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SOLAR ALONG WITH ORGANIC AMENDMENTS ASSISTED INTEGRATED APPROACH FOR THE MANAGEMENT OF SOIL BORNE DISEASES AND PEST ON TOMATO AT NURSERY LEVEL

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Abstract

The paper presents the application of soil solaization in enhancing the effect of sustainable disease management components like neem cake, vermicompost and *Azospirillium* against diseases for the improvement of plant parameters. The observations of all the above management components integrated together carried out in Sendarappatti village, Salem district of Tamil Nadu in nurseries of tomato where heavy infestation of soil born diseases on the same crop tomato during the hot summer was recorded. The results of above cumulative data gathered from the targeted hot spots of the village clearly revealed outstanding performance in the treatments where the radiant sun's energy was trapped by poly sheets in comparison to where no solar trapping was done in respect to plant growth parameters with reduction of soil-borne diseases incidences. The neem cake, and *Azospirillium* protected the entry of pest and diseases through vesicles and arbuscules occupying cortical tissue of the roots around the zone of elongation. The Neem cake and *Azospirillium* are attributed to help in increasing the tolerance level of root while vermicompost enriches the health of tomato plant trough its growth hormones. This solar assisted treatment comprising of Neem cakes Vermicompost and a Bio-fertilizer, is proved to be an ideal package in combating soil borne diseases infecting tomato.

***Key words*:** Solarization, Neem cake, Vermicompost, Poultry manure, *Azospirillium*

Introduction

In recent years soil solarization heat received steadily increasing attention as nonchemical method for controlling Fungal, Bacteria, Actinomycetes, viral as well as Root Knot Nematode diseases. it is simple, safe passive solar heating method that involves the placement of plastic sheets on moist soil during periods of high ambient temperature. The plastic sheets allow the suns radient energy to be trapped in the soil heating the upper levels to the extent of about 5-10 degree higher than the respective temperature of uncovered wet soil (Kaushika and Srivastava, 1980). It is a hydrothermal process accomplished through a combination of physical, chemical and biological mechanism, and is compatible with many other disinfestation methods. Research and development in the field of solarisation has been carried out more then 50 countries. It has been reported to reduced a number of pests and pathogen including fungi, bacteria, nematodes arthropods and weeds (Katan, 1981 and Oka, 2002). In the present paper effect of solar along with organic amendments viz., neem cake, vermicompost and *Azospirillium* assisted integrated approach for the management of soil born diseases and pest on tomato at nursery level has been carried out for the first time at Sendarappatti village of Salem district in Tamil Nadu having identified as hot spots being heavily infested with above mentioned soil borne maladies.

Materials and Methods

The experiment was carried out during hot summer months (March to May) of 2009-2010 in Sendarappatti village of Salem district. 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 gauge 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. Where heavy infestations of pest and diseases (hot spots) were recorded in which the inoculums level of root knot nematode was encounted 15-20 larvae/g soil through sieving & decantation technique (Cob, 1918). Being was much more than the minimum threshold level of 21/ g soil. In respect to the soil mycoflora it was clear that the intensity of fungal colony as observed through heavy spore load of wilt causing fungus mentioned above from the soil isolated from hot spots by the soil dilution technique (Martin.1950). *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.

Results and Discussion

Soil Temperature (°C) at Different Depths

The observations on soil temperature revealed that there was an increase in soil temperature at various depths on all days of observation due to solarization and various types of amendments used. The rise in soil temperature was the highest at 5 cm depth on all days of observation. At 5 cm depth, the treatment T_5 (Solarization with vermicompost) recorded the maximum temperature of 48.38°C followed by the treatment T_6 (Solarization with poultry manure) which recorded 47.43°C and T_4 (Solarization with Neem cake) recorded 46.98°C in order. The treatment T_2 (Solarization without amendment) registered 42.90°C which was lesser than all other treatments involving solarization with amendments but greater than non-solarized control (39.57°C)

At 10 cm depth, there was a slight decrease in the temperature in all the treatments when compared to 5 cm depth. Here also the same treatment, T_5 recorded the highest temperature of 44.36°C, followed by the treatment, T_6 (43.56°C) and T_4 (42.99°C) in order. The treatment T_2 recorded 38.82°C. The least value for temperature was recorded in non-solarized control (35.67°C).

Among the solarized treatments at 15 cm depth, the treatment, T_5 recorded the maximum temperature value of 40.55°C which was followed by the treatment T_6 (39.75°C) and T_4 (39.26°C). The treatment T_2 had recorded a temperature of 33.62°C when compared to T_1, which recorded the least value of 31.87°C. The same trend in temperature variation was observed in 2nd, 3rd and 4th week of observation which is presented in Table 1. It was noticed that the increase in soil temperature was inversely proportional to the increase in soil depth. This finding of solar assisted added performance of disease suppression in integrated pest package is being reported for the first time which deserves further investigation although scanning of literature revealed a wide range of reports world wide where several maladies have been effectively managed on several hosts (Stapleton *et al.,* 1993)

Table 1 : Effect of nursery solarization with amendments on soil temperature (°C) as observed during 1st, 2nd, 3rd and 4th week of solarization

Treatments	1st week			2nd week			3rd week			4th week		
	5 cm	10cm	15cm	5 cm	10cm	15cm	5 cm	10cm	15cm	5 cm	10cm	15cm
T_1	39.57	35.67	31.87	39.64	35.73	31.93	39.67	35.75	31.95	39.60	35.70	31.92
T_2	42.90	38.82	33.62	42.14	37.91	33.48	42.78	38.24	34.16	42.72	38.15	34.11
T_3	46.59	42.67	38.86	47.78	43.66	39.82	48.28	44.30	40.30	48.55	44.34	40.36
T_4	46.98	42.99	39.26	48.20	43.97	40.23	48.71	44.72	40.72	48.77	44.75	40.77
T_5	48.38	44.36	40.55	49.71	45.47	41.63	50.33	42.23	42.23	50.28	46.15	42.26
T_6	47.43	43.56	39.75	48.71	44.57	40.73	49.23	45.23	41.23	49.28	45.25	41.26

T_1- non solarized control, T_2-solarization with no amendments, T_3-solarization with Caster cake,
T_4- solarization with Neem cake, T_5- solarization with Vermicompost, T_6- solarization with poultry manure

Soil microbial and nematode population

As per the data presented in Table 4 the microbial and nematode population differed significantly due to solarization with various amendments. The least number of fungal colonies (15.76x10^{-3} per gram of soil), bacteria (18.00 x 10^{-1}), actinomycetes (13.01 x 10^{-5} per gram of soil) and lowest 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 colonies of fungi (15.77 x 10^{-3} per gram of soil), bacteria (18.99 x10^{-1} per gram of soil), actinomycetes (13.52 x 10^{-5} per gram of soil) and nematode population (14.14). whereas highest population of fungi (39.99 x 10^{-3} per gram of soil), bacteria (40.89 x10^{-1} per gram of soil), actinomycetes (25.62 x 10^{-5} per gram of soil) and nematodes (20.37) was recorded in T_1 (control). The treatment, T_2 recorded a microbial population of 36.82, 37.52 and 23.72 and 19.32 for fungi, bacteria, actinomycetes and nematodes respectively. This was lower than control and higher than solarization with amendments. The percentage reduction over control for nematodes under treatment T_4 varied from 42.97 per cent for *Xiphinema sp*. and 30.00 per cent for *Hoplolaimus sp.* This was comparable with T_4 as shown in Table 5. in all the treatments constituting sustainable compontents the soil was amended with neem cake which is known to posess nematicidal and antifungal and bacterial activity properties (Goswami and Mittal, 2004). This better performance due to the application of vermicompost along with azosprillium as above may be attributed due to the cumulative effect of nematicidal and funugicidal properties of neem cake and being responsible as a protectant through occupying the cortical region of root particularly in the zone of elongation by vesicles and arbuscules (Bhagwati *et al*., 2000; Goswami *et al*., 2007).

Table 4 : Effect of nursery solarization with amendments on soil microbial population as observed on 28th day after solarization

Treatments	Number of cfu.g^{-1} of soil			Nematodes (No of larval per 10 ml of suspension)
	Fungi x 10^{-3}	Bacteria x 10^{-1}	Actinomycetes x 10^{-5}	
T_1- non solarized control	39.99	40.89	25.68	20.37
T_2- solarization with no amendments	36.82	37.52	23.72	19.32
T_3- solarization with Caster cake	33.70	34.48	21.67	18.20
T_4- solarization with Neem cake	15.76	18.00	13.01	13.11
T_5- solarization with Vermicompost	15.77	18.99	13.52	14.14
T_6- solarization with poultry manure	20.76	22.50	21.50	14.61
SED	1.65	1.89	0.90	0.51
CD (P=0.05)	3.32	3.80	1.80	1.03

Table 5 : Effect of nursery solarization on soil nematode population

Nematodes	T_1	T_2	T_3	T_4	T_5	T_6
Hoplolaimus sp.	3.80	3.67 (13.00)	3.53 (27.00)	2.96 (30.00)	3.05 (26.79)	3.30 (17.86)
Tylenchulus sp.	6.42	6.10 (32.00)	5.74 (11.24)	4.64 (32.84)	4.81 (29.70)	5.37 (19.37)
Heterodera sp.	5.23	5.11 (12.00)	4.98	3.79 (34.04)	4.25 (23.17)	4.53 (16.55)
Xiphinema sp.	3.49	3.40 (9.00)	3.31	2.42 (42.97)	2.86 (25.30)	3.09 (16.06)
Rotylenchus sp.	4.33	4.20 (13.00)	4.07	3.30 (30.93)	3.64 (20.72)	3.82 (15.01)

T_1- non solarized control, T_2- solarization with no amendments, T_3- solarization with Caster cake,
T_4- solarization with Neem cake, T_5- solarization with Vermicompost, T_6- solarization with poultry manure

The soil solarisation in conjunction with (IPM) has also been recorded to help growing micro flora which is highly beneficial to plant growth or antagonistic to pathogens and pests through slowing the re-infestation of soil by these organisms for more than one growing season. Increasing plant growth and yield of annual and perennial field, row and nursery has also been reported to occur on flowing soil-solarization (Katan *et al.,*1979).

Conclusion

Results of first experiment revealed that the persistence of heat energy in the soil increased because of solarization treatments with amendments. It could be ranked that the solarization treatment with vermicompost followed by solarization with poultry manure and neem cake were effective in increasing the temperature at 5 cm depth and in all days of solarization. The rise in soil temperature reduced at deeper profile. The range of increase in temperature was between 7-13°C among the treatments when compared to temperature recorded at same depth in non-solarized condition. Implementing solarization alon with organic amendments significantly changed the microbiota of the soil. The analysis revealed that there was a reduction in fungal, bacterial, actinomycetes and nematode population. The least values for fungal, bacterial, actinomycetes and nematode population was recorded in the solarization treatments with neem cake and vermicompost. Both the treatments reduced the microbial population uniformly.

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