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Bio-efficacy of Different Fungal Bio-control Agents against the Root-knot nematode (*Meloidogyne incognita*) Inciting Tomato (*Lycopersicon esculentum* Mill.)

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ABSTRACT

The present investigation was conducted under cage house condition for the management of root-knot nematode (RKN) inciting tomato with seven treatments including untreated control and four replications. Results revealed that all the treatments (*i.e., Trichoderma harzianum, T. viride, Purpureocillium lilacinum, Metarhizium anisopliae*, and *Beauveria bassiana* were used as soil application (SA) at 5 g/kg soil and seedling treatment (ST) at 5 g/l of water) were found significantly superior over an untreated control in increasing biometric parameters and reducing the RKN multiplication in plant and soil at termination. However, soil application at 5 g/kg soil and seedling treatment at 5 g/l of water with *T. harzianum* was found to be more effective in reducing RKN population and maximum biometric parameters of tomato followed by *T. viride* and *P. lilacinum.*

Key words: *Fungal bio-control agents, Root-knot nematode, Tomato, Management.*

Introduction

Tomato is popularly known as "poor man's orange". Tomato (*Solanum lycopersicum* Mill.) is an important vegetable crop grown throughout the world. Tomato fruits have high nutritional value. It is a rich source of minerals, organic acids and vitamins A, B and C (Tewari, 2002).

The crop is attacked by various insect and non-insect pests. In addition to insect pest and diseases, plant parasitic nematodes have also become a limiting factor in the successful cultivation of tomato. Among several plant parasitic nematodes recorded, root-knot nematode, *Meloidogyne incognita* is the most important one. Overall, PPNs cause 21.3 per cent crop losses amounting to Rs. 102,039.79 million (1.58 billion USD) annually. *M. incognita* was economically most important root-knot nematode

(RKN) causing 23% yield losses of Rs. 6035.2 million in tomato (Kumar *et al.,* 2020). Besides, the direct damage caused to the plants, the root-knot nematodes are notorious for the disease complexes involving fungi, bacteria, virus, mycoplasma, insect and other nematodes (Dasgupta and Gaur, 1986).

The control of RKN has been primarily accomplished through chemical nematicides. However, indiscriminate use of these chemicals only resulted in health and environmental hazards. To avoid this, integrated management is become necessary and use of biological and botanical substances or agent in management of root knot nematode should be promoted. In view of this, the present study is undertaken with an objective of management techniques in tomato.

Materials and Methods

Treatments and experimental layout

Pot culture experiment was conducted during *Rabi* 2021 and 2022 to investigate the effect of different fungal bio-control agents against root-knot nematode, *M. incognita* on tomato. *M. incognita* was obtained from naturally infested tomato fields of Department of Nematology, MPUAT, Udaipur (Rajasthan), and maintained as a pure culture on potted tomato plants in a net-house. The experiment was laid out in complete randomized design (CRD) with seven treatments *i.e., T. harzianum, T. viride*, *P. lilacinus, M. anisopliae* and *B. bassiana* as soil application (SA) at 5 g/kg soil and seedling treatment (ST) at 5 g/l of water and carbofuran 3G 2 kg a.i /ha were applied as check and untreated control was also maintained for the comparison. Four replications were maintained for each treatment.

Observation on biometric parameters *viz.,* shoot and root length (cm), fresh shoot & root weight (g), yield (kg/plant) and nematode multiplication *i.e.,* no. of galls/plant, no. of egg masses/plant, no. of eggs/larvae per egg-mass, nematode population/ 200cc soil, final nematode population (soil + plant), root gall index (RGI) (Heald *et al.,* 1989) on a 0-5 scale (0= no galls; 1=1-25 galls; 2=26-50 galls; 3=51-75 galls; 4=76-100 galls; 5=more than 100 galls) and reproduction factor value (R_f).

Results and Discussion

The result of experiment revealed that among the fungal bio-control agents *T. harzianum* as SA at 5g/ kg soil and ST at 5 g/l of water challenged with root-knot nematode in tomato crop at the time of harvesting was effective in suppressing the incidence of root-knot nematode. Further, it also promoted more plant growth of tomato. *T. harzianum* as SA at 5g/kg soil and ST at 5 g/l of water reduced the no. of galls/plant (41.12), no. of egg masses/ plant (27.25), no. of eggs and larvae/egg mass (117.87), nematode population/200cc soil (755.25), final nematode population (soil + plant) (10794.84), root gall index (2) and reproduction factor value (2.69) with an average shoot length (59.50 cm), root length (26.87 cm), fresh shoot weight (47.87 g), fresh root weight (19.87 g) and yield (1.96 kg/plant) pooled data of 2021 and 2022. Similarly, the tomato plants treated with *T. viride* challenged against root-knot nematode expressed a no. of galls/plant (43.50), no. of egg masses/plant (33.87), no. of eggs and larvae/egg mass (128.87), nematode population/200cc soil (834.87), final nematode population

Table 1. Effect of fungal bio-agents on plant growth characters of tomato infected with root-knot nematode, *Meloidogyne incognita* under cage house condition (2021, 2022 and pooled data).

Treatment	Shoot length (cm)			Root length (cm)			Fresh shoot weight (g)			Fresh root weight (g)			Yield per plant (kg)		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
T1	59.75	59.25	59.50	27.25	26.50	26.87	48.25	47.50	47.87	20.50	19.25	19.87	2.03	1.90	1.96
T2	53.75	52.25	53.00	23.75	22.50	23.12	43.00	41.75	42.37	19.00	17.00	18.00	1.75	1.62	1.68
T3	44.50	43.25	43.87	19.25	18.25	18.75	35.75	34.50	35.12	13.75	11.75	12.75	1.37	1.27	1.32
T4	32.00	31.50	31.75	11.25	9.75	10.50	25.50	23.50	24.50	8.75	7.75	8.25	0.87	0.73	0.80
T5	39.14	38.00	38.57	14.25	12.75	13.50	29.50	28.75	29.12	10.75	9.75	10.25	0.98	0.90	0.94
T6	64.62	63.00	63.81	31.50	29.75	30.62	51.50	50.25	50.87	23.75	22.25	23.00	2.18	2.02	2.10
T7	20.00	19.25	19.62	9.00	8.25	8.62	14.00	12.75	13.37	5.75	4.75	5.25	0.47	0.37	0.42
SEm+	0.70	0.21	0.31	0.64	0.40	0.36	0.74	0.30	0.41	0.40	0.27	0.23	0.04	0.06	0.03
CD at 5%	2.07	0.64	1.08	1.89	1.19	1.03	2.18	0.90	1.19	1.20	0.81	0.66	0.12	0.18	0.10

Table 2. Effect of fungal bio-agents on reproduction of root-knot nematode, *Meloidogyne incognita* infecting tomato under cage house condition (2021, 2022 and pooled data).

S. No.	No. of galls per plant			No. of egg masses per plant			No. of eggs & larvae per egg mass			Nematode population per 200 cc soil			Final nematode population (soil + plant)			Root gall index (1-5 scale)			$R_f = P_f/P_i$		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
T1	39.75	42.5	41.12	26.25	28.25	27.25	116.25	119.5	117.87	752.75	757.75	755.25	10618.81	10970.87	10794.84	2	2	2	2.65	2.74	2.69
T2	42.5	44.5	43.50	33.25	34.5	33.87	127.5	130.25	128.87	833.5	836.25	834.87	12616.87	12900.62	12758.75	2	2	2	3.15	3.22	3.18
T3	46.25	48.25	47.25	38.75	40.25	39.50	138.5	140.75	139.62	997.25	1001.25	999.25	15385.62	15725.93	15555.78	2	2	2	3.84	3.93	3.88
T4	58.5	60.25	59.37	51.5	52.75	52.12	171.75	173.75	172.75	1142.5	1148.5	1145.50	20328.62	20710.56	20519.59	3	3	3	5.08	5.17	5.12
T5	51.5	52.75	52.12	46.25	48.75	47.50	156.25	159.25	157.75	1037.8	1042.5	1040.15	17656.06	18241.18	17948.62	3	3	3	4.41	4.56	4.48
T6	33.25	34.5	33.87	20.25	21.5	20.87	105.25	109.75	107.50	638.25	642.25	640.25	8547.06	8816.62	8681.84	2	2	2	2.13	2.20	2.16
T7	67.5	70.25	68.87	59.5	62.75	61.12	192.5	194.25	193.37	1232.8	1242.25	1237.53	23855.25	24915.25	24385.25	3	3	3	5.96	6.22	6.09
SEm+	0.53	0.37	0.34	0.48	0.30	0.28	0.55	1.40	0.72	0.80	4.74	2.32	418.60	503.04	267.17	-	-	-	-	-	-
CD at 5%	1.58	1.11	0.99	1.42	0.89	0.82	1.63	4.12	2.08	2.35	13.94	6.67	1231.03	1479.47	762.51	-	-	-	-	-	-

Treatment description: $\mathbf{T_1}$ –SA and ST with *T. harzianum* at 5g/kg soil & 5 g/l of water, $\mathbf{T_2}$ **-SA** and ST with *T. viride* at 5 g/kg soil & 5g/l of water, $\mathbf{T_3}$ **-** SA and ST with *P. lilacinum* at 5g/kg soil & 5g/l of water, $\mathbf{T_4}$ **-** –SA and ST with *M. anisopliae* at 5 g/kg soil & 5g/lit of water, $\mathbf{T_5}$ –SA and ST with *B. bassiana* at 5 g/kg soil & 5 g/l of water, $\mathbf{T_6}$ -Carbofuran 3G@ 2kg a.i/ha, $\mathbf{T_7}$ -Untreated control.
Initial nematode population* 2 J2/cc soil
Replication- 4

(soil + plant) (12758.75), root gall index (2) and reproduction factor value (3.18) with an average shoot length (53.00 cm), root length (23.12 cm), fresh shoot weight (42.37 g), fresh root weight (18.00 g) and yield (1.68 kg/plant) pooled data of 2021 and 2022. However, the higher root-knot incidence of third grade root gall index was recorded in the untreated control (Table 1-2). These results are coinciding with the findings of Rao *et al.*, (1997) who reported that neem cake and *T. harzianum* significantly increased plant growth and reduced root galling and final population of root-knot nematode in tomato. Ramezani, (2010) found that soil treated with *T. harzianum* reduced the disease by 92 per cent. While, Mwangi *et al.*, (2011) documented that *T. harzianum* when applied to tomatoes increased the height and dry root weight. *T. harzianum* has been found to be an effective biocontrol agent for the management of root-knot and other nematodes (Casas-Flores *et al.*, 2007 and Moosavi *et al.*, 2012). Another findings of Bhatt *et al.*, (2002) who reported that the root-knot index and the number of egg masses were significantly reduced upon three applications of *T. viride*. Mukhtar (2018) who reported that the indigenous isolates of *T. harzianum* and *T. viride* have the potential to control *M. incognita*.

Conflict of Interest- None

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