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Efficacy of Bio-agents in the Management of Root Knot Nematode (*Meloidogyne graminicola*) in Basmati Rice

Abhishek Kumar, Kamal Khilari, Sachin Kumar Jain **10.18805/ag.D-5326**

ABSTRACT

Background: Rice root knot nematode (*M. graminicola*) is considered as a major threat in basmati rice. The main characteristic symptoms produced by *M. graminicola* are terminal hook shaped or spiral galls on the roots and other symptoms of damage include patches of stunted and yellowish plants.

Methods: A field experiment was conducted in *Kharif* season of 2018 and 2019 at Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (UP) to test the efficacy of bio-agents against the root knot nematode. In this experiment, three bio-agents (*Bacillus pumilus*, *Bacillus subtilis* and *Pseudomonas florescence*) and one chemical (carbofuran) were tested in randomized block design with three replications.

Result: It was observed that tested bio-agents and chemical significantly reduced the galls per plant in comparison to the control. At 30 and 60 day after transplanting, minimum (12.7 and 10.0 galls/plant) and (20.9 and 18.8 galls/plant) were recorded with *Bacillus subtilis* @ 20g/ M^2 (2 x 10^8 cfu/g) during 2018 and 2019, respectively. In case of control, 52.7 and 62.5 galls/plant were recorded at 60 days after transplanting during both years. All the tested bio-agents were found effective in reducing the nematode population, increase the growth parameters and yield of basmati rice.

Key words: Bio-agent, *Meloidogyne graminicola*, Rice, Root galls.

INTRODUCTION

Rice (*Oryza sativa* L.) belongs to family Poaceae (Gramineae). Basmati rice production is affected by biotic and abiotic stresses. In biotic stresses various pathogens *i.e*. nematodes, fungi, bacteria and viruses *etc*. affect basmati rice crop adversely. Among the diseases, root knot nematode is an important problem of rice. Nematode problem is increasing very fast in areas where farmers are continuously following rice-wheat cropping system. Basmati variety PB-1121, which is most popular among farmers is most susceptible for this disease (Khilari *et al.,* 2011). Rice root-knot nematode (*M. graminicola*) having established endoparasitic pest of nurseries and main crop. The main characteristic symptoms produced by *M. graminicola* are terminal hook shaped or spiral galls on the roots and other symptoms of damage include patches of stunted and yellowish plants. Presence of root galls and reduced root system ultimately causes significant decline in plant growth and grain yield (Khan *et al.,* 2012). The high population density of *M. graminicola* caused wilting of seedlings along with severe reduction in growth parameters while low population caused only reduction in growth parameters. Root-knot nematode alone is capable of causing up to 50% yield losses in rice in many production regions (Lorenzana *et al.,* 1998). In India, it is reported to cause 17-30% yield loss due to poorly filled kernels (Jain *et al.,* 2007). The use of rice seedlings from non-treated nursery beds has resulted in yield loss of 38% in comparison to 29% when rice seedlings from treated nursery beds (Gaur, 2003). For management of rice root knot nematode, many practices such as chemical method, organic amendments, resistant varieties, soil solarization and biological control have been reported (Sakhuja and Jain, 2001). Use of chemicals is becoming more expensive and undesirable due to environmental and health hazards. Hence a promising alternative is the use of bio-control agents coupled with organic amendments which is eco-friendly and economically feasible. Therefore, in present studies, biocontrol agent's *viz*., *Bacillus pumilus, Bacillus subtilis* and *Pseudomonas fluorescens* were evaluated for the management of rice root knot nematode.

Department of Plant Pathology, Sardar Valabhbhai Patel University of Agriculture and Technology, Modipuram, Meerut-250 110, Uttar Pradesh, India.

Corresponding Author: Sachin Kumar Jain, Amar Singh (PG) College, Lakhaoti, Bulandshahr-203 001, Uttar Pradesh, India.
Email: sachinjiain1115@gmail.com

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MATERIALS AND METHODS

An experiment was conducted under field condition at "Crop Research Centre" of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut during *kharif* season of 2018 and 2019. The seeds were sown in nursery to raise the seedlings. After 24 days of sowing, the seedlings were transplanted in the field. The soil of plots was already sick and the initial nematode population was 415 per 200g of soil recorded before the planting the crop in the field. Three bio-agents (*Bacillus pumilus*@ 20g/M^2 (2x 10^8 cfu/g), *Bacillus subtilis* @ 20g/M^2 (2x 10^8 cfu/g), *Pseudomonas florescence* @ 20g/M^2 (2x 10^8 cfu/g)) and one chemical (carbofuran@1 kg a.i./ha) were tested in randomized block design with three replications. All bio-agents and chemical were applied as soil application in plots before the puddling of the field. In the puddled field, 24 days old nursery seedlings were transplanted. The uniform plant population was maintained in all the plots, with the spacing of 20x10 cm between row to row and plant to plant. Observations on number of galls/plant at 30 and 60 days after transplanting and initial nematode population (before treatment application) and after crop harvesting was recorded.

RESULTS AND DISCUSSION

Effect of bio-agents on number of galls/plant

Results (Table 1) revealed that all the treatments were effective in reducing the number of galls/plant over the check during both the years. At 30 days after transplanting, minimum (12.7 and 10.0 galls/plant) was recorded with *Bacillus subtilis* @20g/M^2 (2x 10^8 cfu/g) followed by 13.7 and 10.7 galls/plant with carbofuran @1 kg a.i./ha. Average 15.0 and 12 galls/plant was recorded with soil application of *P. florescence* @ 20g/ M^2 (2x 10^8 cfu/g), whereas 21.5 and 27.5 galls/plant were in case of *Bacillus pumilus* @20g/ M^2 (2x 10^8 cfu/g). In control, 35.1 and 52.7 galls /plant were recorded. In comparison of control, 63.6 and 73.6% reduction in galls per plant was recorded with *Bacillus subtilis* @20g/M^2 (2x 10^8 cfu/g) followed by 60.7 and 71.7 % with carbofuran @1 kg a.i./ha. At 60 days after transplanting, 20.9 and 18.8 galls/plant were recorded with *Bacillus subtilis* @20g/ M^2 (2x 10^8 cfu/g) followed by 22.6 and 24.2 galls/plant with carbofuran @1 kg a.i./ha. About, 52.7 and 62.5 galls/plant were recorded in control during both the years. In comparison of control, 60.2 and 69.8% reduction in galls formation was recorded with *Bacillus subtilis* @20g/M^2 (2x 10^8 cfu/g). Previously, Muthulakshmi *et al.,* (2010) reported that *P. fluorescens* and *T. viride* were applied in soil alone or in combination effective to check root knot nematode disease and to improve growth of mulberry with increased leaf yield. Saravanan *et al*., (2021) reported that application of single bioagent either *P. fluorescens* @ 10 gm/plant or *T. viride* @ 10 gm/plant along with neem cake were with highest plant growth parameters and poor nematode infestation in banana.

Effect of bio-agents on growth and yield

Data (Table 2) revealed that all the treatments were effective in increasing plant growth. At 30 day after transplanting, maximum (63.1 and 61.1 cm) plant height was recorded with *Bacillus subtilis* @ 20g/ M^2 (2x 10^8 cfu/g) followed by 62.7 and 59.7 cm with *P. florescence* @ 20g/ M^2 (2x 10^8 cfu/g) during both the years, respectively. At 60 day after seedling

Table 1: Effect of application bio-agents on root galls and nematode population in rice field.

Treatments	Average no. of galls/plant at 30 DAT				Average no. of galls/plant at 60 DAT				Nematode population per 200 gm soil	
	2018		2019		2018		2019			
	Galls/plant	% Reduction	Galls/plant	% Reduction	Galls/plant	% Reduction	Galls/plant	% Reduction	2018	2019
T_1:	21.5	38.1	27.5	27.2	31.8	39.6	48.0	23.2	710	860
T_2:	12.7	63.6	10.0	73.6	20.9	60.2	18.8	69.8	620	686
T_3:	15.0	57.2	1200	68.3	27.7	47.4	29.4	52.9	900	755
T_4:	13.7	60.7	10.7	71.5	22.6	57.1	24.2	61.2	600	801
T_5:	35.1	-	37.8	-	52.7	-	62.5	-	970	880
CD@ 5%	1.44	-	1.41	-	2.00	-	2.28	-	-	-
CV	2.92	-	2.89	-	3.11	-	3.25	-	-	-

T_1: *Bacillus pumilus* @20g/M^2 (2x 10^8 cfu/g), T_2: *Bacillus subtilis* @20g/M^2 (2x 10^8 cfu/g),
T_3: *P. florescence* @ 20g/M^2(2x 10^8 cfu/g), T_4: Carbofuran @1 kg a.i./ha, T_5: Control.
DAT = Day after transplanting.

Table 2: Effect of bio-agents on pant growth parameters and grain yield.

Treatments	Average plant height (cm) at 30 DAT		Average plant height (cm) at 60 DAT		Yield q/ha	
	2018	2019	2018	2019	2018	2019
T_1:	61.8	60.7	68.5	72.0	11.3	12.7
T_2:	63.1	61.1	70.0	75.2	14.0	13.3
T_3:	62.7	59.7	69.0	73.5	12.8	12.6
T_4:	59.7	60.8	67.5	71.4	11.7	12.2
T_5:	58.2	60.2	66.7	71.2	10.6	11.9
CD@ 5%	N.S.	N.S.	N.S.	N.S.	1.1	N.S.
CV	4.05	4.02	4.37	4.63	3.03	2.4

T_1: *Bacillus pumilus* @20g/M^2 (2x 10^8 cfu/g), T_2: *Bacillus subtilis* @20g/M^2 (2x 10^8 cfu/g),
T_3: *P. florescence* @ 20g/M^2(2x 10^8 cfu/g), T_4: Carbofuran @1 kg a.i./ha, T_5: Control
DAT = Day after transplanting
N.S.:- Not Significant

transplanting, maximum (70.0, 75.2 cm) plant height was recorded with *Bacillus subtilis* @20g/ M^2 (2x 10^8 cfu/g) followed by 69 and 73.56 cm with *P. florescence* @ 20g/ M^2 (2x 10^8 cfu/g) and 68.50 and 72.00 cm with *Bacillus pumilus* @20g/ M^2 (2x 10^8 cfu/g) during both the years, respectively. Minimum (66.7 and 71.2 cm) plant height was recorded in control at 60 day after transplanting in both years, respectively. All treatments were also found effective in enhancing the grain yield over the check. Maximum grain yield (14.0, 13.3 q/ha) was recorded with *Bacillus subtilis* @20g/ M^2 (2x 10^8 cfu/g). Previously many researchers have reported similar results. Kumar (2018) reported that soil application (@2.5kg/ha) of *Pseudomonas fluorescens* inhibit the nematode population and increase the plant biomass. Anitha and Rajendra (2005) reported that integration of *P. fluorescens* (2.5 kg/ha), neem cake (1 ton/ha) and carbofuran (1 kg a.i./ha) highly effective in improving plant growth and yield in the nursery as well as in main field. Das *et al.,* (2017) found that application of carbofuran @ 0.3 gm/ M^2 in the nursery bed and field application of fungal bio-agent *Trichoderma viride* @ 2.5 kg /ha after transplanting quite effective and economic for the nematode management with increased grain yield.

Effect of bio-agents on final nematode population

Data (Table 1) indicated that all the treatments were found effective in decreasing the nematode population in the field over the check. The initial nematode population 415 per 200g of soil was recorded before the planting the crop in the field. After harvesting, minimum (620 and 686.6 J_2 per 200g of soil) was recorded with *Bacillus subtilis* @20g/ M^2 (2x 10^8 cfu/g). Maximum (970 and 880 J_2 per 200g soil) were recorded in control during both the years, respectively. Narasimhamurthy *et al.,* (2017) found similar results against rice root knot nematode when applied different bio agents and carbofuran 3G @ 0.3% a.i. alone or in combination. They recorded all the treatments significantly superior over check with respect to growth parameters and nematode population.

CONCLUSION

Based on the results, it may be concluded that the *Bacillus subtilis* and *Pseudomonas florescence* is a potential antagonist against root knot nematode of rice. Application of *Bacillus subtilis* @20g/ M^2 (2x 10^8 cfu/g) is effective in the management of rice root knot nematode in field condition. Using of bio-agents can improve economic condition of farmers and will provide protection to the environment. Reduction of pesticide residue problem ultimately will improve export situation of basmati rice and will provide protection to the environment.

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