Effect of soil solarization and organic amendments on root-knot nematode management in tomato nursery

S. Mullaimaran[1*], K. Haripriya[1] and T. R. Barathkumar[1]

[1] Department of Horticulture, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Tamil Nadu, India

Correspondence Author: S. Mullaimaran

Received 29 Sep 2022; Accepted 7 Nov 2022; Published 24 Nov 2022

Abstract

Afield experiment was conducted at farmers field during May 2009 in Salem district to study the effect of soil solarization with organic amendments as a method of root-knot nematode and weed management in tomato nursery bed. Solarization of nursery beds using 300-gauge transparent polyethylene sheets was carried out with various amendments to study the performance of tomato seedlings. The experiment was laid out in randomized block design with 11 treatments replicated thrice. The treatments included, solarization for four weeks with four different amendments viz., vermicompost, poultry manure, Farm Yard Manure (FYM), neem cake and castor cake along with non-solarized control and solarization without amendment. In four treatments, *Azospirillum* was inoculated two days after the polythene sheet removal. The study was carried out during May, 2016. The results of the experiment revealed that solarization treatment with vermicompost followed by solarization with poultry manure and neem cake were found to be effective in increasing the soil temperature in all depths and on all days of observation. Similarly, the least values for root knot nematode population were recorded in the solarization treatment with neem cake. The performance of tomato seedlings was superior under solarization with vermicompost along with *Azospirillum* treatment followed by solarization with vermicompost alone. This was comparable with solarization with neem cake along with *Azospirillum*. Solarized seedlings with vermicompost and *Azospirillum* inoculation attained the transplanting stage 15 days earlier when compared to control.

Keywords: solarization, root-knot nematode, tomato seedlings, weed management, vermi compost and neem cake

Introduction

Indiscriminate use of chemical fertilizers, pesticides and herbicides has led to the deterioration of soil health, ground water quality, soil microbial population, atmospheric constituents, quality of the agricultural produce and thereby the health of animals and humans. Soil organic matter is a vital component of the soil that controls the physical, chemical and biological properties to a large extent. Hence now the emphasis is given for the use of organic resources and non-chemical management practices to maintain the soil quality and environmental health in order to produce high quality produce. The global scenario also currently directs the scientists to produce residue free farm produce and hence there is an emerging awareness among public on the use of high quality food materials which are free from chemical toxicants. This has paved the way for organic farming. Organic farming aims at harmony with nature and achieving production without harming the environment. It is a management system that enhances biodiversity, biological cycles and soil biological activity to produce healthy plants and animals and foster human and environmental health. Organic agriculture dramatically reduces external inputs obtained by reframing chemo-synthetic fertilizer and pesticides. With an increasing demand for organic products especially in Europe, USA and Japan, many countries are making an onset in the development of organic farming as a potential avenue to make a mark in the international market. Organic food contains less of bad stuff, such as pesticides, heavy metals etc., and more of good stuff, such as vitamins and minerals. Several studies have shown that organically grown crops contain higher level of nutrients such as vitamin-C and iron, besides, secondary metabolites (e.g., phenolic metabolites) that are believed to have anticancer properties (Azadi *et al.*, 2011) [2]. Hence, now-a-days, the produce through organic cultivation are fetching higher price, which ultimately increase the income of farmers. Organic farming can be taken up for high value crops like chillies, bengal gram and baby corn. On-farm generation of organic source and possibility of getting high premium price for organically grown crops will commensurate the net return in addition to maintenance of soil ecological equilibrium. (Siddeswaran and Shanmugam, 2013) [5].

Material and methods

The nursery trial was conducted during May 2009 to study the effect of solarization with amendments on the performance of tomato seedlings. The soil was well ploughed to break the clods and plant debris which might interfere with uniform conduction of heat and biogases that may protect some pathogenic organisms to escape. The amendments chosen were among available materials in Salem district. The dosage of amendment used was 1 kg m^{-2}. The organic amendments were incorporated thoroughly into the soil according to the respective treatments. After incorporation of the organic amendments, raised nursery beds of size 3m x 1m were formed. Then the beds were irrigated to field capacity to encourage exothermic fermentation process. After irrigation, the beds were covered with the high density poly ethylene sheet of 300 guage thickness and the sides were tucked into the soil. These beds thus done were solarized for a period of four weeks and monitored carefully. After the solarization period was over, the polyethylene sheets were removed. *Azospirillum* was applied in the respective treatments both to seeds and as band application for respective treatments after 2 days of sheet removal. The seeds of tomato cv. Kashi Sarath were sown in the nursery beds. Mulching was done with paddy straw and the beds were watered using rose can. Germination and growth of the seedlings were monitored until transplantation. The experiment was laid out in Randomized Block Design with 11 treatments replicated thrice. The treatments include combination of solarization for four weeks with four different amendments viz., Vermicompost, Poultry Manure, Castor Cake and neem cake along with non-solarized control and solarization without amendment. At the end of treatment period, inoculation with *Azospirillum* was done for specific treatments.

Treatment details

Table 1

T_1	Non solarized control
T_2	Solarization without amendments
T_3	Solarization with Castor cake
T_4	Solarization with Neem cake
T_5	Solarizationwtihvermicompost
T_6	Solarization with poultry manure
T_7	Solarization with Castor cake + *Azospirillum*
T_8	Solarization with Neem cake + *Azospirillum*
T_9	Solarizationwtihvermicompost + *Azospirillum*
T_{10}	Solarizationwtih poultry manure + *Azospirillum*
T_{11}	Solarization without amendments + *Azospirillum*

Simultaneously main field solarization was carried out with same set of treatments during April-May 2016. The observations *viz.*, Nematode population, Germination Percentage, Shoot length and Root length were recorded and subjected for statistical analysis (Panse and Sukhatme, 1967) [4].

Results and discussion

As per the data presented in Table 2 the soil microbial and nematode population differed significantly due to solarization with various amendments. The least number of larvae of nematodes (13.11) were recorded in the treatments which received solarization with neem cake (T_4). This was on par with the treatment T_5 which recorded the same value for number of nematode population (14.14) whereas highest population of nematodes (20.37) was recorded in T_1 (control). The treatment, T_2 recorded a nematodes population of 19.32 for nematodes. This was lower than control and higher than solarization with amendments. The percentage reduction over control for nematodes under treatment T_4 varied from 46.10 per cent for *Xiphinema sp*. and 38.33 per cent for *Hoplolaimus sp.* This was comparable with T_4 as shown in Table3.

The mean for germination percentage in solarized and non-solarized plots varied significantly. Among the various treatments, the highest germination percentage was recorded in T_9 (96.08) followed by T_5 (94.07), which was on par with T_8 (93.99) as presented in Table4.

The highest shoot length was registered in the treatment T_9 (22.82 cm) and was followed by T_5 (21.79 cm). This was on par with T_4 (20.92 cm). Treatment T_{11} had registered a shoot length of 18.27 cm which was significantly superior to T_2 which recorded a shoot length of 17.45 cm. Though these treatments recorded comparably higher values for shoot length than control (16.21cm), the recorded values were lesser than the other treatments incorporated with amendments. Table4 (fig.1)

The observations recorded on root length after statistical analysis is presented in Table4 (fig.1) 1). All the treatments exerted significant influence over root length when compared to control. The maximum root length (6.78 cm) was recorded in T_9 followed by T_5 (6.46 cm). This was on par with T_8 (6.45cm). Among the two treatments which were not incorporated with amendments, T_{11} recorded the maximum root length (5.16 cm) when compared to T_2 (4.83 cm).

Both the treatments were significantly superior to control (4.28 cm), but the recorded values were lesser than the solarization treatments with various amendments.

Soil solarization is a hydrothermal disinfestation method based on covering the water saturated soil with transparent polyethylene sheet and thus, increasing the soil temperature by the solar energy. The recent string in solarization is combining it with organic amendments like animal waste and plant residues that are capable of producing toxic volatiles. During the process of solarization with amendments, bio toxic volatile compounds are released when organic matter is heated (Stapleton, 1997) [6]. This process has been shown to improve the efficacy of solarization with the improved control of soil borne plant pathogen, nematodes and weeds. Such a treatment was reported to result in certain physical, chemical and biological changes that favour plant health and growth while producing deleterious effect on weeds, pathogens and pests.Soil borne diseases such as damping off, plant parasitic nematodes and weeds are often inoculated in transplants and nursery stocks (Umamaheswari, 2009) [7]. Healthy transplants will be produced from healthy nursery soil. Therefore, investigations were undertaken to study the effect of soil solarization on seedling growth of tomato.

Table 2: Effect of nursery solarization with amendments on soil microbial population as observed on 28th day after solarisation

Treatments	Nematodes (No of larval per 10 ml of suspension)
T_1- non solarized control	20.37
T_2- solarization with no amendments	19.32
T_3- solarization with Caster cake	18.20
T_4- solarization with Neem cake	13.11
T_5- solarization with Vermicompost	14.14
T_6- solarization with poultry manure	14.61
SED	0.51
CD (P=0.05)	1.03

Table 3: Effect of nursery solarization with amendments on soil nematode population

Nematodes	T_1	T_2	T_3	T_4	T_5	T_6
Hoplolaimus sp.	4.80	3.67 (23.54)	3.53 (26.45)	2.96 (38.33)	3.05 (36.45)	3.30 (31.25)
Tylenchulus sp.	7.42	6.10 (17.78)	5.74 (22.64)	4.64 (37.46)	4.81 (35.17)	5.37 (27.62)
Heterodera sp.	6.23	5.11 (17.97)	4.98 (20.06)	3.79 (39.16)	4.25 (31.78)	4.53 (27.28)
Xiphinema sp.	4.49	3.40 (24.27)	3.31 (26.28)	2.42 (46.10)	2.86 (36.30)	3.09 (31.18)
Rotylenchus sp.	5.33	4.20 (21.20)	4.07 (23.63)	3.30 (38.08)	3.64 (31.70)	3.82 (28.33)

Values in parenthesis indicate percentage reduction in population over control.

Table 4: Effect of nursery solarization with amendments on germination percentage, shoot length and root length of tomato seedlings

Treatments	Germination (%)	Shoot length (cm)	Root length (cm)
T_1- non solarized control	64.42 (79.98)	16.21	4.28
T_2- solarization without amendments	66.73 (83.10)	17.45	4.83
T_3- solarization with Castor cake	72.32 (89.74)	20.01	5.81
T_4- solarization with Neem cake	74.45 (91.89)	20.92	6.14
T_5- solarization with Vermicompost	76.91 (94.07)	21.79	6.46
T_6- solarization with poultry manure	70.14 (87.32)	19.12	5.49
T_7- solarization with Castor cake + *Azospirillum*	74.40 (91.84)	20.89	6.13
T_8- solarization with Neem cake + *Azospirillum*	76.81 (93.99)	21.72	6.45
T_9- solarization with Vermicompost + *Azospirillum*	79.59 (96.08)	22.82	6.78
T_{10}- solarization with poultry manure + *Azospirillum*	72.21 (89.62)	19.99	5.80
T_{11}- solarization without amendments + *Azospirillum*	68.21 (85.00)	18.27	5.16
S. ED	0.96	0.39	0.15
CD (P=0.05)	1.92	0.79	0.30

Figures in parentheses indicates original value, Data are arc sin transformed values

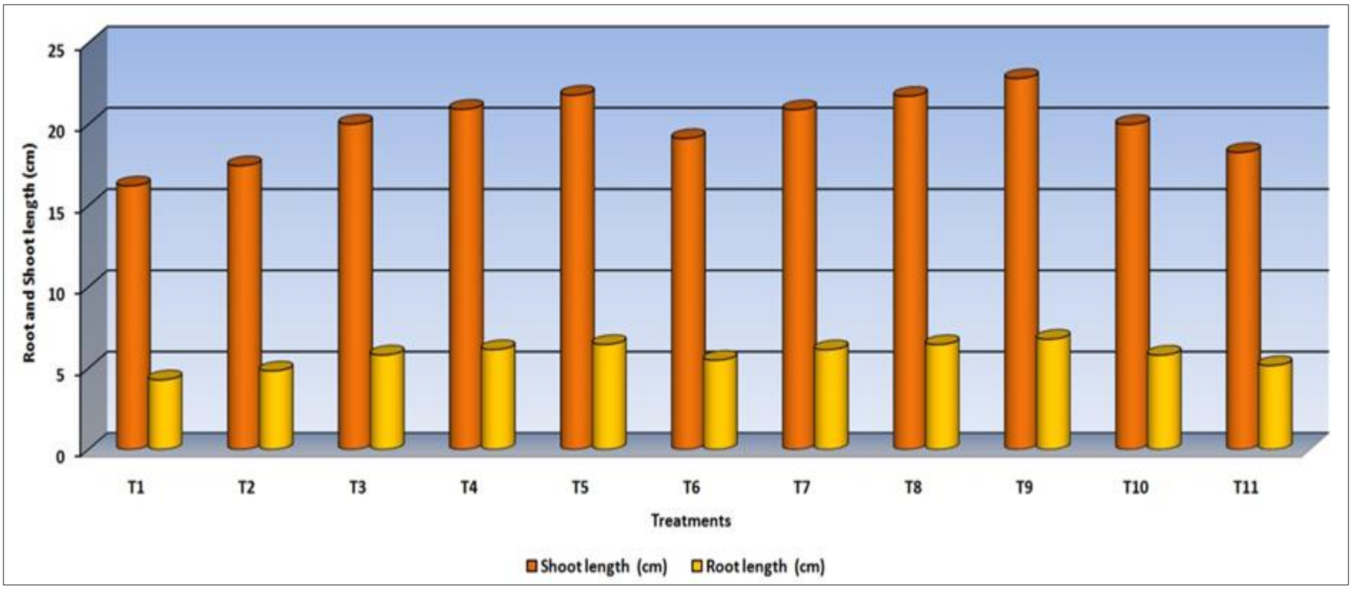

Fig 1: Effect of nursery solarization with amendments on shoot and root length of tomato seedlings

T1- non solarized control, Ti solarization without amendments, 73- solarization with Castor cake, 74- solarization with Neem cake, Ta- solarization with Vermicompost, Ta- solarization with poultry manure, T7- solarization with Castor cake + *Azospirillum*, Ta- solarization with Neem cake+ *Azospirillum*, T9- solarization with Vermicompost+ *Azospirillum*, T19- solarization with poultry manure + *Azospirillum* T„- solarization without amendments+ *Azospirillum.*

Summary

Implementing solarization along with organic amendments significantly changed the microbiota of the soil. The analysis revealed that there was a reduction in nematode population. The least values for were recorded in the solarization treatments with neem cake and vermicompost. Both the treatments increased the germination percentage, root and shoot length uniformly.

References

1. Allen ON. Experiments in soil bacteriology. Burgers Publications, Minnepolies, 1953, p240.
2. Azadi H, Schoonbeek S, MahmoudiDerudder H, De Maeyer B, Witlox F. Organic agriculture and sustainable food production system: Main potentials. Agriculture Ecosystems and Environment, 2011; 144:92-94.
3. Cook R, Baker KT. The nature and practice of biological control of plant pathogens. American phyto pathological Society, 1983.
4. Panse VG, Sukhatme PV. Statistical Methods for Agricultural Workers, ICAR, New Delhi, 1967, 381.

5. Siddeswaran K, Shanmugam PM. Organic Nutrient management in chillies-Bengal gram-Baby corn Sequence. Int. J. Agrl. Sc., 2013; 1:132-126.
6. Stapleton JJ. Fumigation and solarization practice in plasticulture systems. Hort. Tech, 1997; 6(3):189-192.
7. Umamaheswari T. Impact of Organic practices for augmenting the productivity of hot pepper. Ph.D. Thesis, Annamalai University, Annamalainagar, 2009.