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Effect of solarization with fresh chicken manure on verticillium wilt (*Verticillium dahliae* Klebb) and yield in eggplant

Ismail Cimen[1*] and Mahir Basaran[2]

[1]Plant Protection Department, Faculty of Agriculture, Dicle University, Diyarbakır, Turkey.
[2]The Ministry of Agriculture and Animal Food Directorate of Diyarbakir, Turkey.

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The present study was carried out to evaluate the effect of reducing wilt disease through the medium of fresh chicken manure (FCM) mixed with soil before solarized and then artificial *Verticillium dahliae* (V.d) inoculation on yield of eggplant (*Solanum melongena* L.) under field conditions. According to the split-plot design, solarization of main plots, sub-plots with fresh chicken manure and *V dahliae* inoculation were established as a mini parcel in experiment with three replications. During solarization, the average temperature values were ensured by means of increasing the fresh chicken manure per unit area recorded 24 times per day (24 h) at intervals of one week. Among the 6 applications form, the highest average temperature was obtained at "12 kg FCM m^{-2} +solarization" application for soil surface, 10, 20 and 30 cm depth. There was increasing 18°C, a temperature according to control (no FCM), and this difference decreased with increasing soil depth, which was calculated as 8°C at 30 cm depth soil. During the day, the highest temperature values were obtained in the middle of the day on the ground, and underground measurements were performed at night.

Key words: Soil solarization, fresh chicken manure, *Verticillium dahliae*, eggplant, yield.

INTRODUCTION

Turkish cuisine is an indispensable vegetable in the Solanaceae family, eggplant, looking hotter temperature than among the vegetables. One of the most important problems affecting the production of eggplant is Verticillium wilt disease caused by *Verticillium dahliae* in soil borne fungal agents. *V. dahliae* is able to infect more than 400 plant species, including annual, herbaceous crops and weeds, as well as fruit, landscape, and ornamental trees, and shrubs (Pegg and Brady, 2002). This problem could be eliminated by soil fumigation with chemical in vegetable cultivation in narrow spaces (Jarvis, 1993) and/or crop rotation of large areas of land (Green, 1967). However, it is known that chemicals have harmful effects on ecology. The most common chemical to be used in fumigation was methyl-bromide. Due to its dangerous effect on ozone layer of the upper

*Corresponding author. E-mail: icimen@dicle.edu.tr

atmosphere, the methyl bromide has been banned since 2005 (Speth, 2004). Today, the search for an alternative method instead of these chemicals has increased. It is possible to use solar energy instead of fumigation, and it is also beneficial to use it (Katan, 1987; Zayed et al., 2013), for a period of one to two months during the hot days of the year by covering the soil with plastic. Soil solarization is a term that refers to disinfestation of soil by the heat generated from trapped solar energy. This method eradicates or reduces weed seed germination (Cimen et al., 2010b; Lalitha et al., 2003; Ozaslan et al., 2015) and some vegetable diseases caused by soil-borne pathogens (Cimen et. al., 2009; Cimen et. al., 2010a) as well; eggplant (Tamietti and Valentino, 2001).

The level of organic matter in the soil is critical to soil fertility. This situation can be eliminated with animal manure to some extent. Chicken manure has long been recognized as perhaps the most desirable of these natural fertilizers because of its high nitrogen content. For growing vegetables, it is not recommended to use fresh manure directly on the growing area because they will burn tender plant roots (Aryantha et al., 2000).

However, when mixed soil in non-cropland areas, combustion of fresh chicken manure with solarization can be used to heat the soil. This study will be an opportunity for intensive vegetable cultivation; especially, so only solarization with transparent polyethylene is not enough even with summer temperatures and cold climate zone. In this study, both for benefiting from nutritious properties of fresh chicken manure and increasing the temperature of the soil together with solarization, it was aimed to enhance yield in eggplant by reducing wilt disease caused by *V. dahliae,* which is the most important problem in eggplant.

MATERIALS AND METHODS

The study was conducted in the field of loamy-clay structure soil in the Faculty of Agriculture, Dicle University, Turkey. For inoculation, inoculum was prepared in the Phytopathology Laboratory, and seedlings in peat were grown in the greenhouse until they reached two- to three-leaf stage on 23 May 2011. The polythene as a cover sheet material was used as 0.02 mm thickness, and also a digital thermometer was used to measure soil temperature for solarization. Eggplant (*Solanum melongena* L. cv. Kemer) was used as a plant material. *Verticillium dahliae* Kleb. isolates were obtained from the Plant Protection Departments of Agricultural Faculties in University of Çukurova and University of Mustafa Kemal. Fresh chicken manure used in this study was taken from "Diyarbakır Gün Tavukçuluk".

According to the split-plot design, solarization of main plots sub-plots with fresh chicken manure and *V dahliae* inoculation has been established as a mini parcel in experiment with three replications. The study involved a total of 36 parcels, and there were 50 plants per plot (that is, a spacing of 40 cm within the row and 70 cm between rows).

The process of soil solarization

After irrigated on July 8, the soil of trial area was deeply tilled with plow on 15 July 2010. According to the experimental design chosen, after fresh chicken manure (FCM) had been delivered as 6 and 12 kg m^{-2} on 4 August 2010 in predetermined parcels, the soil was mixed by using a field cultivator, and then sprinkler irrigation was performed. Also, on 17 August 2010, predetermined main plots were covered with transparent polythene material in 7 × 15 m size. All sides of polythene were put under the soil with a depth of 40 and 50 cm. Nevertheless, in control parcel, nothing was done except soil treatment. Also, on 17 August 2010, predetermined main plots were covered with transparent polythene material in 7 × 15 m size. All sides of polythene were put under the soil with a depth of 40 and 50 cm, but in control parcel, nothing was done except soil treatment.

Determination of soil temperature

Soil temperature (°C) was measured in both solarized and no solarized parcels. For this purpose, 4 wires were installed at 5, 10, 20 and 30 cm depths inside edge of one meter in each main plots. Soil temperature was measured through these wires connected to a digital thermometer. During solarization, these measurements were recorded 24 times per day (24 h) at intervals of one week.

Growing of eggplant seedlings

Eggplant seedlings were grown under controlled conditions. First, peat (turf) used as substrate was autoclaved for sterilization at 121°C for 90 min in the Phytopathology Laboratory. Then, it was filled with standard plastic seed containers (involving 70 cells). Later, eggplant seeds were sown two per cell in the container; seed sown in this medium was moved to the greenhouse, and germination of the seeds was awaited. The eggplant seedlings germinated were reduced one plant per eye, and water was applied to seedlings every two days.

Preparation of inoculum

Firstly, *V. dahliae* isolates were grown on potato dextrose agar plates at room temperature (22 ± 1°C) and then fungus was grown in erlenmeyers (250 ml) containing autoclaved (121°C) wheat (800 g cracked wheat + 200 ml water). The grains were inoculated with *V. dahliae* isolates and incubated at 22 ± 1°C in darkness. This inoculum was kept in a freezer until it was inoculated in experimental plots.

Inoculation of *V. dahliae*, transplanting of eggplant seedlings and cultural practices on experimental plots

V. dahliae inoculum firstly solarized plots and then non-solarized ones were given on May 23, 2011. For this process, prior to the inoculum saturated with wheat grain of 5 g per plant was mixed with river sand, and then this mixture was given on seedlings to be planted in the ground. On the same day, the eggplant seedlings were before transplanted in mini parcels without *V. dahliae* inoculation and then those with inoculation.

Surface irrigation system was applied 27 times during the eggplant season, from the date of seedlings transplanted to the last harvest (October 10, 2011). This was before going through without inoculum plots in order to help prevent the spread of infection.

Especially, in the initial stage of growing eggplant, intensive weeds in without solarized main plots were observed, and these weeds were drawn by hand. Thrips, red spider and flea beetles damage were observed on eggplants. Wettable powder Sulphur was applied to red spider.

The determination of plant mortality and disease severity

In the beginning of the experiment, dead (diminishing) seedlings were renewed and planted in locations where those dead seedlings diminished on June 13, 2011. Then, the percentage of plant mortality was determined by counting all the dead plants stemming from abiotic or biotic reasons on July 4, July 7 and August 3, 2011. These values were transformed to angle value, and variance analyses were conducted by using MSTAT-C programme.

According to discoloration in the stem section taken at the second nodium from the soil surface, the disease incidence was determined in all of the plants after the last harvest had been done. Disease incidence was evaluated as the following scale: 0=no discoloration xylem on trunk sectional area; 1=1-33% discoloration xylem; 2=34-67% discoloration xylem; 3=68-100% discoloration xylem (Buchenauer and Erwin, 1976).

Observation of plant growth

Plant height was measured from the soil level to the terminal bud by using a meter rule. This measurement was performed three times after 45 days of planting to August 8, 2011 on all plants per plot. The mean plant height (cm) was found by dividing the total number of plants per plant in the plot.

Obtaining yield

The first harvest was made on July 22, 2011; two months after eggplant seedlings had been transplanted. Having taken into account the market situation at harvest time, eggplant fruits reaching a length of 20 to 25 cm were harvested by hand, by pulling up or cutting down at the junction of the fruit and the stalk.

RESULTS AND DISCUSSION

Solarization and fresh chicken manure increased ($p \leq 0.05$ and $p \leq 0.01$) plant height, whereas *V. dahliae* inoculation decreased ($p \leq 0.01$) the height of eggplant seedlings planted in land, approximately 6 months after soil solarization. The effect of solarization was not observed on plant mortality, and disease severity but fresh chicken manure decreased them ($p \leq 0.01$) in parallel with its increasing dose. Therefore, the effect of yield was higher than solarization. The total crop yield increased to 45% by solarization. This increase was 2-fold by fresh chicken manure (12 kg FCM m^{-2}) compared with control (no FCM).

Among triple combination, the highest total yield as 40 tons per hectare was obtained in plot (+S +12 kg FCM m^{-2} -Vd) in which 12 kg m^{-1} of fresh chicken manure was mixed before solarization and without inoculation of *V. dahliae*. In 12 combinations, the least total yield as 6 tons ha^{-1} was obtained in “-S -FCM +Vd “. Here seven-fold increase was obtained. When the aim of the study is considered to reach high efficiency in terms of replacing the application of *V. dahliae*, quick possibility of infection is considered "+ S +12 kg FCM m-2 + Vd" combination, and the yield increase was 4.3 fold higher with respect to the control (-S-FCM + Vd).

Effect of solarization on soil temperature

During solarization, having been recorded 24 times per day (24 h) at intervals of one week, the highest temperature values were obtained in the middle of the day on the soil surface. However, the highest temperature values were measured at night under the ground.

In general, the highest average temperature was obtained on soil surface, and soil temperature dropped with the increase in the depth of soil layer in all the six applications. Soil temperature increased by means of supplementing the FCM per unit area in non-solarized parcels by comparison of treatments to controls (without FCM), and this increase jumped by solarization effect. Solarization process after FCM, the soil temperature continued to rise, and this increase "12 kg FCM m^{-2} + solarization" combination reaching a peak (Figure 1).

This application was compared with the control combination plots (without FCM and solarization); the average temperature increase was 18°C on the soil surface, 11.5°C at 10 cm depth, 10°C at 20 cm depth and 9.5°C at depth 30 cm. With this application, according to the solarization alone, average temperature rise was found as 4°C at 30 cm soil depth (Figure 1).

Our findings have also been supported by the findings according to which a 5 to 9°C of temperature difference alone was sufficient solarization in a previous study (Ragon and Vilson, 1985). Especially, also, temperature above ground was higher than that of previous similar studies (Lalitha et al., 2001; Hassing et al., 2004; Benlioglu et al., 2005; Cimen et al., 2010a).

The first possibility that comes into mind is that FCM must have heated the soil because it had undergone its combustion phases in the soil layer, and soil temperature increased further by a combination between it and solarization. It was not coincide with previous research heating the soil related to heat caused by the fresh chicken manure. However, there were similarities between two studies related to the burned chicken manure in the greenhouse (Boz, 2009) and open land (Benlioğlu et al., 2005).

The determination of plant mortality and disease severity

On the first observation, some of the eggplant seedlings transplanted plants in the plots seemed to have had weaker growth, and then they died. Containing three different dates, the percentage of plant mortality as well as their angle values is given in Table 1. Also, index values related to disease incidence by *V. dahliae* have also been added to Table.

The percentage of plant loss values was close to each other in both solarized main plots and without ones, and so were disease index values. However, plant losses or plant mortality was reduced by means of supplementing

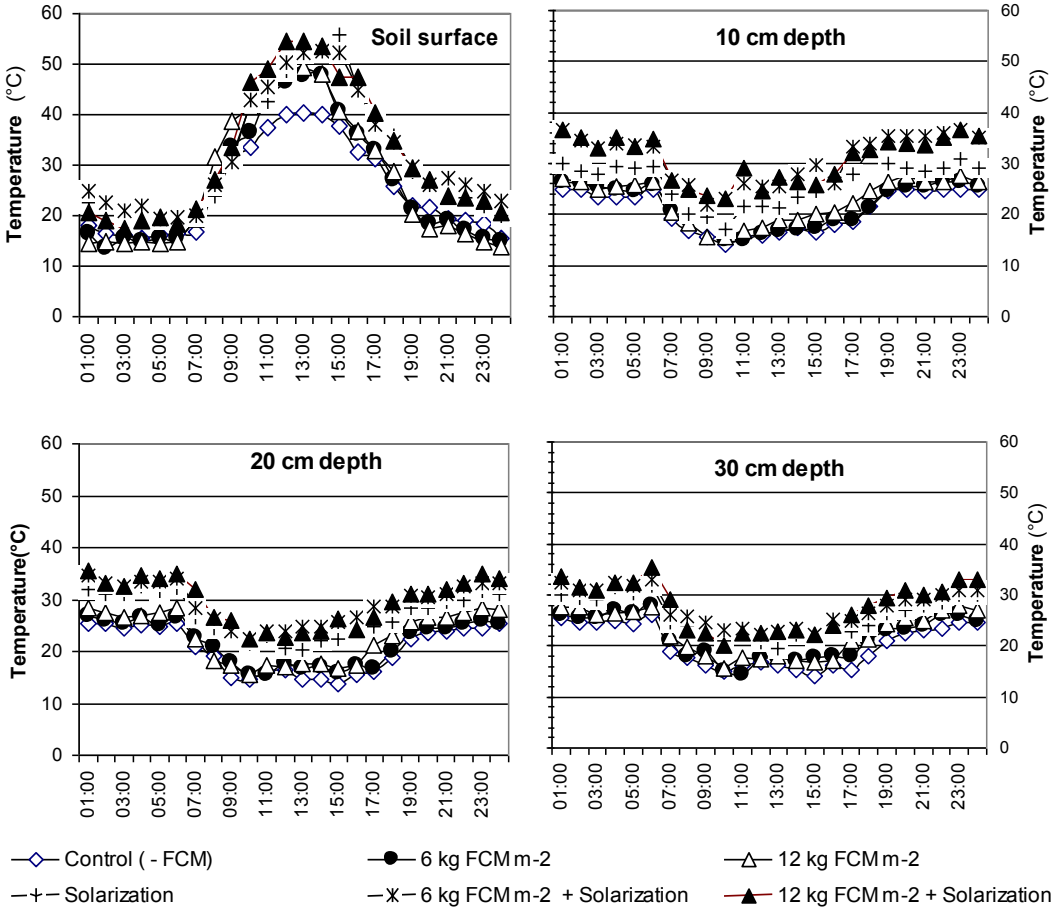

Figure 1. Effect of solarization and together with fresh chicken manure (FCM) on soil temperature (°C) at soil surface, 10, 20 and 30 cm soil depth (2010).

Table 1. Effect of solarization, fresh chicken manure (FCM) and *Verticillium dahliae* on plant mortality with diseases incidence in eggplant (2011).

Treatments	Observation times				
	Plant mortality (number)				Diseases incidence (0-3) (7 December)
	1st count (13 June)	2nd count (4 July)	3rd count (13.July)	4th count (3 Aug)	
Solarization	NS	NS	NS	NS	NS
Non Solarization	27.33(29.43)	31.00(31.84)	31.00(31.88)	32.55(32.93)	0.45
Solarization	25.44(27.96)	30.66(31.74)	30.88(31.97)	31.77(32.59)	0.39
Fresh chicken manure	**	**	**	**	
Non FCM	36.33(36.46)[a]	43.33(40.63)[a]	43.16(40.54)[a]	44.33(41.23)[a]	0.53
6 kg FCM/m^2	31.50(32.80)[a]	31.50(33.00)[b]	31.33(32.89)[b]	33.16(34.12)[b]	0.36
12 kg FCM/m^2	11.33(16.82)[b]	17.66(21.75)[c]	18.33(22.34)[c]	19.00(22.92)[b]	0.36
LSD %1	6.27	7.124	7.083	6.743	
SolX FCM	NS	NS	NS	NS	NS
Inoculation (*V. dahliae*)	**	**	**	**	**
Non V. d	14.44(20.19)[b]	18.88(23.92)[b]	19.22(24.18)	19.77(24.52)	0.07
Ino V. d	38.33(37.19)[a]	42.77(39.66)[a]	42.66(39.67)	44.55(40.99)	0.77
Sol X Ino	NS	NS	NS	NS	NS
FCM X Ino	NS	NS	NS	NS	NS
SolX FCM X Ino	NS	NS	NS	NS	NS

*, ** Significant at 0.05 and 0.01 levels respectively. NS = not significant 0.05 level.

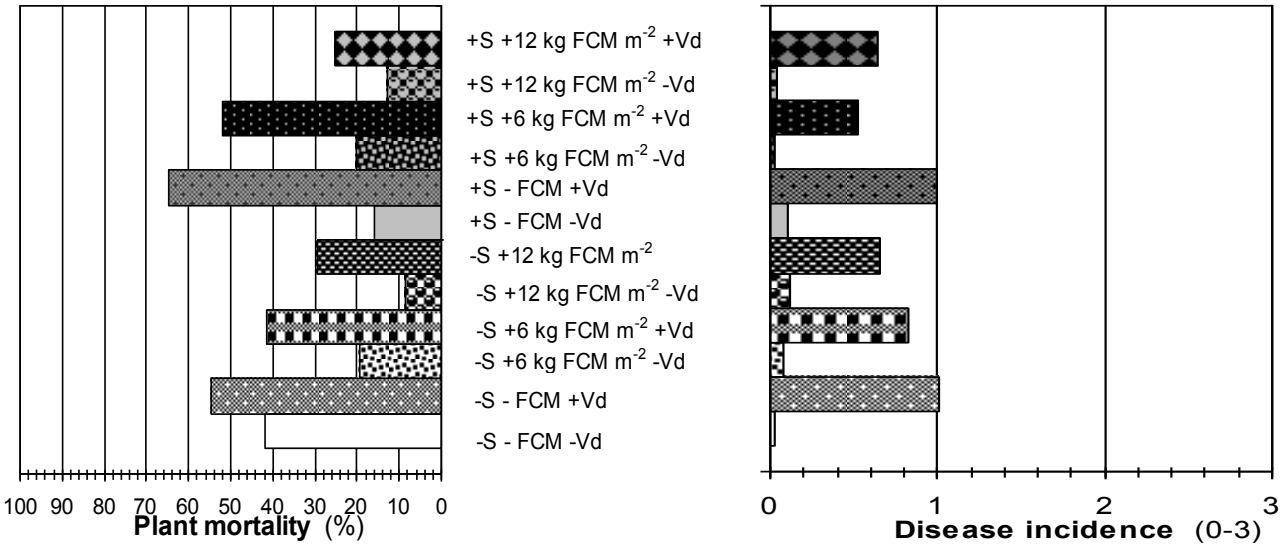

Figure 2. Effect of the triple combination of Solarization, FCM and *V. dahliae* inoculation on plant mortality with diseases incidence in eggplant (2011).

FCM per unit area in the sub plots, and the results of the statistical analysis were significant (P = 0.01) for each count (four times). As to disease incidence value, there were similar situations in the sub plots although statistical difference was not found to be significant. This value was 0.53 for control (no FCM), whereas it was found as 0.36 in both of FCM doses, and there were approximately 32% decrease in the disease incidence. There was statistically insignificant relationship between the solarization and FCM for plant loss and disease index (Table 1).

The young eggplant seedlings were transplanted into soil that may have been exposed to multi-influence from biotic or abiotic factors. It is possible that the application of solarization may have eradicated or reduced common weeds and soil borne pathogens which interfere with nutrition of seedlings or even lead to their death. Contrary to this possibility, solarization may have caused the eradication or decrease in beneficial microorganisms, such as mycorrhizal fungi in soil. Indeed, interpretations of our findings seem to be consistent with those reported in previous studies (Schreiner at al., 2001; Lalitha at al., 2003).

The inoculation of *V. dahliae* in the early stage of transplanting seedling inhibited their growth, hence leading to the death of some of them at the beginning of the vegetation period. Plant loss was 19.77% at the fourth counting in mini plots without inoculation, while this percentage increased to 44.55% with inoculated ones. According to discoloration in the trunk section of the existent plants after the last harvest, little or no disease index value was determined as 0.07 in plots without inoculation, whereas this disease incidence was determined to be 0.77 in inoculated ones. The results of the statistical analysis were significant (P = 0.01) for both the percentage of plant loss and disease incidence in mini parcels.

The difference between the inoculation of *V. dahliae* with the solarization was statistically insignificant and also similarly, there was no interaction between the inoculation of *V. dahliae* and FCM for plant loss and disease index. There was no statistical significance between the triple combination of Solarization, FCM and *V. dahliae* inoculation for plant loss and disease incidence (Table 1).

At the forth count, the least plant mortality (8.66%) emerged in "-S + 12 kg FCM m^{-2} -Vd" application, in which 12 kg of fresh chicken manure per square meter was given but after then, solarization and inoculation of *V. dahliae* were not applied in between triple combination plots. But as for the most plant loss, there was 64.66% in a combination (+ S - FCM + Vd) that FCM had not been used but solarization and inoculation were applied. According to discoloration in the trunk section of the existing plants after the last harvest, the least and the highest diseases were found as plant loss in the same combinations ("-S + 12 kg FCM m^{-2} -Vd" and "+ S - FCM + Vd") (Figure 2).

It is clear that inoculums must have led to disease or even death, whereas solarization has been ineffective for the plant loss in plots with transplanted seedlings. The young eggplant seedlings must have been died by inoculums mixed in the ground of seedling planting. In fact this interpretation is consistent with previous studies reporting that infection could be achieved by single-site inoculations of roots of eggplant seedlings with microsclerotia of the wilt-causing *V. dahliae* (Bejarano-Alcazar et al., 1999), and that occurrence of Verticillium wilt and its severity increased with increasing soil inoculum level of *V. dahliae* (Grogan et al., 1979;

Table 2. Effect of solarization, fresh chicken manure (FCM) and *Verticillium dahliae* on plant height (cm) in eggplant (2011).

Treatments	1st measure (8 June)	2nd measure (27 June)	3rd measure (11 Aug)
Solarization		*	*
Non Solarization	29.62	48.31	54.38
Solarization	30.68	52.68	61.19
Fresh chicken manure	**	**	**
Non FCM	21.50^{b}	40.64^{c}	49.12^{b}
6 kg FCM/m^2	31.97^{a}	51.95^{b}	60.49^{a}
12 kg FCM/m^2	36.99^{a}	58.89^{a}	63.74^{a}
LSD	5.11	6.30	5.66
SolX FCM	*	*	*
Inoculation (*V. dahliae*)	**	**	**
Non ino. V. d	37.35	58.64	63.33
Ino V. d	22.96	42.35	52.24
Sol X Ino V. d			
FCMX Ino V. d	*	*	*
Non FCM x (-) Ino	27.73^{bc}	47.07^{cd}	53.42^{cd}
Non FCM x (+) Ino	15.27^{d}	34.22^{e}	44.82^{e}
6 kg FCM/m^{2}x (-) Ino	42.73^{a}	65.69^{a}	69.71^{a}
6 kg FCM/m^2) x (+) Ino	21.21^{cd}	38.22^{de}	51.28^{de}
12 kg FCM/m^2) x (-) Ino	41.58^{a}	63.16^{ab}	66.87^{ab}
12 kg FCM/m^2) x (+) Ino	32.39^{b}	54.62^{bc}	60.62^{bc}
LSD	7.22	8.919	8.013
SolX FCM X Ino	NS	NS	NS

*, ** Significant at 0.05 and 0.01 levels respectively. NS = not significant 0.05 level.

Paplomatas et al., 1992; Pullman and DeVay, 1982; Xiao and Subbarao, 1998).

Decreasing seedling losses, the severity of *V. dahliae* infection with artificial inoculum must have been reduced because chicken manure is rich organic manure, stimulating the growth of antagonistic saprophytic microorganisms. This opinion has been supported by the results of a similar study conducted in Greece. According to the aforementioned study, the microbial nature involved in the suppressiveness of a compost amendment against *V. dahliae* was investigated in eggplant seedling in both the nursery and the field, and as a result of study, it was reported that treatments with *F. oxysporum* and *P. fluorescens* strains exhibited reduced disease severity; however, an increase in yield compared to the untreated control was not observed (Malandraki et al., 2008).

Plant growth

Plant height in solarized plots was higher than that in non-solarized ones, and results based on the second and third measurements were significant (P = 0.05). Plant growth also increased by means of supplementing FCM per unit area in the sub plots, and results of measurement in statistical terms were significant (P = 0.01) at three times. There was an interaction between the solarization and FCM in statistical significance (P = 0.05) (Table 2).

As a result of increasing soil temperature thanks to solarization (Figure 1), it must have made a strong effect on growth by means of more nutrients taken up by eggplant because of eradicating or decreasing the soil borne pathogens and weeds. The current findings are also consistent with previous studies (Yucel et al., 2007; Lalitha et al., 2001; Candido et al., 2008; Cimen et al., 2010a). In addition, eggplant growth was accelerated even further by chicken manure due to the fact that it improved soil structure thanks to its contain organic materials.

Artificial inoculation of *V. dahliae* caused decrease in the plant height, and results of all three measurements were significant (P = 0.01). This effect decreased from beginning towards the end of vegetation. From the first to third measurement, these decreases were calculated as follows: 38.52, 27.77 and 17.51% (Table 2).

The plant mortality was the highest, and growth of surviving ones was gradually decreasingly inhibited from the stage of transplanting due to given inoculum. This interpretation is consistent with a previous study on infection that could be achieved by single-site inoculations

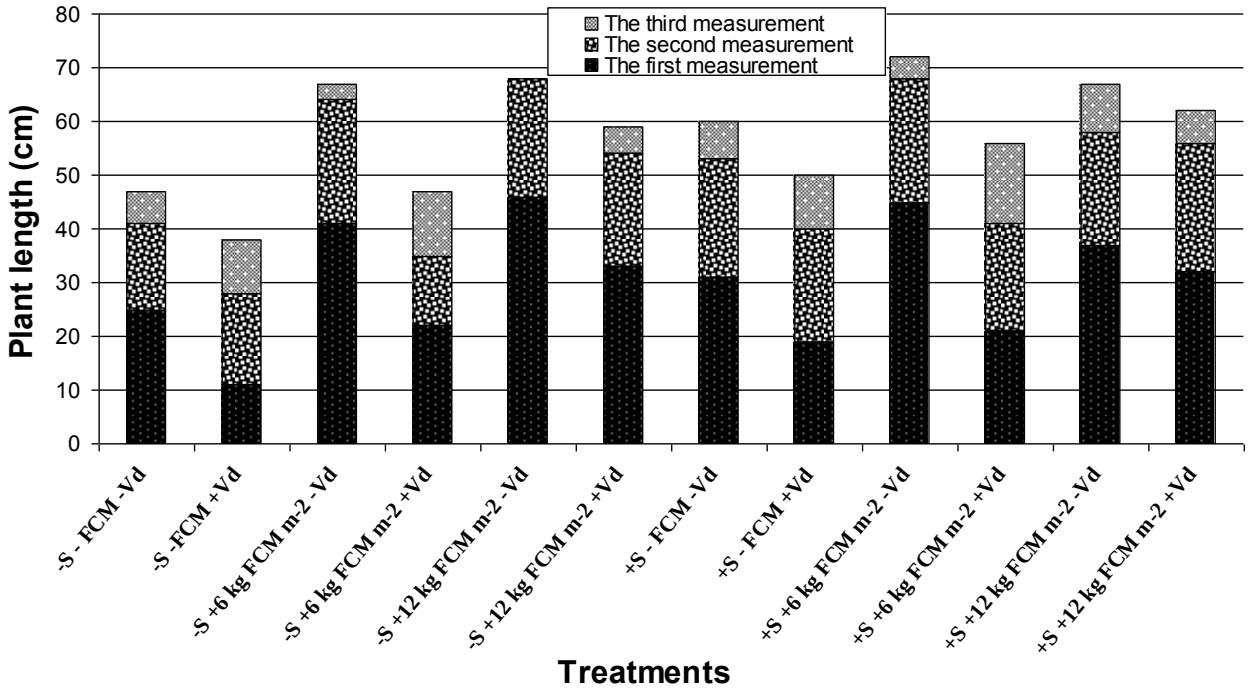

Figure 3. Effect of the triple combination of Solarization, FCM and *V. dahliae* inoculation on plant growth in eggplant; among measurement dates, plant growth as plant height for this triple combination was cumulatively given (First measure, 8 June; Second measure, 27 June; Third measure, 11 August, 2011).

of roots of eggplant seedlings with microsclerotia of the wilt-causing *V. dahliae* (Bejarano-Alcazar at al., 1999). Afterwards, we reached the opinion that plant growth had accelerated owing to reducing of the number plant per plot and increasing the soil temperature.

Interaction between the inoculation of *V. dahliae* together with solarization was statistically insignificant for plant length, whereas its interaction between with FCM was seen and it was significant (P = 0.05) for three measurements. The effect of the one together with solarization, FCM and inoculation of *V. dahliae* on plant growth was insignificant (Table 2). Among measurement dates, plant growth as plant height for this triple combination is cumulatively given in Figure 3. In triple combination plots, the highest plant height was measured as 72. 13 cm at the last measurement in "+S +6 kg FCM m^{-2} -Vd" combination plots where 12 kg of FCM per square meter was given after which solarization applied but there was not inoculation of *V. dahliae*. However, the least plant growth occurred as 38.42 in FCM and solarization non applied but inoculated with *V. dahliae* (-S - FCM +Vd) combination ones (Figure 3).

Yield

For total yield at first 3 harvests, the increasing yield rate was 22% in solarized plots in terms of earliness, as compared to non-solarized ones. This increment trend continued throughout the growing season and resulted in 45% increment at final assessment as total of 9 harvesting (Table 3). Positive effect on plant growth by means of solarization has also reflected yield increase. Hence, repeating the same interpretation is available as well, and results are compatible with those reported by Schreiner et al. (2001) and Lalitha et al. (2003). Growth of common weeds was faster than those of eggplant in non-solarized plots, and they were manually removed or cut off. If this cultural practice was not necessary, the yield would be decreased even more due to inhibiting growth of eggplant in non-solarized parcels as control. For this reason, the effect of solarization on yield could have increased much more according to us. Our findings are consistent with previous studies carried out on eggplant (Tamietti and Valentino, 2001) and for some vegetables (Cimen at al., 2009; Cimen at al., 2010a).

Since chicken manure reduced both plant loss and wilt disease severity caused by *V. dahliae* (Table 1), and also it positively stimulated the plant growth (Table 2), increasing the yield of eggplant. For total yield at first 3 harvests, the highest yield was obtained in a sub plots where FCM had been given as 12 kg km^{-2}, and this rate of yield increase was 2.8-fold greater than the control without FCM. This increment trend continued throughout the growing season and resulted as 2-fold increment at final assessment as a total of 9 harvesting. Both of the results were statistically significant (Table 3). The interaction between solarization and FCM was statistically

Table 3. Effect of solarization, fresh chicken manure (FCM) and *Verticillium dahliae* on yield(ton/ha) in eggplant (2011).

Treatments	Harvest										
	1 (22 Jul)[x]	2 (02 Aug)	3 (12 Aug)	Total of 3 harvest	4 (24 Aug)	5 (06 Sep)	6 (20 Sep)	7 (30 Sep)	8 (14 Oct)	9 (14 Nov)	Total of 9 harvest
Solarization	NS	NS	**	NS	*	*	NS	NS	NS	NS	NS
Non-solarized	0.21	1.43	2.04	3.68	2.99	2.95	2.57	1.88	3.24	0.87	18.18
Solarized	0.18	1.51	2.78	4.47	4.93	4.45	5.25	2.20	3.80	1.18	26.28
FCM		**	**	**	**		**	**	**		**
-FCM	0.07	0.67[b]	1.28[b]	2.02[b]	2.30[b]	3.29	2.03[b]	1.04[b]	2.00[b]	0.77	13.45[b]
6 kg FCM m^{-2}	0.17	1.63[ab]	2.95[a]	4.75[a]	4.85[a]	3.32	4.27[a]	2.67[a]	4.61[a]	1.01	25.48[a]
12 kg FCM m^{-2}	0.34	2.11[a]	3.01[a]	5.46[a]	4.72[a]	4.47	5.42[a]	2.38[ab]	3.93[a]	1.29	27.67[a]
SX FCM	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
V. dahliae ino.	**	**	**	**	**	NS	NS	**	**	*	**
- V. d	0.34	2.41	3.43	6.18	5.65	4.01	4.49	2.66	4.59	1.22	28.80
+ V. d	0.05	0.52	1.39	1.96	2.27	3.38	3.32	1.42	2.44	0.82	15.56
SX Vd ino.	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
FCM X Vd ino.	NS	*	NS	NS	NS	NS	NS	NS	NS	NS	NS
SX FCM x Vd ino.	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

* , ** Significant at 0.05 and 0.01 levels respectively. NS = not significant 0.05 level. [x:] harvest date in 2011.

insignificant for the results of yield. According to the aforementioned study, our finding is supported by a study conducted in Greece (Malandraki et al., 2008).

Inoculation of *V. dahliae* caused a decrease in yield because of both the increase in eggplant seedlings and incidence of disease in surviving ones. Total yield decreased by 46%, and the result was significant at the 1% level.

The interaction among solarization, FCM and inoculation of *V. dahliae* on eggplant yield was insignificant (Table 3), but the numerical values differ considerably among treatments for this triple combination plots (Figure 4).The highest yield was obtained as 40.00 ton ha^{-1} in total yield of harvest for "+S +12 kg FCM m^{-2} -Vd" combination plots where 12 kg of FCM per square meter was given after then solarization applied but there was not inoculation of *V. dahliae*, and this was followed by "+S +6 kg FCM m^{-2} -Vd" treatment as 38.20 ton ha $-^{-1}$. However, the least yield occurred as 6.00-ton ha^{-1} in "-S -FCM +Vd "between triple combinations. The yield increased by more than seven folds for first one as compared to the last one. In that practical application, considering the possibility of infection of *V. dahliae* instead of the first one, that is, with "+S +12 kg FCM m^{-2} +Vd" treatment, this increase was 4.3 folds according to last one (Figure 4). These findings obtained by us in field conditions are consistent with those of earlier studies in controlled environments (Grogan et al., 1979; Paplomatas et al., 1992; Pullman and DeVay, 1982; Xiao and Subbarao, 1998; Bejarano-Alcazar at al., 1999).

Conclusıons

The amount of organic matter in soil is an important factor in soil structure. This problem can be overcome by supplementation of green plant or animal manure to some extent if there is inadequate soil organic matter. The nutritional value of chicken manure is quite higher than others, but it is recommended to have been burnt for growing vegetable. When used as fresh, it can cause burning or be harmful to culture plants. However, on non**-** crop land**,** its stage of combustion can be used for heating of soil, which is mixed before solarization. This situation will be an opportunity for intensive vegetable cultivation even if there is simple transparent polyethylene for solarization in cold-mild climate zones with

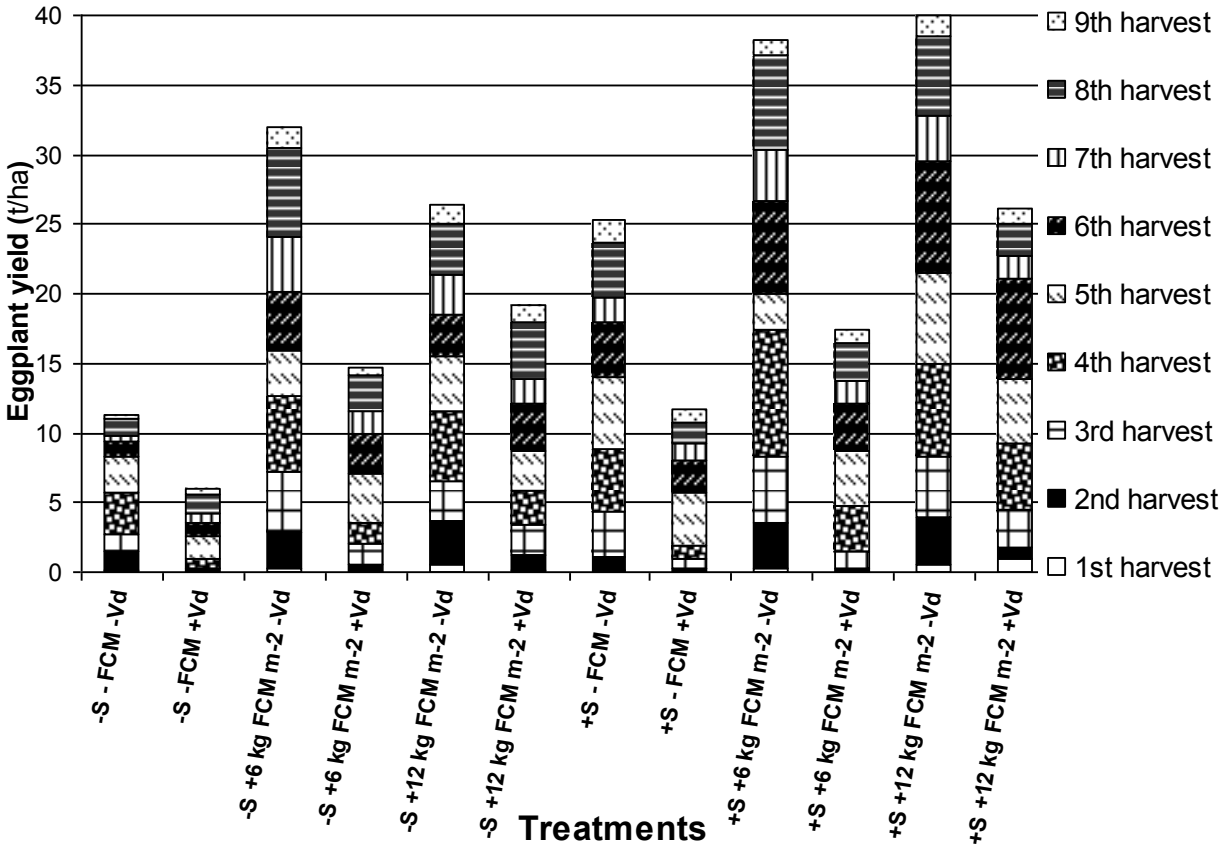

Figure 4. Effect of the triple combination of Solarization, FCM and *V. dahliae* inoculation on yield in eggplant; 9 harvest for this triple combination was cumulatively given (2011).

inadequate summer temperatures. By means of chicken manure with solarization application, even if there have been adequate summer temperatures**,** most of which have high resistance to heat and drought also non-possibility of chemical control, some of soil-borne disease pathogens, nematodes and weed seeds will be possible to eradicate. On the other hand**,** poultry growers will not encounter problems in order to keep the stage of the combustion of this fresh manure in their chicken farming; that is to say, this fresh chicken manure will be better assessed.

Conflicts of Interests

The authors have not declared any conflict of interests.

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