Response of some tomato mutants/variety to management practices against root-knot (*Meloidogyne incognita*)

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Abstract: The experiment was carried out in the Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh during summer of 2011 to find out the effects of chemical nematicide Curaterr, bio-agent BAU-Biofungicide and straw mulch against root-knot *(Meloidogyne incognita)* of tomato mutants TM-219, TM-134 and variety Binatomato-3. The experiment was designed with two factors e.g. three mutants/variety and four treatments including the three control measures and an untreated control following Completely Randomized Design with five replications. Curaterr and BAU-Biofungicide were applied as side dressing. Chemical nematicide Curaterr showed significant effect with the highest plant growth characters like length of shoot and root as well as fresh weight of shoot and root with lower galling incidence, eggmasses and nematode populations. BAU-Biofungicide appeared with higher plant growth characters with lower galling incidence and nematode population. Treatment with straw mulch showed lower responses in all the growth parameters. Among the three mutants/variety of tomato, variety Binatomato-3 appeared with the higher responses in the plant growth characters with reduced nematode populations. In the interaction effects, variety Binatomato-3 interacting with Curaterr revealed promising results in plant growth characters with reduction of galls and nematode populations. Therefore, BAU-Biofungicde as a bio-control means may be used for the control of root-knot of tomato as alternative to chemical nematicide in order to maintain eco-friendly management of this nemic disease.
Key words: Tomato, root-knot, nematicide, Curaterr, BAU-Biofungicide and straw-mulch.

Introduction

Tomato is a popular vegetable widely grown in Bangladesh. It is rich in vitamins A, B and C containing important minerals like calcium, phosphorus and iron (Salam *et al*., 2010) used as fresh or cooked, ingredient for salad, soup, pickle, chatney, ketchup, sauce etc. In Bangladesh, the area of cultivation of tomato is about 48538 acres with the production of 143058 m tons (BBS, 2008). The profitable cultivation of this crop is now hampered due to many factors of which diseases play an important role. Plant parasitic nematodes can cause severe yield losses, typically up to 50 percent, as a result of root deformation which diminishes function and predisposes plants to other pathogens (Anon, 2005). The hot and humid climatic condition of Bangladesh is suitable for plant parasitic nematodes attacking various crops including tomato (Mian, 1986). As an important vegetable crop, its production is necessary throughout the year covering two main cropping seasons winter and summer. But there are some synthetic nematicides which are notoriously toxic and expensive (Anon., 2006). With that view in mind, the present research work was undertaken to determine the comparative efficacy of few management practices against root knot (*Meloidogyne incognita*) of some tomato mutants/variety.

Materials and Methods

The experiment was conducted in Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh during 2011. Two factors factorial experiment having three tomato mutants/variety viz. IM-219 (M_1), TM-134 (M_2) and BINA Tomato-3 (V) and four treatments viz. Control (T_0), Curaterr (T_1), BAU-Biofungicide (T_2) and straw mulch (T_3) was conducted following Completely Randomized Design (CRD) with five replications. Curaterr (carbofuran) was applied as side dressing @ 1000 mg/plant in two splits at 10 days interval around the root region of the tomato plants; BAU-Biofungicide (2 % solution) was applied as side drench; and about 150g of straw was used to cover the upper surface of the pot as mulch after 7 days of inoculation with eggmasses. Curaterr @ 1000 mg/plant in two splits at 10 days interval and BAU-Biofungicide (2 % solution) were applied as side dressing and 150g of rice straw was used as mulch after 7 days of inoculation with eggmasses. The straw and tomato seeds were sterilized by 10% chlorox solution for 2-3 and 1-2 minutes, respectively and subsequent washings were done with water for three times.

For the experiment sandy loam soil, sand and well decomposed cowdung were taken at the ratio of 2: 1.5: 0.5 and mixed uniformly. The mixed soil was then sterilized with formalin at the rate of 30 ml dissolved in 1000 ml water per cubic feet soil and was covered by polythene sheet. After 72 hours, the polythene sheet was removed for the purpose of exposing the sterilized soil to air for 48 hours in order to remove excess vapour of formalin. Sixty plastic pots were cleaned with water and surface sterilized with formalin. Each pot was filled with 5 kg sterilized and dried soil. Mature eggmasses of root knot nematode (*Meloidogyne incognita*) were collected from severely galled root system of brinjal plants (*Solanum melongena*) which were previously inoculated with the single eggmass of *Meloidogyne incognita*. The brinjal plants were allowed to grow in large earthen pots (30 cm diameter) under nethouse condition of the Seed Pathology Centre, BAU, Mymensingh. For inoculation, reddish brown mature eggmasses were collected from infected roots with fine forceps. The collected eggmasses were placed in a moist petridish. Before inoculation, the collected eggmasses were surface sterilized with 10% Chlorox solution for about half minute followed by subsequent washings with sterile water for three times.

Five seeds were sown in the pots on 2 March 2011 and the seeds were thinly covered with soil. One healthy seedling was allowed to grow in each pot. Weeding, mulching, irrigation etc. were done as and when necessary. After 28 days of sowing, each tomato plant was inoculated with six eggmasses collected from infected brinjal roots. After 70 days of inoculation, the plants at mature stage were carefully uprooted from the pots to record length of shoot and root, fresh weight of shoot and root, number of galls and eggmasses per g of root and number of adult females,

J_2, J_3 and J_4 juveniles in 10 galls/treatment. All the data were analyzed statistically to find out the level of significance according to Gomez and Gomez (1984). Duncan's New Multiple Range Test (DMRT) was applied to evaluate the mean differences for their significant level. Linear correlation co-efficient was also calculated and regression graphs were prepared.

Results and Discussion

Effect of treatments: Effect of four different treatments on plant growth and galling incidence and development of adult females, eggmasses, J_2, J_3 and J_4 juveniles of *Meloidogyne incognita* in the tomato mutants/variety are presented in Table 1. The study revealed that the highest plant growth characters were achieved in management practices using chemical nematicide Curaterr followed by BAU-Biofungicide and straw mulch correspondingly with lower galling incidence, adult females, eggmasses, J3 and J4 population of *Meloidogyne incognita*. The control treatment appeared with the lowest performance in almost all the characters compared to others. The highest length of shoot (72.25 cm) and root (23.94 cm), fresh weight of shoot (41.50 g) and root (4.18 g) with lower galling incidence (4.07 galls per g of root) and the lowest numbers of adult females (7.67 per 10 galls), eggmasses (1.40 per g of root), J_3 juveniles (4.67 per 10 galls) and J_4 juveniles (6.67 per 10 galls) were obtained with the treatment Curaterr. The lowest length of shoot (53.07 cm) and root (15.23 cm), fresh weight of shoot (26.71 g) and root (2.21 g) with the highest galling incidence (19.27 galls per g of root), adult females (14.67 per 10 galls), eggmasses (15.40 per g of root J_3 juveniles (11.33 per 10 galls) and J_4 juveniles (13.27 per 10 galls) were observed in control treatment.

Table 1. Effects of different treatments on the plant growth and development of nematode in three tomatao mutants/variety

Treatments	Shoot length (cm)	Root length (cm)	Shoot wt. (g)	Root wt.(g)	Galls/g of root	Adult females in 10 galls/ treatment	Egg masses/g of root	J_2 juveniles in 10 galls/ treatment	J_3 juveniles in 10 galls/ treatment	J4 juveniles in 10 galls/ treatment
T_0 (control)	53.07d	15.23d	26.71d	2.21d	19.27a	14.67a	15.40a	8	11.33a	13.27a
T_1 (Curaterr)	72.25a	23.94a	41.50a	4.18a	4.07b	7.67d	1.40d	7	4.67d	6.67d
T_2 (BAU-Biofungicide)	62.72b	20.04b	36.21b	3.61b	7.33c	9.33c	5.40c	7	6.67c	8.33c
T_3 (Mulch with straw)	54.43c	16.90c	30.59c	2.89c	10.60d	12.33b	11.40b	8	8.67b	10.67b

Each value is an average of five replications; values in the column having common letter(s) do not differ significantly at P 0.05 level by DMRT.

The highly toxic effect of carbofuran inhibits the larval hatching of nematode which resulted in the observation. Jain (1990) reported that carbofuran treated nursery plants of tomato and okra infected with *M. incognita*. had lower root-knot index. Similar observations are also made by Enokpa *et al*. (1996) working with root-knot (*M. incognita*) infected tomato plants having the best vegetative growth of plants with reduced galling incidence. Hassan (1995) found superior response in plant growth characters with corresponding lower number of galls, adult females, eggmasses and larval population in brinjal. Sharma *et al.* (2001) and Shah *et al*. (2003) also reported the effective performance of nematicide with carbofuran group against the root knot nematode on brinjal, groundnut and tomato, respectively. All these reports are in agreement with the findings about Curaterr.

The effectiveness of *Trichoderma spp*., component in BAU-Biofungicide may be attributed to the fact that the fungi occupy the niche before nematode infection and thereby hinder the establishment of the nematode pathogen. Yang-Xiu Juan *et al*. (2000) working with tomato found *Trichoderma* spp. showing significant efficiency in controlling *Meloidogyne* spp. and promoting the growth of tomato. Similarly, Siddiqui and Shaukat (2004) observed greater reduction in nematode population densities in tomato roots treated with *Pseudomonas fluorescence* and *Trichoderma harzianum*. Davila *et al*. (1999) reported *Trichoderma harzianum* as a potential bio-control agent of *Meloidogyne* spp. due to its antagonistic association with eggs, larvae and females of the nematoodes. The suppressing activities of *Trichoderma harzianum* and other *Trichoderma* spp. against root-knot nematodes *Meloidogyne* spp. attacking crop plants have been attributed to egg parasitism or opportunism, antagonism and larval mortality with reduced eggmasses and adult females as reported by Sharma (1999), Rangaswamy *et al.* (2000), Senthilkumar and Rajendra (2004). Moreover, an antibiotic substance is trichodermin is produced by *Trichoderma* spp. which has been found to be toxic to the nematode hampering its growth development and reproduction (Tverdyukev *et al*., 1994).

Mulched surface affects the plant light environment and soil temperatures which ultimately act upon the soil population of microorganisms including nematode. Treatment mulch with straw appeared to have lower plant growth with comparatively lower galling incidence as well as eggmasses, adult females and juvenile populations compared to control treatment. This might be due to conservation of more heat energy which interfered microbial biomass and its metabolic activities in the soil affecting less harm to the plants compared to control treatment. The reports made by Ijoyah and Koutatouka (2009) and Scopa *et al*. (2009) are also in agreement with the present findings.

Effect of tomato mutants/variety: Response of the mutants/variety to the length of shoot and root, fresh weight of shoot and root, galling incidence, number of adult females, eggmasses, J_2, J_3 and J_4 juveniles of *Meloidogyne incognita* were found to be significant and presented in Table 2. Among the three mutants/variety of tomato, variety Binatomato-3 gave the highest length of shoot and root (62.10 and 26.91 cm, respectively) and fresh weight of shoot with higher response in fresh weight of root (37.94 and 3.40 g, respectively). In case of galling incidence, mutant M_2 (TM-134) showed the lowest galling incidence (7.50 g of root). Other than eggmasses, Binatomato-3 gave the best performance with the lowest nematode population of adult females, J_2, J_3 and J_4 juveniles (9.25, 6.00, 6.50 and 8.75 in 10 galls, respectively).

Table 2. Responses of three tomato mutants/variety inoculated with M. incognita on plant growth, galling and nematode development

Treatments	Shoot length (cm)	Root length (cm)	Shoot wt. (g)	Root wt.(g)	Galls/g of root	Adult females in 10 galls/ treatment	Egg masses/g of root	J_2 juveniles in 10 galls/ treatment	J_3 juveniles in 10 galls/ treatment	J4 juveniles in 10 galls/ treatment
M_1 (TM-219)	60.11b	14.10c	32.74b	3.63a	11.45a	8.300b	10.75b	9.950a	8.50a	8.25a
M_2 (TM-134)	59.63b	16.07b	30.58c	2.64c	7.45b	6.350c	13.00a	10.50a	8.50a	8.50a
V (BINA tomato-3)	62.10a	26.91a	37.94a	3.40b	12.05a	10.55a	9.250c	8.750b	6.50b	6.00b

Each value is an average of five replications; values in the column having common letter(s) do not differ significantly at P 0.05 level by DMRT.

Table 3. Interaction effects of different treatments and three tomato mutant/variety inoculated with *M. incognita*

Mutants/Variety × Treatment		Length of shoot (cm)	Length of root (cm)	Fresh weight of shoot (g)	Fresh weight of root (g)	No. of galls/g of root
M_1 (TM-219)	T_0	51.40i	11.74i	25.68g	2.54f	21.00a
	T_1	75.62a	18.50e	41.76b	4.56a	3.40g
	T_2	61.40e	14.14g	34.56d	4.14b	10.60c
	T_3	52.02i	12.04hi	28.94f	3.26de	10.80c
M_2 (TM-134)	T_0	52.80hi	12.82h	25.26g	1.74g	15.80b
	T_1	68.62c	20.94d	34.26de	3.32d	3.40g
	T_2	63.50d	16.82f	33.58e	3.04de	4.20fg
	T_3	53.60gh	13.70g	29.24f	2.46f	6.40de
V (Binatomato-3)	T_0	55.00g	21.14d	29.20f	2.34f	21.00a
	T_1	72.50b	32.38a	48.48a	4.66a	5.40ef
	T_2	63.26d	29.16b	40.48c	3.64c	7.20d
	T_3	57.66f	24.96c	33.58e	2.96e	14.60b

Each value is an average of five replications; values in the same column having common letter (s) do not differ significantly at 5% level of significance by DMRT, T0 (Control), T2 (BAU-Biofungicide), T1 (Curaterr), T3 (Mulch with straw)

Table 4. Interaction effects of different treatments and three tomato mutants/variety on the nematode (*Meloidogyne incognita*) development

Mutants/Variety × Treatment		No. of adult females in 10 galls /treatment	No. of egg masses/g root	No. of J_2 juveniles in 10 galls/ treatment	No. of J_3 juveniles in 10 galls/ treatment	No. of J_4 juveniles in 10 galls/ treatment
M_1 (TM-219)	T_0	15.00ab	17.20a	10.00	13.00a	13.80a
	T_1	7.00fg	2.20f	7.00	5.00g	6.00e
	T_2	8.00f	5.00e	8.00	7.00ef	8.00d
	T_3	13.00cd	8.80d	9.00	9.00cd	12.00b
M_2 (TM-134)	T_0	16.00a	11.80c	9.00	11.00b	14.00a
	T_1	10.00e	0.60f	8.00	6.00fg	9.00cd
	T_2	12.00d	1.80f	8.00	8.00de	9.00cd
	T_3	14.00bc	11.20c	9.00	9.00cd	10.00c
V (Binatomato-3)	T_0	13.00cd	17.20a	7.00	10.00bc	12.00b
	T_1	6.00g	1.40f	6.00	3.00h	5.00e
	T_2	8.00f	9.40d	6.00	5.00g	8.00d
	T_3	10.00e	14.20b	6.00	8.00de	10.00c

Each value is an average of five replications; values in the same column having common letter (s) do not differ significantly at 5% level of significance by DMRT, T0 (Control), T2 (BAU-Biofungicide), T1 (Curaterr), T3 (Mulch with straw).

Interaction effect of treatments and tomato mutants/variety: Interaction effect of four treatments and three mutants/variety on plant growth and nematode development are presented in Table 3 and 4, respectively. Binatomato-3 interacting with Curaterr gave the highest length of root (32.38 cm), fresh weight of shoot and root (48.48 and 4.66 g, respectively). The highest shoot length (75.62 cm) was found in mutant M_1 (TM-219) interacting with treatment Curaterr. Mutant M_1 (TM-219) and M_2 (TM-134) interacting with Curaterr appeared with lowest number of galls/g of root (3.40). Binatomato-3 interacting with treatment Curaterr working with *M. incognita* infested tomato seedlings also showed the highest response resulting in the lowest number of nematode population. The number of adult females, J_3 and J_4 juveniles were 6.00, 3.00 and 5.00 in 10 galls, respectively. The number of eggmasses was the lowest (0.60 g root) were observed in interaction of M_2 and Curaterr.

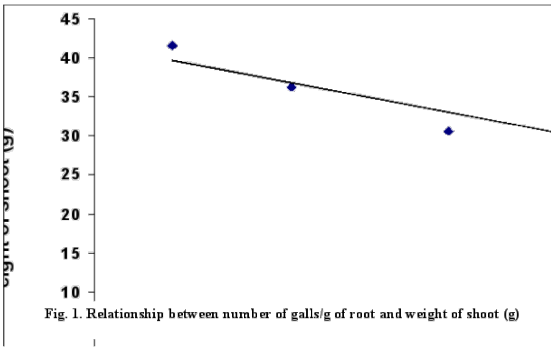

Fig. 1. Relationship between number of galls/g of root and weight of shoot (g)

Correlation and regression study: Correlation study was done to examine the relationship of gall number with fresh weight of shoot, gall number with length of root and gall number with fresh weight of root. The study revealed significant and negative correlation between gall number and weight of shoot (Fig. 1), gall number and length of root (Fig. 2) and gall number and fresh weigh of root (Fig. 3) and followed the regression equations; $y = -0.9503x + 43.491$ ($r = -0.954^*$), $y = -0.542x + 24.556$ ($r = -0.921^*$) and $y = -0.130x + 4.5613$ ($r = -0.979^{**}$), respectively. The results indicated that the galling incidence hampered the plant growth in terms of weight of shoot, length of root as well as weight of root or in other words, treatments gave positive responses increasing the growth characters as well as evident with decreased galling incidence.

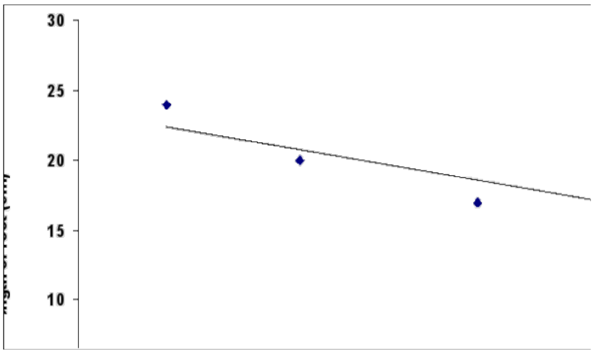

Fig. 2. Relationship between number of galls/g of root and length of root (cm)

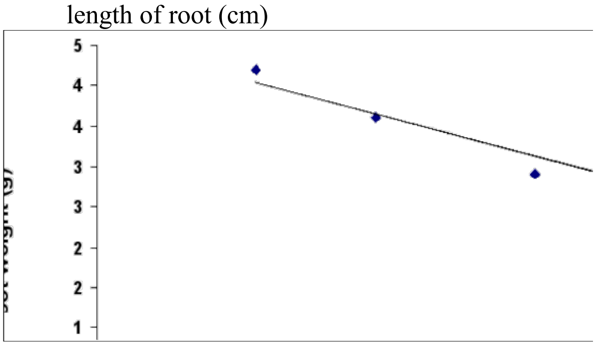

Fig. 3. Relationship between number of galls/g of root and root weight (g)

It is evident from the study that management of root-knot nematode (*Meloidogyne incognita*) infecting tomato mutants/variety with chemical nematicide as well as antagonistic bio-preparation BAU-Biofungicide are found to be effective. Therefore, control of root-knot disease of tomato mutants (TM-219, TM-134)/variety (Binatomato-3) caused by *Meloidogyne incognita* may be explored through the use of BAU-Biofungicide for ecofriendly management of this nemic disease avoiding chemical nematicide Curaterr.

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