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Integrated Management of Root-Knot Nematode, *Meloidogyne javanica* in Hybrid Tomato

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Abstract Studies were carried out on integrated management of root-knot nematode, *Meloidogyne javanica* in hybrid tomato under nursery and under main field conditions. individual practices of nematode management such as biocontrol agents (Trichoderma viride @ 50 g/m^2, Paecilomyces lilacinus @ 50 g/m^2), chemicals (carbofuran @ 7g/m^2, cartap hydrochloride @ 7.5 g/m^2) and organic amendments (neem and mustard cake each @ 750 g/m^2) were first evaluated in nursery beds and then treated nursery was transplated in the main field. At the time of transplanting maximum plant growth parameters of seedlings and minimum number of galls was observed in neem cake followed by *T. viride*. When these treated seedlings hving better seedling growth and minimum nematode multiplication i.e neem cake and *T. viride* were transplanted in *M. javanica* infested main field, the observations taken at 50 days after transplanting (mid season evaluation experiment) showed that highest plant growth parameters were observed in neem cake treated nursery when transplanted in *T. viride* main field.Minimum nematode reproduction and multiplication was observed in neem cake (nursery) integration with *T. viride* (field) followed by *T. viride* (nursery) + *T. viride* (main field).

Keywords Carbofuran, Heem sona, Integrated management, *Meloidogyne javanica,* Tomato.

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Introduction

Tomato (*Lycopersicon esculentum* Mill.) is a member of solanaceae family which is the most popular, widely grown and second most cultivated vegetable crop the world. A large number of insect pests, diseases and weeds are attributed to constraint successful cultivation of this crop. Among different yield limiting factors, plant parasitic nematodes of which root-knot nematode, Meloidogyne spp. is a serious threat to tomato cultivation in many countries including India Jain et al.[1] estimated an average yield loss of 27.2% in tomato infested with root-knot nematode, *Meloidogyne* spp. numerous methods are being employed in combinations managing plant parasitic nematodes confining the use of chemical nematicide to be minimum. Lot of work has been done on tomato cultivars/varieties with different

Table 1. Effect of various management practices on growth of tomato nursery and galling of root-knot nematode, *Meloidogyne javanica.* Fig. in ()* are angular trannsformed values, Fig. in parentheses are √n transformed values, initial nematode population : 262j_2/200 cc soil.

Sl. No.	Treatments	Germination percentage	Seedling length/20 seedlings (cm)	% increase in seedling length over untreated check	Seedling weight/20 seedling (g)	% increase in seedling weight over untreated check	Number galls /20 of galls/20 seedlings	% decrease in number of galls/20 seedlings over untreated check
1	Neem Cake @ 750 g/m^2	90.67 (72.22)*	358.00	56.33	74.00	72.09	130.00 (11.41)	45.61
2	Mustard cake @ 750 g/m^2	90.72 (72.34)*	330.00	44.10	64.00	48.84	150.00 (12.82)	37.23
3	*Trichoderma viride* @ 50 g/m^2	91.33 (72.92)*	344.00	50.22	67.00	55.81	143.00 (11.99)	40.17
4	*Paecilomyces lilacinus* @ 50g/m^2	91.67 (73.24)*	269.00	17.47	52.00	20.93	201.00 (14.21)	15.89
5	Cartap hydrochloride (Dartriz 4G) @ 7.5 g/m^2	88.00 (69.45)*	260.00	13.54	55.00	27.91	171.00 (13.11)	28.45
6	Carbofuran (furadan 3G) @ 7 g/m^2	93.33 (72.58)*	302.00	31.88	60.00	39.53	141.00 (11.91)	41.00
7	Untreated check	91.00 (75.12)*	229.00	-	43.00	-	239.00 (15.59)	-
8	CD at 5 %	(2.70)	11.90	-	2.54	-	(0.24)	-

management practices against root-knot nematodes but not much work has been done on hybrids. Since hybrids have occupied most of the cultivation area of the tomato crop because of their high yield potential, so keeping in view the seriousness of nematode menace, present management scenario and its various components into consideration, the present studies were conducted to study effective biocontrol agents, organic cakes and nematicides applied to tomato nursery individually or in combination with biocontrol agents and nematicides applied in main fields at the time of transplanting in hybrid tomato.

Materials and Methods

The experiments were conducted at sick plot of department of Nematology, CCS HAU, Hisar. The infested brinjal roots were washed and stained in 0.1% acid fuchsin lacto phenol for two minutes. 5-10 matured females were extracted from these roots by teasing them under a stereoscopic binocular microscope with the help of needle and forceps for preparation of perineal pattern for the identification and confirmation of species of *M. javanica.* Initial nematode population was found 262 j_2/200 cc soil in nursery experiment and 245 j_2/200 cc for main field experiment. Tomato (Lycopersicon esculentum Mill.) hybrid Heem Sona was used for the experimentation. Other materials used in nursery experiment were neem cake @ 750 g/m^2, mustard cake @ 750 g/m^2, *Trichoderma viride* @ 50 g/m^2, *Paecilomyces lilacinus* @ 50 g/m^2, cartap hydrochloride @ 7.5 g/m^2, carbofuran @ 7 g/m^2. In nursery experiment there were total seven treatments in three replications laid out in randomized block design (RBD). Deoiled cakes at recommended dosages were applied seven days prior and fungal enriched farm yard manure were also incorporated one day before sowing. Seeds were sown manually by broadcasting on 21 raised beds (0.5 × 0.5 m) with an estimate of 250 seeds in each plot. Recommended dose of fertilizers were applied.

After attaining transplanting stage, seedlings were uprooted with the help of 'Khurpa' from the nursery area. 20 seedling from each plot were up-

Table 2. Effect of integration of nursery bed and field treatments on the growth of tomato by root-knot nematode, *M. Javanica* (50 days after transplanting). (Av. of three replications). N-Nursery application, F-Main field application.

Sl. No.	Treatments	Plant stand at 20 days after trans-planting	Plant stand at harvest	Per cent plant stand at harvest	Shoot length (cm)	Fresh shoot weight (g)	Dry shoot weight (g)
1	Neem cake (N)	16	16	100	43.8	116.20	23.2
2	*Trichoderma viride* (N)	16	16	100	41.1	108.50	20.1
3	*T. Viride* @ 2.5 kg/ha (F)	16	16	100	42.9	112.03	22.8
4	Neem cake (N) + *T. viride* @ 2.5 kg/ha (F)	16	16	100	52.9	147.20	30.4
5	Neem cake (N) + carbofuran @ 1 kg a.i./ha (F)	16	16	100	46.1	131.30	24.1
6	*T. viride* (N) + *T.viride* @ 2.5 kg/ha (F)	16	16	100	49.3	140.80	27.2
7	*T. viride* (N) + carbofuran @ 1 kg a.i./ha (F)	16	16	100	45.4	123.20	23.7
8	Carbofuron @ 1 kg a. i. /ha (F)	16	16	100	42.3	109.60	20.3
9	Untreated Check	16	15	93.75	37.2	97.10	17.1
	CD at 5%				3.01	6.51	2.31

rooted randmly with the help of 'Khurpa' to assess seedling growth parameters and nematode reproduction and multiplication factor. Best two treatments, i.e., neem cake and *T. viride* along with untreated check were combined with three treatments in the main field (*T. viride* @ 2.5 kg/ha, carbofuran @ 1 kg a.i./ha along with untreated check). In field experiment there were total nine treatments in three replications laid out in randomized block design (RBD). Total 27 plots for field experiment were made with size of 2.8 × 2.5 m each. The raised beds were prepared in each plot as per recommended spacing of 60 cm. The uprooted seedlings were transplanted in their respective plot of main field where the soil was mixed with the treatments. 28 plants were maintained in each plot. Plants were uprooted carefully after 50 days of transplanting. The roots were washed carefully to remove adhering soil particles and observations were recorded. Meter scale and an electronic balance were used to measure the height and weight of the seedling /shoot, respectively. Five egg masses of uniform size were picked up randomly from the plants of each plot and dissolved in 5% NaOCl solution for 10 minutes to count number of eggs/egg mass.

Treatments of nursery

T_1= Neem cake @ 750g/m^2, T_2 = Mustard cake @ 750 g/m^2, T_3 = *Trichoderma viride* @ 50 g/m^2, T_4 = *Paecilomyces lilacinus* @ 50 g/m^2, T_5 = Cartap hydrochloride @ 7.5 g/m^2, T_6 = Carbofuran @ 7 g/m^2, T_7 = Untreated check.

Treatments of main field

T_1 = Neem cake alone applied in nursery (N), T_2 = *T.viride* alone applied in nursery (N), T_3 = *T. viride* @ 2.5 kg/ha applied in field before transplanting (F), T_4=Neem cake (N) + *T. viride* @ 2.5 kg/ha (F), T_5 = Neem cake (N) + carbofuran @ 1 kg a.i. ha (F), T_6 = *T. viride* (N) + *T. viride* (N) + T. viride @ 2.5 kg/ha (F), T_7 = *T. Viride* (N) + carbofuran @ 1 kg a.i. /ha (F), T_8 = Carbofuran @ 1 kg a. i. /ha (F), T_9 = Untreated check.

Results and Discussion

The data in Table 1 reveal that maximum and significantly highest seedling length was observed in neem cake followed by *Trichoderma viride,* mustard cake, carbofuran. *Paecilomyces lilacinus* was at par with cartap hydrochloride but statistically different from all the treatments including untreated check. Our results are in total agreement with earlier reports [2, 3] who also observed that *Trichoderma* spp. suppressed the nematode reproduction and increased the growth of tomato plants.

Seedling weight in all the treatments was sig-

nificantly different from each other and also from untreated check. Maximum and significantly highest seedling weight was recorded in neem cake followed by application of *T. viride* and mustard cake. *T. viride* observed statistically at par with carbofuran.

The results obtained by Javed et al. [4] are in total conformity with the results of the present investigation. The probable reason for having the increased weight of tomato seedlings in the treatment of neem cake at nursery stage might be due to the additive effect of this organic amendment in the soil. In addition to providing antagonistic effect, it also supplies nutrient since it is a source of organic matter. Significantly lowest and minimum number of galls per 20 seedlings was observed in neem cake followed by carbifuran, *T. viride* and mustard cake. The probable anti nematode mechanism of the fungus might be due to the production of biochemical substances such as Trichodermin.

In the main field experiment, 100 plant stand after 20 days of transplanting and at harvest was ensured except untreated check. Significantly maximum shoot length was obtained when neem cake amended seedlings were transplanted in *Trichoderma viride* applied plots followed by a combination of *T. viride* (nursery) and *T. viride* as main field application (Table 2). Application of *T. viride* at nursery alone,neem cake alone and field application of carbofuran was found statistically at par with *T . viride* field application. Goswami et al. [5] also observed higher plant growth by *T. harzianum* due to the production of growth hormones produced by this fungus. Application of neem cake alone applied in nursery beds was found statistically at par with neem cake and carbofuran combination and also with integration of *T. viride* (nursery) and carbofuran field application.

Data on dry root weight concluded that significantly maximum and highest dry root weight was found when neem cake amended nusery was transplanted in *T. viride* treated field followed bt *T. viride* (nursery) + *T. viride* (field), neem cake (nusery) + carbofuran (field) integration (Table 3). The healthy seedlings grown under neem cake application performed better in the presence of *T. viride* after transplanting. Our results are in conformity with those of Kumar and Khanna [6] who also observed higher plant growth of tomato under neem cake and *T. viride* combinations. In nursery experiment that neem cake boosted the growth of tomato seedling which gave the best results in terms of highest plant growth parameters when combined with main field treatment of *T. viride* at 50 days after transplating under field conditions. The healthy seedlings grown under neem cake application performed better in the presence of *T. viride* after transplating.

Table 3. Effect of integration of nursery bed and main field treatments on growth of tomato nursery infested with *Meloidogyne javanica* (50 days after transplanting). (Av. of three replications). N-Nursery application, F-Main field application.

Sl. No.	Treatments	Root length (cm)	Fresh root weight (g)	Dry root weight (g)
1	Neem cake (N)	13.4	17.1	3.2
2	*Trichoderma viride* (N)	12.2	15.3	2.4
3	*T. viride* (F) @ 2.5 kg/ha	13.1	16.6	2.7
4	Neem cake (N)+*Trichoderma viride* @ 2.5 kg/ha (F)	14.4	23.8	4.2
5	Neem cake (N) + carbofuran @ 1 kg a.i./ha (F)	13.9	18.9	3.5
6	*T. viride* (N) + *T. viride* @ 2.5 kg/ha (F)	14.2	21.4	3.7
7	*T.viride* (N) + carbofuran @ 1 kg a.i./ha (F)	13.6	18.2	3.4
8	Carbofuran @ 1 kg a.i../ha (F)	12.7	15.9	2.5
9	Untreated check	11.9	13.9	2.2
	CD at 5%	NS	1.96	0.41

Maximum and significantly highest fresh shoot weight was obtained in neem cake and *Trichoderma viride* combination followed by *T. viride* nursery and *T. viride* field integration,neem cake (nursery) + carbofuran (field). In combined treatments, neem cake at nursery integrated with *T. viride* in minimum number of galls was found in neem cake (nursery) + *T. viride* (field) combination followed by *T. viride* (nursery) + *T. viride* (field) combination (Table 4). Significantly minimum and lowest number of egg masses per plant was found in neem cake (nursery) and *T. viride* (field) combination followed by *T. viride* (nursery) + *T. viride* (field), neem cake (nurs-

Table 4. Effect of integration of nursery bed and field treatments on reproduction and multiplication of root knot nematode, *M. javanica* (50 days after transplanting). Av. of three replications). Figure in the parentheses are √n transformed values. N-Nursery application , F-Main field application.

Sl. No.	Treatments	Number of galls/ plant	No.of egg masses/ plant	No.of eggs /egg mass	Final nematode population/ 200 cc soil
1	Neem cake (N)	220 (14.89)	72 (8.54)	166 (12.92)	225 (15.03)
2	*Trichoderma viride* (N)	275 (16.61)	89 (9.49)	157 (12.57)	278 (16.70)
3	*T. viride* @ 2.5 kg/ha (F)	210 (14.52)	82 (9.11)	153 (12.41)	210 (14.53)
4	Neem cake (N) + *T. viride* @ 2.5 kg/ha (F)	155 (12.49)	46 (6.85)	144 (12.04)	143 (12.00)
5	Neem cake (N) + carbofuran @ 1 kg a.i./ha (F)	194 (13.96)	63 (8.00)	161 (12.72)	180 (13.45)
6	*T. viride* (N) + *T. viride* @ 2.5 kg/ha (F)	171 (13.11)	54 (7.42)	140 (11.89)	159 (12.65)
7	*T. viride* (N) + carbofuran @ 1 kg a. i./ha (F)	201 (14.21)	68 (8.31)	149 (13.65)	203 (14.28)
8	Carbofuran @ 1 kg a.i. /ha (F)	236 (15.39)	89 (9.49)	163 (12.81)	247 (15.75)
9	Untreated check	290 (17.06)	105 (10.30)	168 (13.00)	296 (17.23)
	CD at 5%	(0.59)	(0.31)	NS	(0.24)

ery) + carbofuran (field). Earlier reports [7, 8] are in total agreement with our results. *T. viride* also had significant impact in lowering down the number of galls on tomato seedlings indicating its inhibitory impact on root-knot nematode. Minimum nematode population in soil was found in neem cake (nursery) and *T. viride* field combination followed by integration of *T. viride* (nursery) and *T. viride* field application.

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