Environment & Ecology 35 (4) : 2806—2810, October—December 2017
Website: environmentandecology.com ISSN 0970-0420

Effect of Vesicular Arbuscular Mycorrhiza on Verticilluim Wilt (*Verticillium dahliae* Kleb.) and Yield of Eggplant on the Field Applied with Fresh Chicken Manure and Solarization Together

Vedat Pirinc, Ismail Cimen, Cumali Ozaslan

Received 3 April 2017; Accepted 11 April 2017; Published online 29 April 2017

Abstract This study was carried out in 2012 in order to determine the effect on the yield of eggplants that were inoculated with Glomus intrarides (Vesicular Arbuscular Mycorrhiza-VAM) in a experimental field applied with fresh chicken manure followed by solarization followed by Verticillium wilt (*Verticillium dahliae* Kleb.). The result of the study indicated that although Mycorrhiza has no effect on yield, there has been an increase in the total yield with the application of solarization after fresh chicken manure. In addition to that, it was determined that in intensive vegetable farming done in cold and mild climate where the summer temperatures are not enough, applications of solarization after fresh chicken manure would be appropriate against soil borne disease factors and weeds which are difficult to fight with drugs.

Keywords Verticillium, Mycorrhiza, Chicken manure, Eggplant.

Introduction

The most important problem in vegetable gardening is the soil borne disease factors and the yield decrease due to weeds. The most impotant cause among the disease factors is the wilt disease, which is caused by *Verticillium dahliae* Kleb. In recent years, the host strain of disease factor has exceeded 400, mainly in annual vegetables and field crops [1]. This problem can be avoided in large areas with rotation (seedling) and in small seed fields, which is the vegetable field, by fumigating the soil with chemicals. However, it is known that these fumigants have negative effects on the environment. It was suggested in 2005 that this fumigant be completely abandoned due to the damage to the ozone layer by Methyl Bromide, which is widely used in these chemicals [2]. It is suggested to make use of solar energy instead of these fumigants [3]. With this method called solarization, soil is covered with plastic for one or two months during the hot days of the year in order to heat and pasteurize the soil, thereby reducing soil borne disease weed seeds [4] and vegetables [5—7].

V. Pirinc[1], I. Cimen[2], C. Ozaslan[2]*
[1]Department of Horticulture,
[2]Plant Protection Department,
Faculty of Agriculture, Dicle University,
Diyarbakir 21280, Turkey
e-mail : cumali.ozaslan@dicle.edu.tr
*Correspondence

Contrary to these benefits of solarization, there is also the question of reducement or destruction of microorganisms that are beneficial to the soil [8]. The leading of these microorganisms is mycorrhiza, which co-lives with the plant and increases the plant root surface [9]. Within this ecosystem formed between Mycorrhiza and the plant, the plant is protected against some soil borne disease factors [10].

In this study, it was aimed to determine the increase of yield and quality by decreasing Verticillium Wilt (*Verticillium dahliae* Kleb.) disease in eggplants, which were inoculated with *Glomus intrarides* (Vesicular Arbuscular Mycorrhiza) in areas where fresh chicken manure and solarization were applied together.

(We would like to express our gratitude for Prof Dr Ibrahim Ortas (Cukurova University, Soil Department, Turkey) for providing Mycorrhiza (*Glomus intraradices*). Associate Professor Dr Sibel Dervis from Mustafa Kernal University Agriculture Faculty Plant Protection Department, for sending *Verticillium dahlia* Klepp isolate).

Materials and Methods

Material

The research was carried out at the experimental area of Dicle University, Faculty of Agriculture, on experimental plots in 2012, where fresh chicken manure was applied a year ago, followed by solarization and then *Verticillium dahliae* inoculation and finally planted eggplants. In the study, eggplant (*Solanum melongena*) type was used as plant material. *Verticillium dahliae* Kleb isolate used in the experiments was provided from the Department of Plant Protection of Mustafa Kemal University Faculty of Agriculture and *Glomus intraradices* Smith and Schenck mycorrhiza fungus was obtained from Cukurova University, Faculty of Agriculture, Department of Soil Science.

Method

The experiment was carried out with three recurrences; it was established according to the Split Split Plots Experiment Design, where solarization took place as main, fresh chicken manure as bottom, disease inoculation as mini and mycorrhiza as mini mini plots.

Production of eggplant seedlings with and without Mycorrhiza

The eggplant seedlings to be used in the experiment were grown under the conditions of polycarbonate greenhouse. As a substance for growing seedlings; peat and peat + mycorrhizal soil mixture were used by filling in the vials. During these operations mycorrhizal (*Glomus intraradices*) soil was calculated to be 15 grams per plant. Two eggplant seeds were planted per each cell in the viols. This process was carried out in the phytopathology laboratory on March 2, 2012. The planted viols were later transported to the controlled greenhouse and germination of the seeds was expected. The eggplant seedlings were irrigated at intervals of 2 days.

Preparation of inoculum and imoculation

On April 6th 2012, inoculum was prepared in the planting cabin which has an ultraviolet light feature. *Verticillium* dahliae isolates used in inoculation were first transferred to PDA nutrient media and left to mycelia growth in 222 + -2^{o}C incubator. After the complete cover of mycelial development of the petri, the mycelial parts were taken to sterile bulgur environment. Before this process, bulgur was sterilized by autoclaving at 121^{o}C after adding 30, 55, and 82 gr bulgur followed by respectively 24, 25, and 65 mm water to 9 and 18 mm petri dishes and 250 mm volume erlens. *Verticillium dahliae* inoculum was multiplied in the bulgur environment in 22 ± 2^{o}C incubator. The obtained inoculum was left in deep freezer. It was foreseen to give 5 grams per plant from this mixture. This amount was mixed with 100 g of stream samd per plant and mixed with *V. dahliae* inoculum to the soil at seedling planting areas. Eggplant seedlings were first planted to mini plots where *V. dahliae* inoculum was not given and then staggered at seedling sites where the inoculum was mixed.

Transmission of eggplant seedling to land

In the experiment field, firstly a line was drawn with the tractor as to have 70 cm between the rows. Then,

Table 1. Effect of solarization, fresh chicken manure, and Mycorrhiza (VAM) applications on plant development, Wilt (*Verticillium dahliae*) disease and yield of eggplant (2012). *, **Significant at 0.05 and 0.01 levels respectively.

Application	Plant length (cm) Measurement 1 17.07.12	Measurement t 2 08.08.12	Disease severity	Yield (ton/ha) First 3 harvest total	Last 7 harvest total	Total 10 harvest
Solarization (S) (A)	*			*	*	*
Without Solarization	34.841	56.040	0.157	4.96	18.10	23.06
With Solarization	38.228	61.634	0.245	7.51	22.76	30.37
Fresh chicken manure (FCM) (B)	***	**	**	**	**	**
Without Fresh Chicken Manure	24.170	42.360	0.139	1.58	8.52	10.10
Fresh Chicken Manure 6 kg/m^2	43.754	65.815	0.202	8.50	28.68	37.18
Fresh Chicken Manure 12 kg m^2	41.679	68.336	0.263	8.61	24.10	32.71
V. dahliae inoculation (Vd) (C)			**	*		*
Without Inoculation (*V. dahliae*)	38.159	59.074	0.096	7.49	21.60	29.09
With Inoculation (*V. dahliae*)	34.910	58.601	0.306	4.97	19.26	24.23
Mycorrhizae (D)				*	*	
Without Mycorrhizae	35.682	60.171	0.220	5.39	22.05	27.44
With Mycorrhizae	37.387	57.504	0.183	7.07	18.81	25.88

on May 21st, 2012, in the mini mini plots determined as 40 cm on the order, the place where *V. dahliae* inoculum was given on the same day were planted with eggplant seedlings after 2 days. Eggplant seedling; were first planted to mini plots where *V. dahliae* inoculum was not given and then seedlings with and without Mycorrhiza were planted to places where inoculum was mixed. In total of 72 plots, 30 plants were placed per plot.

From the date the seedlings were transferred to the land until September 10, 2012, irrigation operation was carried out in the form of surface irrigation with a period of 4 days intervals. In order to avoid contamination with other plots, the irrigation began first with plots without any inoculum. Then the other plots were irrigated.

Determination of disease severity

After the last harvest, all plants in the plot were cut from the root throat on October 31, and the disease index was determined by observing the color change in the cross section of the stem in this area. The disease index was formed according to 0–3 scale. Accordingly: 0= no color change in xylem transmission bundles in trunk section; 1-color change in xylem 1%–34%; 2=color change in xylem 35%–67%; 3=68–100% [11].

Observation of plant development

10 days after planting, the average plant height (cm) was found by dividing the total value of all the plants in the plot were measured from soil surface to the extreme point were divided by the number of plants in the plot in order to find the average plant height (cm). This process was repeated for the second time on 08.08.2012.

Determination of harvest and yield

Harvesting of eggplant was carried out in accordance with the general characteristics of the type, when the fruit received its normal color (purple-dark purple color) and when it reached adequate length (belt-type cylindrical variety). A total of 10 harvests were made during the experiment; first 3 harvests were evaluated separately and the remaining 7 harvests were evaluated also.

Results and Discussion

Effect of solarization on plant development, disease and yield

Two years after the application of solarization, it has been seen to have a positive effect on eggplant development. Despite the increase in disease severity with *Verticillium dahliae* inoculation, while the first 3 harvest increased by 51% in total by means of earliness, later this ratio decreased and the total yield of 10 harvests was calculated as 30% increased compared to the areas without solarization (Table 1).

We find that these results are in accordance with the view of previous studies as that solarization causes the increase of yield in vegetables by decreasing the amount of disease factors and weed oxistence in the soil [4, 5, 12, 13].

Our view on the rapid growth of the factor inoculated to wilt caused by *Verticillium dahliae* in soil, might be caused by pre-existing soil borne beneficial anthogenesic microorganisms demolishment by solarization, is in agreement with the previous study [14].

The effect of fresh chicken manure on plant development, disease and yield

In the second year of the solarized plots after fresh chicken manure was applied, it had a positive effect on eggplant development and the yield increased despite the increase in wilt severity caused by *Verticillium dahliae* Kleb. This increase was found to be significant at a level of 1%. This effect was observed at most in the maximum 6 kg of application per decare, the yield increase has been approximately 4 times that of the application without chicken manure (Table 1). Fresh chicken manure content is an organic manure rich in nutrients as potassium and phosphorus and especially nitrogen content. This stage causes burning or even death in vegetables due to high nitrogen content. This negative effect has been overcome by us bringing fresh chicken manure to empty field and mixing with soil and then solarizing and in the following years it became to a nutritious condition for eggplant.

Effect of *Verticillium dahliae* inoculation on plant development, disease and yield

With *Verticillium dahliae* artificial inoculation, the severity of disease increased (at a level of 1% significance) this effect was high in the initial stage of yield (in the first total 3 harvests) and was found statistically significant at a level of 5% and yield decreased by about 35%. This effect continued to diminish and at total 10 harvests, this value was found to be 17%, statistically meaning a significance level of 5%. At the beginning of the vegetation period, the sensitivity of the eggplant seedlings to *V. Dahliar* was high and then this sensitivity decreased with the rapid development of the plant.

Effect of mycorrhizal application on plant development, disease and yield

Artificial inoculation of Mycorrhiza fungus (*Glomus intradices*) did nit affect the growth of eggplant although it reduced the degree of wilt by 17%. Mycorrhiza increased the yield of the first 3 harvests by 30% (significant at a level of 5%). However, this increase was not observed in the following periods (Table 1). Previous studies are in agreement with our findings that mycorrhiza inhibits the development of soil-based fungal factors which cause disease [5, 15].

The seedlings of the eggplants needed coexistence with the mycorrhiza during the time when the roots had not yet reached a depth in the young seedling period, which is in agreement with our finding on their dependence on mycorrhiza in plants with the crop root system [13]. Deep root system of the plants in the period of vegetation to go deep and to take nutrients with its own roots is considered as a possibility in reducing the effectiveness of Mycorrhiza.

Conclusion

The amount of organic matter in our soil is insufficient. This situation is partly resolved by farm manure reinforcement. Among these fertilizers, the nutritive value of chicken manure is much higher than the others. It is advised for this manure to be used as aged (fermented) in garden agriculture. When used fresh, it causes damages to the plant, especially burning. However, when given to the soil during non cultivation/planting period, the burning step together with solarization can be used in heating of the soil. This is especially an opportunity for the cultivation of cold and mild climate zone intensive vegetable farmimg, in which only transparent polyethylene that is when summer hot is not enough even if simply solarization is applied. With these study results, even though summer temperatures are sufficient, some disease pathogens and nematodes, which ae not capable of highly resistant chemical struggle with soil borne warm water, will be eliminated. Again, it will be possible to destroy some weed seeds resistant to drought. Chicken breeders are having trouble keeping their fresh chicken manure in their managements because of the time it takes for the combustion stage to take place. This work, in the light of what has been given above, is addressed to a wide audience and will contribute greatly to the vegetable growers and then the chicken breeders and hence the economy of the country.

References

1. Mc Cain AH, Raabe RD, Wilhelm S (1981) Plants resistant or susceptible to Verticillium wilt. In: Coperative extension. Depart of Agric, Univ of California, Berkeley, USA, pp 1—12.
2. Katan J (1989) The Methyl Bromide Issue: Problems and potantial solutions. J Pl Pathol 81 : 153—159.
3. Katan J (1987) Soil Solarization John Willey and Sons, Inc, London, pp 77—105.
4. Lalitha BS, Nanjappa HV, Ramachandrappa BK (2003) Effect of soil solarization in soil microbial population and the germination of weed seeds in the soil. J Ecobiol 15 : 169—173.
5. Cimen I, Pirinc V, Sagir A, Akpinar C, Guzel S (2009) Effects of solarization and vesicular arbuscular mycorrhizal fungus (VAM) on phytopthora blight (*Phytophthora capsici* Leonian) and yield in pepper. Afr J Biotechnol 8 : 4884—4894.
6. Özaslan C, Cimen I, Kizmaz MZ, Pirinc V, Kara A (2015) Determination of long-term effects of consecutive effective fresh chicken manure with solarization and verticillium wilt (*Verticillium dahliae* Kleb) on weed and its control in eggplant. Afr J Biotechnol 14 : 1614—1623.
7. Cimen I, Basaran M (2016) Effect of solarization with fresh chicken manure on verticillium wilt (*Verticillium dahliae* Kleb) and yield in eggplant. Afr J Biotechnol 15 : 2804—2813.
8. Schreiner RP, Ivors LK, Pinkerton JN (2001) Soil solarization reduces arbuscular mycorrhizal fungi as a consequence of weed suppression. Mycorrhiza 11 : 265—311.
9. Smith SE, Read DJ (2008) Mycorrhizal Symbiosis (3rd edn). Acedemic Pres London.
10. Harrier LA, Watson CA (2004) The potential role of arbuscular mycorrhizal (AM) fungi in the bioprotection of plants against soil-borne pathogens in organic and/or other sustainable farming systems. Pest Mgnt Sci 60 : 149—157.
11. Buchenauer HD, Erwin C (1976) Effect of the plant growth retardant Pydanon on Verticillium wilt of cotton and tomato. Phytopathology 49 : 68—72.
12. Cimen I, Turgay B, Pirinc V (2010) Effect of solarization and vesicular arbuscular mychorrizal on weed density and yield of lettuce (*Lactuca sativa* L.) in autumn season. Afr J Biotechnol 9 : 3520—3526.
13. Cimen I, Pirinc V, Sagir A (2010) Determination of long-term effects of consecutive effrctive soil solarization with vesicular arbuscular mycorrhizal (VAM) on white rot disease (*Sclerotium cepivorum* Berk.) and yield of onion. Res Crops 11 : 109—117.
14. Stapleton JJ, Devay JE (1984) Thermal components of soil solarization as related to changes in soil and root microflora and increased plant growth response. Rhytopathology 74 : 255—259.
15. Karagiannidis N, Bletsos F, Stavropoulos N (2002) Effect of Verticillium wilt (*Verticillium dahliae* Kleb.) and mycorrhiza (*Glomus mosseae*) on root colonization, growth and nutrient uptake in tomato and eggplant seedlings. Scientia Horticulturae 94 : 145—156.