Biological Forum – An International Journal **15(10): 1501-1507(2023)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Pathogenicity and Management of *Meloidogyne graminicola* in Rice (*Oryza sativa* L.), variety, *Pusa Bhagwati* under Bihar Conditions

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(Received: 18 August 2023; Revised: 20 September 2023; Accepted: 04 October 2023; Published: 15 October 2023)
(Published by Research Trend)

ABSTRACT: Rice (*Oryza sativa* L.) is one of the most widely grown crops in the world, and is a staple food for more than half of the global total population. Root-knot nematodes (RKNs), *Meloidogyne* spp., especially *M. graminicola*, seem to be significant rice pests, which makes them the most economically important plant-parasitic nematode in this crop. The current investigation was conducted to ascertain the effect of initial population densities of *Meloidogyne graminicola* on the root-knot development, nematode multiplication and plant growth characters of rice seedlings under earthen pot conditions. When the inoculum density level increased from 10J_2/pot to 10000J_2/pot, vegetative and reproductive characters of the plant decreased significantly and nematode multiplication parameters increased significantly. The maximum galls per root system, eggs and juveniles per egg mass, nematode population/200cc soil, root knot index and number of females per gall were enhanced significantly with increase in inoculum level and maximum was at 10000 J_2 /pot. The fungal biocontrol agent, *Trichoderma viride* @ 5g, 6g, 7g, 8g, 9g and 10g/pot with carbofuran @ 2kg a.i./ha as treated check and another untreated check in 1 kg soil were taken and the effect was reported on the development of plant and nematode multiplication parameters, keeping two sets as pre and post application of *T. viride,* one week before and after germination, respectively. Although carbofuran treated plants have shown significantly effective treatment but among the different doses of *T. viride* in both pre and post treatment, the highest dose10g/pot has given the maximum growth parameters and minimum nematode multiplication parameters in both pre and post treatments. When we compared the results in both pre and post treatments, it was revealed that in all the characters, the increase was higher in pretreatments than the post treatments.

Keywords: *Trichoderma viride, Meloidogyne graminicola, Oryza sativa, Pusa Bhagwati*, carbofuran.

INTRODUCTION

India ranks first in terms of both area and production in rice. Among all states in India, West Bengal has its first place in rice production and Tamil Nadu in productivity. Golden and Birchfield (1965) for the first time recorded and described *Meloidoguyne graminicola* from barnyard grass roots, *Echinochloa colonum* in Louisiana. The level of 1 J_2 of *M. graminicola*/g soil was found to be pathogenic. The growth parameters of rice crop were significantly more in clay loam soil followed by loam and sandy loam irrespective of inoculum levels. Maximum growth was found in uninoculated check and growth decreased significantly when the pathogenic level increased from 1-4 J_2/g soil. Maximum reproduction of nematode was observed in clay loam and loam textured soil. The nematode reproduction increased when the pathogenic level increased (Kanwar *et al.,* 2017).

In the constantly evolving rice production system, there are over 200 species of phytonematodes that have been recognized to be related to rice (Tian *et al.,* 2018). RKNs are capable of penetrating the roots, causing root galling, suppressing plant defense mechanisms, hijacking the plant's metabolism, and establishing giant cells for their benefit (Kyan *et al.,* 2017).

The options to control *M. graminicola* are still limited for many years. The use of nematicides has been the most efficient way to manage this pest. Due to their negative impact on the environment and the implementation of new directives and regulations to reduce chemical applications, alternative strategies are now needed to reduce root knot nematode populations (Villaverde *et al.,* 2016). Chemical pesticides are most frequently used by growers to manage this nematode in rice. However, besides their adverse and harmful impact, pesticides often prove non-economic under the rice ecosystem. Organic management approaches such as host resistance, especially the use of resistant cultivars, botanical pesticides, use of organic matters (organic amendments with oilcakes, manures/composts, essential oils, bio fumigation etc.) and integrated disease management are good alternatives to chemical pesticides, and can deliver safe management of rice root-knot nematodes (Haquel *et al.,* 2022).

MATERIALS AND METHODS

Rice variety: Pusa Bhagwati

The experiment was done in Department of Plant Pathology & Nematology of Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur to

study the pathogenic levels of rice root-knot nematode, *Meloidogyne graminicola* in rice at different level of inoculums. The earthen pots of 20 cm diameter were filled with 1kg sterilized soil and seeds were sown, proper care taken during raising of seedlings and the proper recommended practices have been taken regarding irrigation, weeding etc.

Seedlings were injected with the freshly hatched second-stage juveniles of *M. graminicola* with different inoculum levels, *viz*., 0, 10, 100, 1000, 5000 and 10000 J_2 per pot on to the exposed roots by making holes in the soil around the plant. An uninoculated treatment was kept to interpret and compare the effects of different inoculum. Each treatment was replicated three times and the statistical analysis was done by CRD design. The mean numbers of nematodes per ml of water was assessed by taking five counts in a counting dish.

For management experiment, the earthen pots of 20cm diameter size in three replications, were taken. Each earthen pot was filled with sterilized soil. In each pot, 5-10 seeds were sown. Seedlings were inoculated with 1000 freshly hatched second-stage juveniles (J_2). The treatment with bioagent, *Trichoderma viride* and carbofuran was done 7 days before sowing (pre-germination) and after 7 days of sowing (post-germination) planting as per doses mentioned below and plants were uprooted for data collection after 60 days of pathogenic injection. The treatments were as follows:

Factor 1 – *Trichoderma viride*@ 5g, 6g, 7g, 8g, 9g and 10g/pot, Carbofuran @ 2 kg a.i./ha (Treated check) and one untreated check

Factor 2 – Pre-treatment (one week before germination) and post treatment (one week after germination)

Replication – 03

Design - CRD

The plants were uprooted 60 days after pathogenic injection, each rice seedling of earthen pots tagged with replication and treatment number and got to the lab for further data collection.

RESULTS AND DISCUSSION

The pathogenic levels *viz*., 10,100, 1000, 5000 and 10000 J_2 per pot on the vegetative growth parameters of rice (variety –*Pusa Bhagwati*) has been shown in the Table 1. The data recorded, analyzed and percentage decrease in growth parameters was calculated. The data in Table 1 showed that all the vegetative growth characters were decreased significantly with the increase in inoculum levels, from 10 J_2 to 10000 J_2 per pot. The maximum shoot length (71.16 cm), root length (7.6cm), fresh shoot weight (3.5 g), dry shoot weight (2.43g), fresh root weight (1.36 g) and dry root weight (0.98g) were observed in the treatment 6 where no nematodes were inoculated. Significant decrease in growth characters was observed at and above 10 J_2 per pot except in shoot length where significant decrease was observed from 100 J_2 per pot inoculum level. At 10 J_2 per pot, the decrease in shoot length is non-significant. The reduction percentages were 26.7%, 52.63%, 78.88%, 85.15%, 86.02% and 83.67% in shoot length, root length, fresh shoot weight, dry shoot weight, fresh root weight and dry root weight respectively. However, the decrease in dry shoot weight at 5000 J_2/ pot (0.63g) and 10000 J_2 per pot (0.36g) was at par. In fresh shoot weight also, the decrease at 1000 J_2 / pot (0.26g), 5000J_2/pot (0.22 g) and at 10000 J_2/pot (0.19g), was at par, similarly in dry root weight also, the decrease at 1000 J_2/ pot and 5000 J_2/pot (0.23 g & 0.19g) was at par and decrease at 5000 J_2/pot (0.19 g) and 10000 J_2/ pot (0.16 g) was also at par. Thus it can be concluded from the result that the minimum pathogenic level for all vegetative parameters of plant was found at 10 J_2/ pot except in shoot length where it was at 100 J_2/pot. It is in acceptance with the work of Dhurwey *et al.* (2019), where seven days old seedlings of wheat were exposed at various pathogenic levels of *M. graminicola viz.*, 10, 100, 1000 and 10,000 J_2 per pot along with supernatant. An uninoculated treatment was also maintained to serve check. It was noted that a level of 1000 J_2/plant was pathogenic level infecting the plant roots and significantly reduced plant development parameters of wheat. There was a simultaneous decrease in shoot length, root length, fresh shoot weight and dry shoot weight as the level of inoculation increased.

The effect of pathogenic levels of *viz*., 10,100, 1000, 5000 and 10000 J_2 per pot on the reproductive growth characters of rice (variety, *Pusa Bhagwati*) has been shown in the Table 2. The data recorded, analyzed and percentage decrease in reproductive growth parameters were calculated. The data in Table 2 revealed that all the reproductive growth parameters were decreased significantly when pathogenic levels ascended from 10 J_2 to 10000 J_2 per pot. The maximum tillers (4.66), earhead length (16.36 cm), number of grains per ear head (80.33) was observed in treatment 6 where no nematodes were inoculated. Major reduction in reproductive growth parameters could be noticed at and above 10 J_2 per pot except for number of tillers per plant where it is non-significant at 10 J_2 and 100 J_2 per pot. At 1000 J_2/pot (3.66) and 5,000 J_2/pot (3.33), the decrease in number of tillers are at par.

Similarly, the decrease in number of tillers at 5000 J_2/pot (3.33) and 10,000 J_2/pot (3.00), are at par. The reduction percentages were highest at 10000 J_2/pot (35.62, 58.25 cm and 65.97 in number of tillers per plant, ear head length, number of grains per ear head respectively). However, the decrease in ear head length at 1000 J_2/pot (8.13 cm), 5000 J_2/pot (7.76 cm) and 10000 J_2/pot (6.83 cm) was at par. It can be concluded from the result that the minimum damaging threshold level for all reproductive growth parameters was found at 10 J_2/pot. This finding was also similar to Kumar *et al.* (2017) who studied the comparative effect of *Meloidogyne graminicola* on both types of rice, *i.e.*, scented (var. Pusa 1121) and non-scented rice (PR 114), where the plant growth characters decreased significantly as inoculum levels increased from 100-10000 J_2 irrespective of soil types indicating 100 J_2 as damaging threshold level of *M. graminicola* on both types of rice. Whereas in this research, minimum pathogenic level for all vegetative and reproductive

characters was found at 10 J_2/ pot except in shoot length where it was at 100 J_2/pot.

The biocontrol agent, *Trichoderma viride* @ 5g, 6g, 7 g, 8g, 9g and 10 g/pot control on the growth parameters and nematode multiplication parameters was observed keeping one set as pre-application of *T. viride* and another set as post application of *T. viride* one week after germination of rice (variety: *Pusa Bhagwati*). The data recorded on different plant growth parameters were analyzed statistically and presented in the Tables 3 and 4. The carbofuran @ 2 kg ai/ha was kept as treated check for comparison and another treatment was kept as uninoculated untreated check.

Table 1: Effect of different inoculum levels of *Meloidogyne graminicola* on growth parameters of rice, variety Pusa Bhagwati (Mean of three replications).

Treatments	Shoot length (cm)		Root length (cm)		Fresh shoot wt. (g)		Dry shoot wt. (g)		Fresh root wt. (g)		Dry root wt. (g)	
	Mean	% decrease	Mean	% decrease	Mean	% decrease	Mean	% decrease	Mean	% decrease	Mean	% decrease
T_1 - 10 J_2 /pot	69.56	2.24	6.96	8.42	2.90	17.14	1.76	27.57	1.05	22.79	0.89	9.18
T_2 - 100 J_2 /pot	64.83	8.89	5.70	25.00	2.30	34.28	1.30	46.50	0.36	73.52	0.31	68.36
T_3 - 1000 J_2 /pot	62.46	12.22	5.00	34.21	1.80	48.57	0.86	64.60	0.26	80.88	0.23	76.53
T_4 - 5000 J_2 /pot	55.26	22.34	4.23	44.34	1.16	66.85	0.63	74.07	0.22	83.82	0.19	80.61
T_5 - 10000 J_2 /pot	52.16	26.70	3.60	52.63	0.66	78.88	0.36	85.15	0.19	86.02	0.16	83.67
T_6 – Uninoculated	71.16		7.60		3.50		2.43		1.36		0.98	
S.Em(±)	**0.60**		**0.13**		**0.10**		**0.10**		**0.04**		**0.02**	
CD (at 5 %)	**1.86**		**0.40**		**0.30**		**0.30**		**0.14**		**0.06**	

According to the data from Tables 3 and 4, the dose of *T. viride* increased from 5g/pot to 10g/pot, all vegetative plant characteristics (shoot length, root length, fresh shoot weight, dry shoot weight, fresh root weight and dry root weight) increased but more significant difference was observed in the rice plants where these were treated with carbofuran @ 2kg a.i/ha (70.00cm, 12.26cm, 7.40g, 3.50g, 2.60g and 1.02g respectively in pre-treatment before one week of germination and 65.00cm, 12.26cm, g, 5.46g, 3.20g, 2.23 g and 0.89g respectively in post treatment after one week of germination).

Although carbofuran treated plants have shown significantly highly effective treatment but among the different doses of *T. viride* in both pre and post treatments, the highest dose 10g/pot has given the maximum growth parameters in both pre and post treatments. When we compare the growth parameter values in both pre and post treatments, it was found that for all the characters, the increase was more in pre-treatment than post treatment. In general *T. viride* has the feature that when it is applied in soil having sufficient organic matter before sowing, it multiplied on the organic matter and when seeds are sown and germinated, the effect on their growth parameters is more compared to post treatment where it is applied after one week of germination and at that time, *T. viride* does not find time to multiply to act on the juveniles.

The effect of biocontrol agent, *Trichoderma viride* @ 5 g, 6 g, 7 g, 8 g, 9 g and 10 g/pot on the rice reproductive parameters was observed keeping one set as pre-application of *T. viride* one week before germination and another set as post application of *T. viride* one week after germination of rice. The data recorded, were statistically analyzed and presented in the Table 5. The carbofuran @ 2 kg a.i./ha was kept as treated check for comparison and another treatment was kept as uninoculated untreated check.

In the Table 5, all the treatments were significantly superior over untreated check i.e. number of tillers, earhead length, number of grains per earhead in pre (2.00, 8.33 cm and 32.33 respectively) and post treatment (1.66, 7.66 cm and29.00 respectively). The pots treated with carbofuran @ 2 kg a.i./ha recorded significant higher number of tillers, earhead length and number of grains per earhead in pre-treatment (4.66, 17.20 cm and 77.00 respectively) and post treatment (4.00, 14.76 cm and 69.00 respectively). The number of tillers, earhead length, and number of grains per earhead in various treatments of *T. viride* from 5 g, 6 g, 7 g, 8 g, 9 g, 10 g and carbofuran @ 2 kg a.i./ha differed significantly in various treatments. The next best treatments after carbofuran @ 2 kg a.i/ha, is the application of *T. viride* @ 10 g/ pot which showed higher number of tillers, earhead length and number of grains per earhead in pre-treatment (4.00, 16.10 cm and 72.66 respectively) and in post treatment(3.66, 13.73 cm and 62.66 respectively).The earhead length in treatment of 1 and 7 (9.83 cm &14.76 cm) are significantly different from untreated control and rest all the treatments are non-significant.

This was in acceptance with Subhidi *et al.*, (2019) who applied carbofuran @ 60 mg/pot at the time of sowing and the result exhibited higher increase in plant growth characters over untreated check followed by soil application of *Pseudomonas fluorescens* @ 20 mg/pot with 1 kg soil registering increased shoot length, root length, fresh shoot weight, dry shoot weight, fresh root weight and dry root weight by 16.08 %, 32.72 %, 50.26 %, 59.49 %, 48.00 % and 44.28 % respectively.

The effect of biocontrol agent, *Trichoderma viride* @5g, 6g, 7g, 8g, 9g and 10g/pot on the nematode multiplication parameters was observed keeping one set as pre application of *T. viride* one week before

germination and another set as post application of *T. viride* one week after germination of rice (variety: *Pusa Bhagwati*). The carbofuran @2kg a.i./ha was kept as treated check for comparison and another treatment was kept as uninoculated untreated check. The result is presented in Table 6.

Table 6 revealed that as dose of *T. viride* increased from 5g/pot to 10g/pot, all the nematode multiplication parameters decreased significantly. The minimum galls per root system, eggs and juveniles per eggs mass, nematode population/200cc soil, number of females per gall, and root knot index in pre (0.66, 0.33, 23.25, 0.00 and 1.66) and post treatment (1.00, 1.00, 25.02, 0.00 and 1.66) respectively observed in the treatment 7. Although carbofuran treated plants have shown significantly highly effective treatment but among the different doses of *T. viride* in both pre and post treatment, the highest dose i.e. 10g/pot has given the minimum galls per root system, eggs and juveniles per egg mass, nematode population in 200cc soil, number of females per gall and root knot index in both pre (0.66, 1.00, 25.08, 0.33 and 1.66) and post treatment (1.00, 1.66, 27.70, 0.66, 2.00) but, when we compare the pre and post treatment, it is found that in all the nematode multiplication parameters, the decrease was more in pre-treatment than post treatment. Pre-application of *T. viride* was found better as it got time for its multiplication and by the time seed germinated, it inhibited the penetration of juveniles inside the roots, So the control was effective in pre-treatment than post treatment and it is found beneficial for the farmers and also safe for environment. The use of biological control agents, such as the fungi, *Paecilomyces lilacinus*, *Trichoderma harzianum*, *T. viride*, and other *Trichoderma* spp.; the bacteria *Bacillus subtilis*; and the rhizobacterium *Pseudomonas fluorescence*, have shown promising results against *M. graminicola* (Narasimhamurthy *et al*., 2017; Seenivasan *et al*., 2021). Studies by (Amarasinghe and Hemachandra 2020) in Sri Lanka, revealed that *T. viride* reduces gall formation and production of egg masses, which represents a potential strategy to be included in integrated pest management programs.

Table 2: Effect of different inoculum levels of *Meloidogyne graminicola* on reproductive parameters of rice (mean of three replications).

Treatment	Number of tillers per plant		Earhead length (cm)		Number of grains per earhead	
	Mean	% decrease	Mean	% decrease	Mean	% decrease
T_1 - 10 J_2/pot	4.33	07.81	14.00	14.42	66.33	17.42
T_2 - 100 J_2/pot	4.00	14.16	10.76	34.22	56.66	29.46
T_3 - 1000 J_2/pot	3.66	21.45	8.13	50.30	42.33	47.33
T_4 - 5000 J_2/pot	3.33	28.54	7.76	52.56	33.33	58.50
T_5 - 10000 J_2/pot	3.00	35.62	6.83	58.25	27.33	65.97
T_6 - Uninoculated	4.66		16.36		80.33	
SEm(±)	**0.27**		**0.40**		**0.99**	
CD (P=0.05)	**0.85**		**1.24**		**3.36**	

Table 3: Effect of *Trichoderma viride* on the vegetative growth of rice (mean of three replication).

Treatments	Shoot length (cm)				Fresh shoot wt.(g)				Dry shoot wt.(g)			
	Pre	% increase	Post	% increase	Pre	% increase	Post	% increase	Pre	% increase	Post	% increase
T_1 - *Trichoderma viride*@ 5 g/pot	53.16	19.75	49.50	19.19	4.66	21.45	3.46	16.18	1.75	24.57	1.16	25.86
T_2 -*Trichoderma viride*@ 6 g/pot	55.16	23.56	52.00	23.07	4.80	23.75	3.63	20.11	2.01	34.32	1.49	42.22
T_3 -*Trichoderma viride*@ 7 g/pot	58.00	26.44	54.83	27.04	5.10	28.23	3.80	23.65	2.30	42.60	1.82	52.74
T_4 -*Trichoderma viride*@ 8 g/pot	60.50	29.48	57.16	30.00	5.66	35.33	4.16	30.28	2.61	49.42	2.13	59.62
T_5 -*Trichoderma viride*@ 9 g/pot	63.16	32.45	59.16	32.38	6.16	40.58	4.46	34.97	2.96	55.40	2.46	65.04
T_6 -*Trichoderma viride*@ 10 g/pot	66.16	35.55	62.00	35.48	6.90	46.95	5.03	42.34	3.23	59.13	2.88	70.13
T_7 -Carbofuran @ 2 kg a.i./ha	70.00	39.05	65.50	38.93	7.40	50.4	5.46	46.88	3.50	62.22	3.20	73.12
T_8 -Untreated check	42.66		40.00		3.66		2.90		1.32		0.86	
SEm(±)	**0.47**		**0.55**		**0.11**		**0.11**		**0.08**		**0.09**	
CD (P=0.05)	**1.43**		**1.66**		**0.36**		**0.35**		**0.25**		**0.29**	

Table 4: Effect of *Trichoderma viride* on the vegetative growth of rice (mean of three replications).

Treatments	Root length (cm)				Fresh root wt.(g)				Dry root wt.(g)			
	Pre	% increase	Post	% increase	Pre	% increase	post		Pre	% increase	Post	% increase
T_1 - *Trichoderma viride*@ 5 g/pot	7.43	33.64	6.90	34.34	0.79	35.44	0.45	40.00	0.31	35.48	0.21	61.90
T_2 - *Trichoderma viride*@ 6 g/pot	8.43	41.51	7.50	39.60	1.03	50.48	0.82	67.07	0.43	53.48	0.31	74.19
T_3 - *Trichoderma viride*@ 7 g/pot	9.56	48.43	7.72	41.32	1.30	60.76	0.93	70.96	0.55	63.63	0.42	80.95
T_4 - *Trichoderma viride*@ 8 g/pot	10.73	54.05	8.53	46.89	1.60	68.12	1.16	76.72	0.68	70.58	0.55	85.45
T_5 - *Trichoderma viride*@ 9 g/pot	11.66	57.71	9.58	52.71	1.86	72.58	1.60	83.12	0.79	74.68	0.66	87.87
T_6 - *Trichoderma viride*@ 10 g/pot	13.06	62.25	10.43	56.56	2.16	76.38	2.00	86.50	0.90	77.77	0.78	89.74
T_7 -Carbofuran @ 2 kg a.i./ha	14.46	65.90	12.26	63.05	2.60	80.38	2.23	87.89	1.02	80.39	0.89	91.01
T_8 -Untreated check	4.93		4.53		0.51		0.27		0.20		0.08	
SEm(±)	**0.28**		**0.25**		**0.06**		**0.05**		**0.03**		**0.03**	
CD (P=0.05)	**0.85**		**0.75**		**0.18**		**0.16**		**0.10**		**0.09**	

Table 5: Effect of *Trichoderma viride* on the reproductive growth parameters of rice (mean of three replications).

Treatments	Number of tillers		Ear head length		Number of grains per ear head	
	Pre	Post	Pre	Post	Pre	Post
T_1 -*Trichoderma viride*@ 5 g/pot	2.33	2.00	10.10	9.83	48.00	43.00
T_2 -*Trichoderma viride*@ 6 g/pot	2.66	2.33	11.21	11.33	54.66	47.66
T_3 -*Trichoderma viride*@ 7 g/pot	3.00	2.66	12.26	11.59	60.33	51.66
T_4 -*Trichoderma viride*@ 8 g/pot	3.33	3.00	13.60	11.90	64.00	55.00
T_5 -*Trichoderma viride*@ 9 g/pot	3.66	3.33	15.00	12.68	68.66	57.66
T_6 -*Trichoderma viride*@ 10 g/pot	4.00	3.66	16.10	13.73	72.66	62.66
T_7 -Carbofuran @ 2 kg a.i./ha	4.66	4.00	17.20	14.76	77.00	69.00
T_8 -Untreated check	2.00	1.66	8.33	7.66	32.33	29.00
SEm(±)	**0.09**	**0.07**	**0.35**	**0.33**	**0.95**	**2.64**
CD (P=0.05)	**0.27**	**0.22**	**1.03**	**0.97**	**2.87**	**0.87**

Table 6: Effect of *Trichoderma viride* on the nematode multiplication parameters (mean of three replications).

Treatments	Number of galls/root system		Number eggs and juveniles/gall		Nematode population in 200 cc soil		Number of females per gall		Root knot index	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
T_1 - *Trichoderma viride*@ 5 g/pot	8.33	10.33	9.00	11.00	33.05	33.28	2.00	2.33	2.00	2.33
T_2 -*Trichoderma viride*@ 6 g/pot	6.00	7.66	7.00	8.33	31.87	32.90	1.00	1.33	2.00	2.00
T_3 -*Trichoderma viride*@ 7 g/pot	4.73	6.00	6.40	7.66	31.46	32.10	1.00	1.00	2.00	2.00
T_4 -*Trichoderma viride*@ 8 g/pot	3.00	4.50	4.66	5.66	29.69	30.83	0.33	1.00	2.00	2.00
T_5 -*Trichoderma viride*@ 9 g/pot	1.00	2.33	1.66	2.33	27.89	29.57	0.33	0.66	1.66	2.00
T_6 -*Trichoderma viride*@ 10 g/pot	0.67	1.00	1.00	1.66	25.08	27.70	0.33	0.66	1.66	2.00
T_7 -Carbofuran @ 2 kg a.i./ha	0.67	1.00	0.33	1.00	23.25	25.02	0.00	0.00	1.66	1.66
T_8 -Untreated check	29.33	31.00	36.00	39.00	56.55	58.30	2.00	2.67	4.00	4.00
SEm(±)	**0.56**	**0.71**	**0.55**	**0.63**	**0.42**	**0.40**	**0.20**	**0.26**	**0.20**	**0.16**
CD (P=0.05)	**1.70**	**2.16**	**1.67**	**1.91**	**1.28**	**1.23**	**0.61**	**0.79**	**0.61**	**0.50**

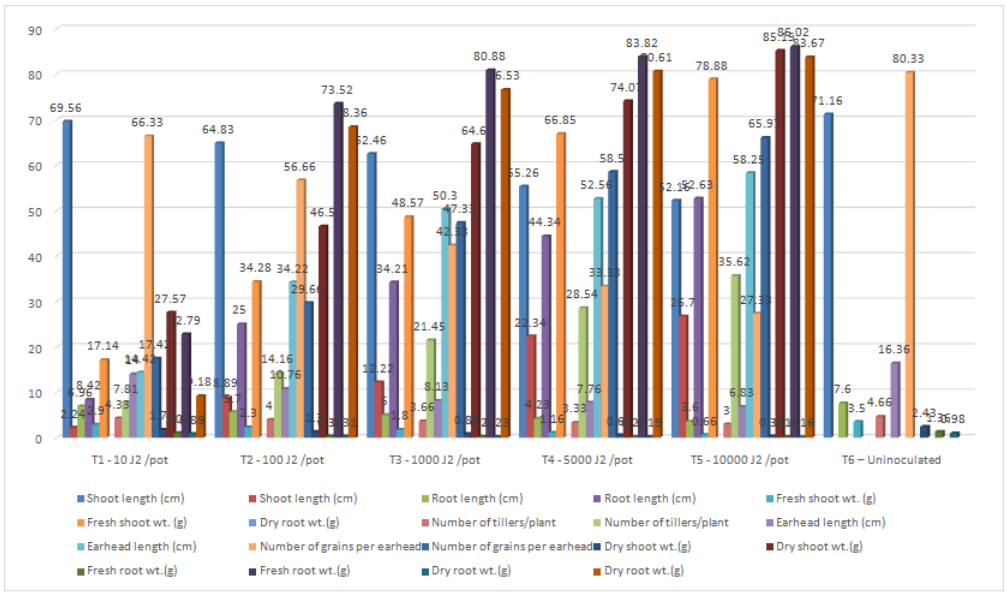

Fig. 1. Effect of different inoculum levels of *Meloidogyne graminicola* on growth parameters of rice, variety Pusa Bhagwati (Mean of three replications).

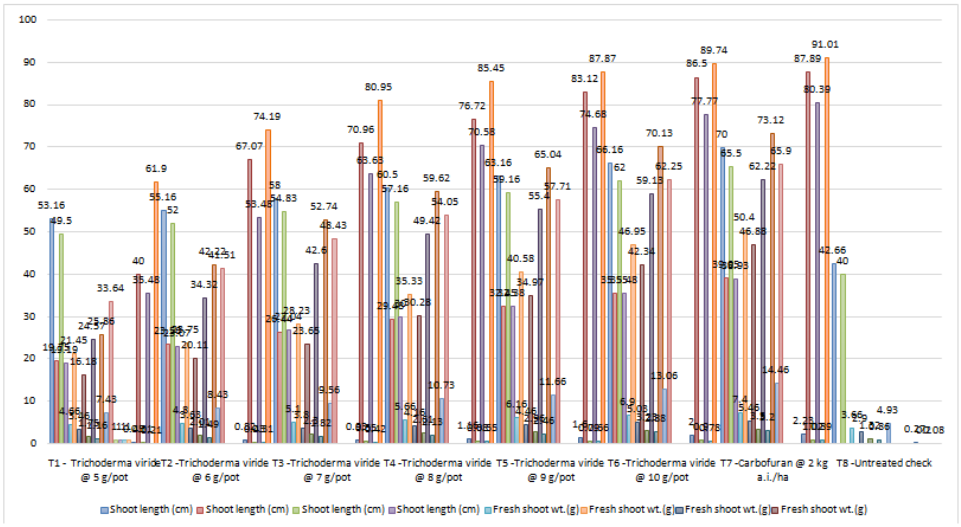

Fig. 2. Effect of *Trichoderma viride* on the vegetative parameters on rice (mean of three replications).

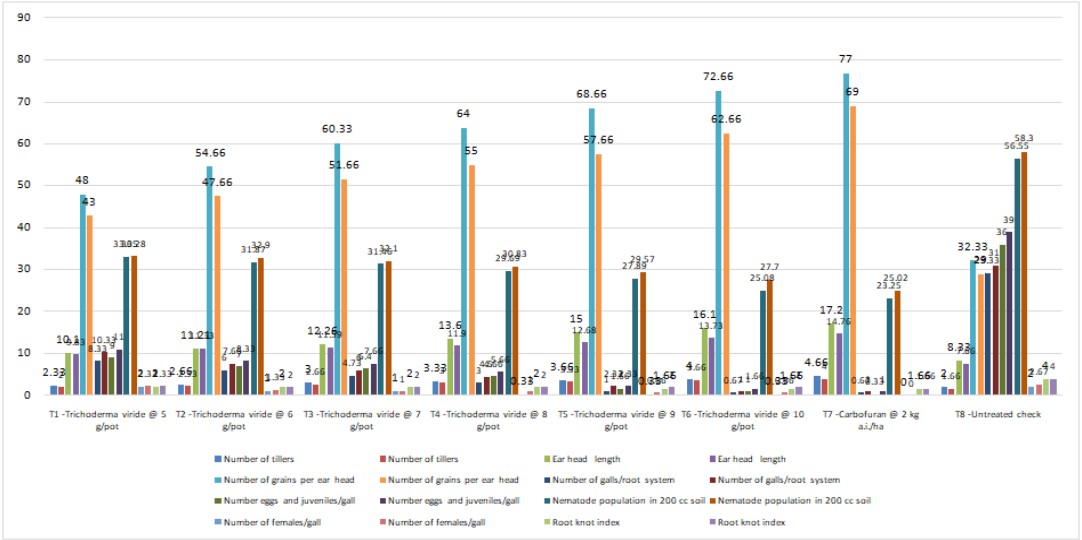

Fig. 3. Effect of *Trichoderma viride* on the reproductive and nematode multiplication parameters on rice (mean of three replications).

CONCLUSIONS

In the present study concluded that as the inoculum level increased plant growth parameters decreased significantly and nematode multiplication parameters increased significantly and management of *M. graminicola* can be done by increasing the *T. viride* level apart from the chemical control.

Acknowledgment. The authors gratefully acknowledge Dr. Rajendra Prasad Central Agricultural University, Samastipur, Pusa Bihar and ICAR for granting National Fellowship for the research.

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How to cite this article: Gajja Bharath Goud, Nishi Keshari, Sethu Lakshmi S. and Palukuru Usha (2023). Pathogenicity and management of *Meloidogyne graminicola* in Rice (*Oryza sativa* L.), variety, *Pusa Bhagwati* under Bihar Conditions. *Biological Forum – An International Journal, 15*(10): 1501-1507.