHua, *et al.*, 2008).

Methyl bromide has been used to fumigate the infested soil because of its broad spectrum and simplicity in the use but its problem that destroy the ozone layer. Various trials have been conducted to find viable alternative agrochemicals to cope with the Methyl bromide fadeout (Abd El Kareem, *et al.,* 2004 and Uematsu, *et al.,* 2003 and 2005).

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Moreover, the use of fungicides treatments is the most commonly known means of controlling fungal disease in field and greenhouses (Washington and McGee, 2000 and Fravel, *et al*., 2005). Although this method has been very effective in controlling plant fungal disease, some major problems threaten to limit the continued use of fungicides. Firstly some fungi have developed resistance to chemicals; secondly some fungicides are not readily biodegradable and tend to persist for years in environment. This leads to a third problem, the detrimental effects of chemicals on organisms other than target fungi (Brady, 1984). Because of these associated problems, researchers are now trying to use environmentally safe alternative methods to control plant pathogenic fungi.

The hot water treatment has recently received special attention in Japan as the most promising Methyl bromide alternative (Kita, *et al*., 2003). Application of hot water (95 to 100°C) onto soil surface raise the soil temperature up to the lethal level of the plant pathogens as well as pests and weed seeds (Kita, *et al*., 2003; Fujinaga, *et al.,* 2005 and Ogawara, *et al.,* 2006).

The present work was designed to study the effect of different hot water temperatures and exposures time on viability of pathogenic fungi under laboratory conditions. In addition to test the hot water soil treatment on the incidence of cucumber root rot disease under pot experiments.

Materials and Methods

Survey of Cucumber Root Diseases under Commercial Greenhouse Conditions:

Survey was carried out three times during each autumn and winter growing seasons in commercial greenhouse at different locations *i.e* El- Dokki, El- Haram, El- Noubareia, and Gazerit El- Dahab for determining the important root diseases that attack cucumber plants under greenhouse conditions.

Isolation, Purification and Identification of Cucumber Root Rot Fungi:

Roots of the collected diseased plants were washed with tap water to remove any adhering soil particles. Small parts of infected roots were surface disinfected using Sodium hypochlorite solution (3%) for 3 minutes, and washed with sterilized water several times. Then they were dried using sterilized filter paper and transferred into Petri-plates containing water agar medium. Plates were incubated at 25°C for 5 days. Hyphal tip cultures of grown fungi were maintained on PDA medium. All fungi were purified using single spore or hyphal tip technique cultures, then they were identified.

Identification of fungi was carried out according to Gilman, 1957, Sen and Srivastava, (1968). Booth, (1971), Ellis, (1971), Barnett and Hunter, (1972) and Nelson, *et al.,* 1983.

Pathogenicity Test:

The purified isolates of *R. solani, F. solani, S. rolfsii* and *P. ultimum* which isolated from commercial greenhouses *i.e.* El- Dokki(d), El-Haram (h), El-Noubareia (n) and Gazerit El-Dahab (g) were tested for pathogenic ability on cucumber plants under greenhouse conditions.

Preparation of Fungal Inocula:

Inocula of *R. solani, F. solani, S. rolfsii* and *P. ultimum* were prepared by culturing each fungus on 50.0 ml potato dextrose broth (PDB) medium in 250 ml Erlenmeyer flasks for 15 days at 25° - 27 ºC. and fungal inocula were prepared as follows:

Inoculum of *F. solani* was prepared as the upper solid layers that grew were washed and blended in sterilized water.Colonies forming units (cfu) were adjusted to 10^6 cfu / ml using haemocytometers slide. Soil infestation was carried out at rate of 50 ml (10^6 cfu / ml) / kg soil (Elad and Baker, 1985).

Inoculum of *S. rolfsii* and *R. solani* was prepared as the upper solid layers that grew were washed and air-dried with sterilized filter paper layers. The air-dry mycelium was blended in distilled water to obtain inocula pieces of 1-2 mm in diameter. Soil infestation was carried out at rate of 2.0 g dry mycelium / kg soil, (Al-Mahareeq, 2005).

Inoculum of *P. ultimum* was prepared as the upper solid layers that grew were washed and blended in distilled water. Propagules were adjusted to 10^6 / ml using haemocytometers slide. Soil infestation was carried out at rate of 50 ml (10^6 Propagules/ ml) / kg soil (Lu *et al*., 2004).

Soil Infestation:

Sandy -loam soil was autoclaved at 120°C for 1 h on three successive days. Plastic pots (30 cm diameter, 5.0 kg soil) containing sterilized sandy -loam soil were artificially infested individual with the inoculm of each fungus as mentioned before. Eight pots were used as replicates for each treatment as well as check treatment (un- infested soil). Disinfected cucumber seeds, c.v. Beit Alpha, were sown at the rate of 8 seeds / pot. Root rot incidence was recorded as percentages of pre, and post- emergence stage after 12 and 40 days, of sowing respectively.

Laboratory Experiments:

Effect of Hot-water Treatments on Viability of Cucumber Root Rot Fungi:

Viability of agar disks with mycelia and growth suspension of *R. solani, F. solani S. rolfsii* and *P. ultimum* was carried out according to the method described by Whiting**,** *et al.*, (2001). Agar disks with mycelia and growth suspension of cucumber root rot fungi were evaluated at different temperatures and exposure times using digital hot water bath (Neslab GP-300 Series Constant Temperature Bath, Union City, CA). Screw-cap glass vials, 20.0 cm long and 20.0 mm in diameter, containing 20.0 ml sterilized water were placed in water path at different temperatures.

Agar Disks with Mycelia Treatments:

Disks of agar with mycelia and spores, 6- mm diameter, were cut from the grown edge of 10 days -old cultures of *R. solani, F. solani S. rolfsii* and *P. ultimum* growing on PDA medium. Agar disks with mycelia were transferred to Screw-cap glass vials, 20.0 cm long and 20.0 mm in diameter, containing 20.0 ml sterilized water placed in water path at 25, 50, 52, 54, 56, and 58 ºC, for different exposures time *i. e*. 1, 10, 20, and 30 minutes. Treated agar disks with mycelia were dried using sterilized filter paper and transferred into Petri-plates containing PDA medium. Six Screw-cap glass vials, and 3 disks per each were used for each treatment. Viability of mycelia from agar disk that had been subjected to previous temperatures was assessed by planting treated disks on PDA medium and incubated at 25 ºC for 5 days. Disks showing growth or non- growth were recorded.

Growth Suspension Treatments:

Plates with growing colonies of *R. solani, F. solani S. rolfsii* and *P. ultimum* grown on PDA medium were flooded with 10 ml of sterile water and mycelia or spores were released using a sterile inoculation loop. The growth suspension (spore or mycelia) were blended in blender under sterilized conditions. The number of spores or mycelial fragments in the stock suspension was counted with a haemocytometer slide and adjusted to 10^6 cfu or mycelial fragments / ml. One ml of growth suspensions was added to Screw-cap glass vials, 20.0 cm long and 20.0 mm in diameter, containing 20.0 ml sterilized water placed in water path at 25, 50, 52, 54, 56, and 58 ºC, for different exposures times *i. e*. 1, 10, 20, and 30 minutes. One ml of treated suspension was transferred into Petri plates (9 cm diameter) and sterilized PDA medium before its solidification disbanded in Petri- plates which containing treated growth suspensions. Plates were incubated at 25°C for 5 days. Plates showing growth or non- growth were recorded.

Pot Experiments:

In this experiments soil temperatures were obtained either by adding different volumes of boiling water (100 ºC) or adding a constant volume of hot water at rate of 0.5 l/ kg soil differ in its temperatures.

Plant Materials:

Cucumber seeds c.v. Beit-Alpha used in these experiments were obtained from Department of Vegetable Crop Research, Agricultural Research Centre, Giza.

Fungal Inocula and Soil Infestation:

Inocula of Pathogenic root rot fungi *i.e. R. solani, F. solani, S. rolfsii* and *P. Ultimum,* soil infestation and assessment of root rot disease was carried out as mentioned before. Eight pots were used as replicates for each

treatment. Disinfected cucumber seeds, c.v. Beit Alpha, were sown at the rate of 8 seeds / pot.

Effect of Hot Water on Cucumber Root Rot Disease:

Different volumes of boiling water (100 ° C) *i.e*. 0.0, 0.2,0.3, 0.4 and 0.5 l / kg soil in addition to different degree of hot water temperatures (at rate 0.5 l / kg soil) *i.e*. 25.0, 70.0, 80.0, 90.0 and 100.0 ° C were tested to study their effect on soil temperatures, total count of root rot fungi and disease incidence of cucumber plants under pot experiments. Twenty four hour later of soil treatments with hot water disinfected cucumber seeds, c.v. Beit Alpha, were sown at the rate of 8 seeds / pot. Root rot incidence was recorded as percentages of pre, and post- emergence stage after 12 and 40 days, of sowing respectively.

Determination of Total Count of Pathogenic Fungi:

Total count of pathogenic fungi was carried out according the methods described by Porras, *et al*., (2007). Soil samples (10.0 g) from each treatment were shaken in conical flasks containing 90 ml of sterile water for 10 min then left standing for a further 20 min. A dilution series was made up to 10^{-6}. Aliquots (1.0 ml) of suitable dilution were transferred onto sterilized Petri plates. Sterilized PDA medium before solidification were transferred to inoculated Petri plate for determination the total count of pathogenic fungi and mixed gently. Plates were incubated at 25°C for 5.0 days. Each dilution was represented by 10 plates as replicates. The resulting colonies are then calculated as colonies per gram of dry soil and the reduction was calculated as follow:-

$$\text{Reduction \%} = \frac{\text{No. of colonies in control} - \text{No. of colonies in treatment}}{\text{No. of colonies in control}} \times 100$$

Disease Assessment:

Root rot incidence was recorded as percentages of pre, and post- emergence stage after 12 and 40 days, of sowing respectively.

Statistical Analysis:

Tukey test for multiple comparison among means was utilized (Neler, *et al.,* 1985).

Results:

Survey of Cucumber Root Diseases under Commercial Greenhouse Conditions:

Survey was carried out in different commercial greenhouse at different places *i.e* El- Dokki, El- Haram, El- Noubareia, and Gazerit El- Dahab for determining the root rot disease that attack cucumber plants under greenhouse conditions. Results in Table (1) indicate that high percentages of root rot infection were recorded in all surveyed locations. The highest infections were recorded in winter growing season, as compared to autumn growing season. Root rot disease recorded the highest infections in autumn and winter growing seasons.

Table 1: Survey of cucumber root rot disease under commercial greenhouse conditions

Locations	Root rot incidence %	
	Winter growing season	Autumn growing season
El- Dokki	A 17.0 a	B[(1)] 10.0 a
El- Haram	A 12.0 b	B 6.0 b
El- Noubareia	A 12.0b	B 10.0 b
Gazerit El- Dahab	A 11.0 a	B 8. 5 a
Mean	A 13	B 8.6

1-Figures with the same letter are not significantly different small letters to compare between locations and capital letters to compare between growing seasons(P=0.05) .

2- Soil-borne diseases expressed as percentage of diseased plants.

3- Survey was carried out at three times for each growing season.

Purification and Identification of Root Rot Fungi:

Samples of plants showing root rot symptoms collected from different locations were used for isolation. Hyphal tip cultures of grown fungi were maintained on PDA medium. All fungi were purified using single spore or hyphal tip technique cultures, then they were identified. Results indicate that the most dominant fungi which identified are *Rhizoctonia solani* Khun, *Pythuim ultimum* DAOM*, Sclerotium rolfsii* Sacc. and *Fusarium solani* (Mart.) App. & Wr.

Pathogenicity Test:

The purified isolates, of *R. solani, F. solani, S. rolfsii* and *P. ultimum* were tested for their pathogenic ability on cucumber plants under greenhouse conditions. Results in Table (2) indicate that all isolates were able to attack cucumber plants causing root rot symptoms. The tested fungal isolates significantly varied in their ability to cause root rot infection of cucumber plants under greenhouse conditions. The most aggressive fungi are *S. rolfsii* (h*)* and *P. ultimum* (d), they caused disease infection as 59.4 & 50.0 % at pre-emergence and 80.7 & 75.0 % at post-emergence stages, respectively. Meanwhile, *R. solani*(h) and *F. solani* (d) showed moderate aggressiveness against cucumber plants, which caused 50.0 & 35.9 % and 71.0 & 70.5 at pre and post-emergence stages respectively.

Table 2: Pathogenicity tests of different fungal isolates collected from commercial greenhouses[2].

Isolates	Root rot incidence %[3]	
	Pre-emergence	Post- emergence
Fusarium solani(d)	35.9 c[1]	70.5 bc
F. solani(g)	29.7 d	55.6 d
F. solani(h)	35.9 c	64.7 c
F. solani(n)	29.7 d	55.6 d
Rhizoctonia solani(d)	28.1 d	43.5 e
R. solani(g)	46.9 b	70.0 bc
R. solani(h)	50.0 b	71.0 bc
R. solani(n)	46.9 b	65.7 c
Sclerotium rolfsii(d)	61.1 a	65.7 c
S. rolfsii(g)	25.0 d	45.8 e
S. rolfsii(h)	59.4 a	80.7 a
S. rolfsii(n)	46.9 b	70.0 bc
Pythium ultimum(d)	50.0 b	75.0 ab
P. ultimum(g)	46.9 b	69.2 bc
P. ultimum(h)	46.9 b	65.7 c
P. ultimum(n)	35.9 c	64.7 c
Control(Non-infested soil	4.7 e	3.3 f

1- Figures with the same letter are not significantly different(P = 0.05)
2- Different fungi isolates collected from commercial greenhouse of El- Dokki., El- Haram, El- Noubareia and Gazerit El- Dahab.
3- Each treatment represented by 8, pots and,8 seeds for each pot.

Laboratory Experiments:
Effect of Hot Water Temperatures and Exposure Times on the Viability of Cucumber Root Rot Fungi:

Effect on Agar Disks with Mycelia and Growth Suspension:

Agar disks with mycelia and growth suspension of *R. solani, F. solani, S. rolfsii* and *P. ultimum* were tested against different temperatures *i.e.* 25, 50, 52, 54, 56, and 58 ºC and exposure times *i. e,* 1, 10, 20, and 30 minutes in digital water path. Results in Table(3 and 4) indicate that growth(spores or mycelial) suspension more sensitive than disks of agar to high temperatures and exposure times. When exposures times increased the lethal temperatures of hot water decreased for all tested fungi. The lethal temperatures to *R. solani, F. solani, S. rolfsii* and *P. ultimum* are 54.0, 58.0, 56 or 58.0 ºC and 52.0, 56.0, 54.0 and 56.0 ºC when were exposed to temperatures for one minutes as agar disks or growth suspension respectively.It is noticed that *F. solani* and *P. ultimum* were more resistant to hot water than *R. solani* and *S. rolfsii.*

Table 3: Viability of growth agar disks of cucumber root rot fungi as affected with hot water temperatures and exposure times.

Hot water °C	Viability of cucumber root rot fungi Exposure time(minutes)															
	F. solani				*R. solani*				*S. rolfsii*				*P. ultimum*			
	1	10	20	30	1	10	20	30	1	10	20	30	1	10	20	30
25	1	+	+	+	1	+	+	+	+	+	+	+	+	+	+	30
50	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
52	+	+	+	+	+	+	—	—	+	+	+	–	+	+	+	+
54	+	+	+	+	—	—	—	—	+	+	—	—	+	+	+	+
56	+	+	—	—	—	—	—	—	—	—	—	—	+	+	—	—
58	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Table 4: Viability of growth suspension of cucumber root rot fungi as affected with hot water temperatures and exposure times.

Hot water °C	Viability of cucumber root rot fungi Exposure time(minutes)															
	F. solani				*R. solani*				*S. rolfsii*				*P. ultimum*			
	1	10	20	30	1	10	20	30	1	10	20	30	1	10	20	30
25	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
50	0	0	0	0	0	0	—	—	+	+	0	—	+	+	0	0
52	0	0	0	0	—	—	—	—	0	—	—	—	0	0	0	0
54	0	0	—	—	—	—	—	—	—	—	—	—	0	0	—	—
56	–	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Pot Experiments:

Effect of Different Volumes of Boiling Water on Cucumber Root Rot Disease under Pot Experiments:

Different volumes of boiling water(100 ° C) *i.e.* 0.0, 0.2,0.3, 0.4 and 0.5 L / kg soil applied as soil treatment were tested to study their effect on soil temperatures, total count of root rot fungi and soil microflora in addition to the disease incidence of cucumber plants under pot experiments.

a- Effect on Soil Temperatures:

Results in Fig(1) indicate that all tested volumes of hot water significantly increased the soil temperatures. The highest increase in soil temperatures was obtained with hot water at rate 0.4 and 0.5 l / kg soil, which increased soil temperatures to 74.0 and 82.0 ºC respectively. Volume of hot water at rate 0.3 l/ kg soil increased soil temperature to 62.0 ºC. Meanwhile, volume at 0.2 l / kg soil was less effective.

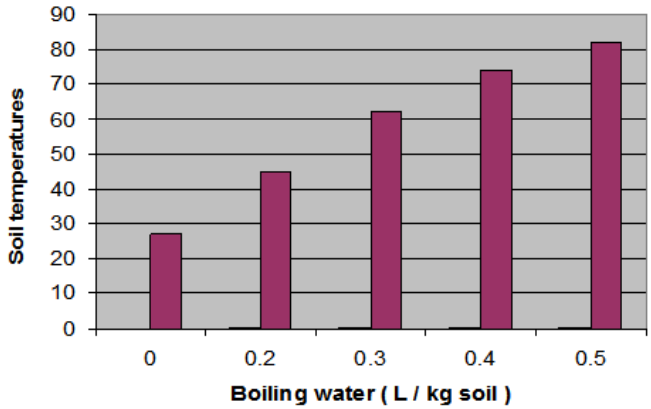

Fig. 1: Effect of boiling) 100 ºC(water on soil temperatures .

b- Effect on Total Count of Root Rot Fungi:

Results in Fig(2) indicate that complete reduction in total count of all tested fungi was obtained with hot water at 0.4 and 0.5 l / kg soil.The highest reduction was obtained with hot water at 0.3 l / kg soil which reduced the total count more than 74.0 % for all tested fungi. Meanwhile, hot water at 0.2 l / kg soil was less effective.

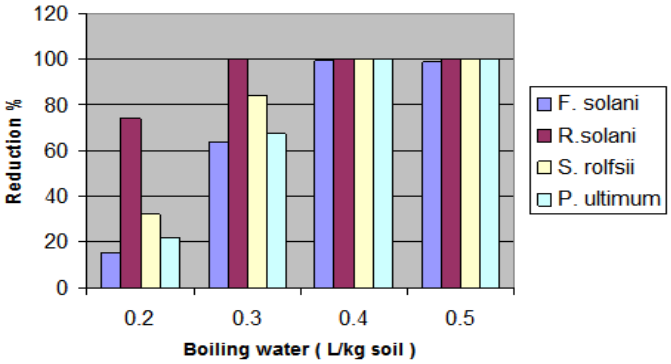

Fig. 2: Reduction in cucumber root rot fungi populations as affected with different volumes of boiling water under pot experiments.

c- Effect on Cucumber Root Rot Disease:

Results in Table(5) indicate that all volumes of hot water significantly reduced the root rot incidence.The most effective treatments are hot water at rate 0.4 and 0.5 l / kg soil which reduced the root rot disease more than 89.6 and 95.0 % for pre and post emergence respectively. Moderate effect was obtained with hot water at 0.3 l / kg soil which reduced the disease incidence more than 65.6 and 43.7 % for pre and post emergence respectively. While, hot water at 0.2 l / kg soil showed less effect.

Table 5: Root rot incidence (%) of cucumber plants as affected with different volumes of boiling water treatments(100 ^{O}C).

Hot water 100 ºC (l/ kg soil)		Cucumber root rot disease							
		F. solani		*R. solani*		*S. rolfsii*		*P. ultimum*	
	Soil temp.	Pre-emergence	Post-emergence	Pre-emergence	Post-emergence	Pre-emergence	Post-emergence	Pre-emergence	Post-emergence
0.2	45	37.5 b[(1)]	47.5 b	31.1 b	25.0 b	40.1 b	43.2 b	40.6 b	42.7 b
0.3	62	15.6 c	37.0 c	6.3 c	6.7 c	23.4 c	18.4 c	14.1 c	35.5 c
0.4	74	4.7 d	3.3 d	4.7 c	3.3 c	3.1 d	3.2 d	4.7 d	3.3 d
0.5	82	3.1 d	3.2 d	3.1c	3.2 c	3.1 d	4.8 d	4.7 d	3.3 d
Control (non - infested soil)	27	3.1 d	3.2 d	3.1c	3.2 c	3.1 d	3.2 d	3.1 d	3.2 d
Control (infested soil)	27	45.3 a	65.7 a	54.7 a	72.4 a	62.5 a	83.3 a	59.4 a	76.7 a

1- Figures with the same letter are not significantly different(P = 0.05)
Each treatment represented by 8, pots and,8 seeds for each pot were used.

Effect of Different Degrees of Hot Water Temperatures(at Rate 0.5L/kg Soil) On Cucumber Root Rot Disease:

Different degrees of hot water temperatures(at rate 0.5 L / kg soil) *i.e* 25.0, 70.0, 80.0, 90.0 and 100.0 ºC were tested to study their effect on soil temperatures, total count of root rot fungi and soil microflora in addition to the disease incidence of cucumber plants under pot experiments.

a- Effect on Soil Temperatures:

Results in Fig(3) indicate that all degrees of hot water significantly increased the soil temperatures. The highest increase was obtained with 90 and 100 ºC which increased the soil temperatures to 76.0 and 83.0 ºC respectively.

Hot water at 80.0 ºC increased the soil temperature to 66 ºC. While, hot water at 70.0 ºC showed less effect.

b- Effect on Total Count of Root Rot Fungi:

Results in Fig(4) indicate that complete reduction in total count of root rot fungi was obtained with hot water at 80.0, 90.0 and 100 º C for all tested fungi except that *F. solani* and *Pythium* sp. with 80.0 º C.The moderate reduction was obtained with hot water at 70.0 º C which reduced the total count more than 62.0 % for all tested fungi.

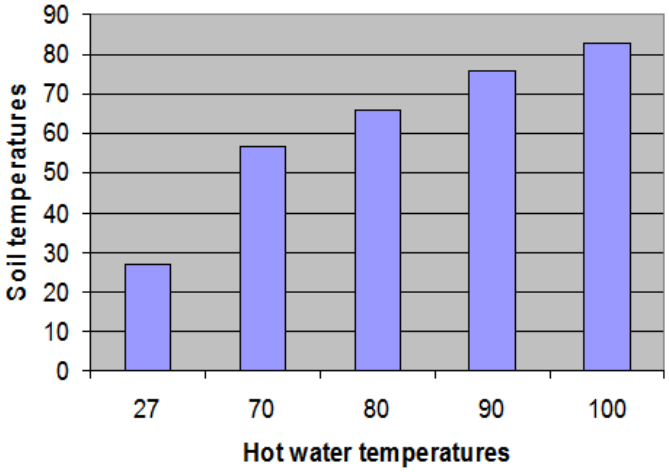

Fig. 3: Minimum temperature of sandy loam soil as affected with different degree of hot water(0.5 L / kg soil) at zero time of sowing under pot experiments

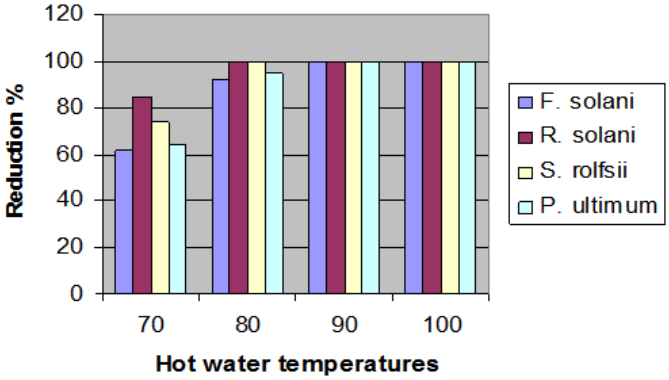

Fig. 4: Reduction in cucumber root rot fungi population as affected with different degrees of hot water treatments at rate 0.5 L/ kg soil

c- Effect on Cucumber Root Rot Disease:

Results in Table(6) indicate that all hot water temperatures significantly reduced the root rot incidence.The most effective treatments are hot water at 90.0 and 100.0 ° C which reduced the root rot disease more than 88.4 and 92.9 % for pre and post emergence respectively. Hot water at 80.0 ºC reduced the disease incidence more than 73.2 and 78.3 % for pre and post emergence respectively fo all tested fungi. Moderate effect was obtained with hot water at 70.0 ºC.

Table 6: Root rot incidence(%) of cucumber plants as affected with different degrees of hot water treatments at rate 0.5 l/ kg soil.

Hot water 100 ºC		Cucumber root rot disease							
		F. solani		*R. solani*		*S. rolfsii*		*P. ultimum*	
	Soil temp.	Pre-emergence	Post-emergence	Pre-emergence	Post-emergence	Pre-emergence	Post-emergence	Pre-emergence	Post-emergence
70	57	20.3 b[(1)]	39.2 b	9.4 b	10.2 b	23.4 b	24.5 b	15.6 b	35.2 b
80	66	10.9 c	14.3 c	3.1 c	4.8 c	9.4 c	8.6 c	9.4 c	12.1 c
90	76	4.7 d	3.3 d	4.7 c	4.9 c	4.7 cd	4.9 cd	3.3 d	3.2 d
100	83	3.1 d	4.8 d	3.1 c	3.2 c	3.1 d	4.8 cd	3.1 d	4.8 d
Control (non -infested soil)	27	4.7 d	3.3 d	4.7 c	3.3 c	4.7 d	3.3 d	4.7 d	3.3 d
Control (infested soil)	27	40.6 a	65.8 a	50.0 a	68.8 a	61.0 a	80.0 a	65.6 a	81.0 a

1- Figures with the same letter are not significantly different(P = 0.05)
Each treatment represented by 8, pots and,8 seeds for each pot were used.

Discussion:

Root rot are the most important diseases affecting cucumber plants specially in plastic houses. Many reports have been published in this concern by Haikal - Nahed,(2007) , Kiewnick, *et al*.,(2008) , Abd El Kareem,(2009) and Morsy *et al.,*(2009) . In the present study, it was found that infection with soil-borne diseases increased during the winter growing season. This may be, mainly, due to the increase of pathogens inocula in the soil in winter growing season as compared to the autumn growing season which are sown after summer fallow or soil treatment. It is also may be due to low temperature during the winter growing season which is favorable to many soil fungi as compared to plant growth(Abd El Kareem, 1998) . In the present study the most aggressive fungi are *S. rolfsii*(h*)* and *P. ultimum*(d), they caused disease infection as 59.4 & 50.0 % at pre-emergence and 80.7 & 75.0 % at post-emergence stages, respectively. Meanwhile, *R. solani*(h) and *F. solani* (d) showed moderate aggressive against cucumber plants. In this concern, soil borne pathogens, *R. solani*, *Pythuim ultimum, Fusarium* spp., *S. rolfsii* and *F. solani* can cause severe economic losses to field and greenhouse grown cucumber(Roberts *et al*., 2005 and JingHua, *et al.*, 2008) . In this regards, Morsy *et al.,* (2009) reported that several species of Fusarium were isolated from cucumber plants showed root rot disease grown under field conditions in El-Behera Governorate. *Fusarium oxysporum,* was the most prevalent fungus, followed by *F. solani, Sclerotium rolfsii, Rhizoctonia solani* and *M. phaseolina*. While, *Pythium* sp. was less frequency.

Controlling these diseases depends mainly on fungicidal application.

Various trials have been conducted to find viable alternative agrochemicals to cope with the Methyl bromide fadeout. The hot water treatment has recently been received special attention in Japan as the most promising Methyl bromide alternative. (Kita *et al*., 2003). In the present study results indicate that spores or mycelial suspension more sensitive than agar disks with mycelia to high temperatures and exposure times. The lethal temperatures to *R. solani; F. solani; S. rolfsii* and *P. ultimum* are 54.0, 58.0, 56 or 58.0 ºC and 52.0, 56.0, 54.0 and 56.0 ºC when exposures to temperatures for one minute as agar disks with mycelia or growth suspension respectively. In this respect Kita *et al*.,(2003) reported that in Japan, when hot water is applied onto the soil, the surface is immediately heated but soon cools down whereas the temperature of the deeper soil gradually increases and remains high for few days after the treatment. In the 30cm depth, temperature over 55°C, the lethal temperature for the Fusarium. Actually, when *Fusarium oxysporum* f.sp. *lycopersici* present within the 30cm depth soil was exposed to the lethal temperature, complete disinfestations was successfully achieved leading to the effective suppression of the wilt disease.

Application of hot water (95 -100°C) onto soil surface raise the soil temperature up to the lethal level to the plant pathogens as well as pests and weed seeds (Kita *et al*., 2003; Fujinaga, *et al.,* 2005 and Ogawara, *et al.,* 2006).

In the present study, results indicate that complete reduction in total count of all tested fungi was obtained with hot water at 0.4 & 0.5 l / kg soil and hot water at 90.0 & 100 °C. When root rot fungi were exposed to the lethal temperature, complete disinfestations was successfully achieved leading to the effective suppression of the disease incidence. Under pot experiments, the highest reduction in root rot disease was obtained with hot water at 0.4 & 0.5 l / kg soil and hot water at 90.0 & 100 °C which reduced the disease incidence more than 88.4 and 95.0 % for pre and post emergence respectively. Using of soil sterilization with hot water treatments for controlling several soil-borne diseases was reported about Fusarium wilt of spinach, (Kuniyasa *et al.*, 1993 and Iwamoto *et al.,* 2000); Fusarium wilt of Chrysanthemum(Iwamoto *et al*., 2005) and Fusarium wilt of melonis(Ogawara, *et al.,* 2006).

The hot water treatment is easier to use than steam sterilization and, unlike solar heat sterilization, its application is not limited to the summer season. Because the wet-heat provided by the hot water does not wipe all the living organisms out, this technology is regarded as an eco -friendly Methyl bromide alternative that can widely be applied to various crop production (Noling, 1995 and Kita, *et al.*, 2003).

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