

Original Research Article

<https://doi.org/10.20546/ijcmas.2018.701.421>

Management of Root-Knot Nematode, *Meloidogyne graminicola* in Rice Using Bacterial Strains

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ABSTRACT

Keywords

Rice, *M. graminicola*,
Pseudomonas spp.,
Gluconacetobacter
diazotrophicus,
Azotobacter
chroococcum,
Bacillus spp.

Article Info

Accepted:
01 December 2017
Available Online:
10 January 2018

To study the effect of eleven strains of rhizobacteria, namely *Azotobacter chroococcum* (103, MSX-9, HT-54 and BNR-6), *Gluconacetobacter diazotrophicus* (CO 99-70, 35-47 and 760-50), *Bacillus* spp (91 and 65), *Pseudomonas fluorescens* and *Pseudomonas maltophilia* were used on rice (cv. PR-106) infected with *Meloidogyne graminicola* under greenhouse conditions. Soaking of seed for five minutes in plain water was treated as untreated check. After 45 days of sowing results indicated that all the rhizobacterial strains significantly increased the plant height and weight and reduced the number of galls/plant and multiplication of *M. graminicola* on rice significantly over untreated check, except *A. chroococcum* strain 103. Maximum plant height (6.75cm) was recorded in *G. diazotrophicus* strain 760-50 and *B. spp.* 91. Similarly, maximum plant weight 0.83g and 0.93g recorded in both treatments, respectively. However, maximum reduction of nematode population (0.5 and 0.6) times was observed in *G. diazotrophicus* strain 760-50 and *A. chroococcum* strain BNR-6, respectively over untreated check (1.5).

Introduction

Rice (*Oryza sativa* L.) is one of the most important among cereal crop in India. A remarkable achievement in food grain production after green revolution, transformed India from a net importing country in the mid-1960s to exporter country in rice by the early 1990s. Rice is the world's most important staple food and is cultivated in around 162 million ha annually with an annual global production of 464 million metric tons (FAO, 2013)

The cultivation of rice is affected by several biotic and abiotic stresses. A number of ecto

and endo-parasites of root, stem and foliar parts e.g., *Aphelenchoides besseyi*, *Ditylenchus angustus* and *Hirshmanniella* spp. have been already reported as major pests of rice from India (Prasad *et al.*, 1987). Rice root-knot nematode, *Meloidogyne graminicola* is a pest of international importance and it is reported to cause 17-30% yield loss due to poorly filled kernels (Mac Gowan and Langdon, 1989) while in India nematodes of rice alone cause 10.54 per cent yield loss which causes monetary losses of 779.30 million rupees (Jain *et al.*, 2007).

Due to serious loss on rice yields, particularly under sub optimal management conditions and easy means of spread along with water and soil, there is a high potential to expand the infected area in the country by this nematode. The rice root-knot nematode, *M. graminicola* is being one of the major nematode pests in rice-wheat cropping system. Management of this nematode is need of an hour.

A number of practices are used for the management of this nematode. The chemical nematicides can effectively be used for their management but their use give rise to many serious problems viz. pollution, food contamination, environmental hazard and development of pesticidal resistance etc.

Due to these limitations of the hazardous chemicals, biopesticides of botanical origin and rhizobacteria with antagonistic potential have become the focus of attention today for managing the nematode problems which provide eco-friendly and low cost technology.

Materials and Methods

The experiment was conducted in green house of Department of Nematology, Chaudhary Charan Singh Haryana Agricultural University, Hisar. Eleven strains of rhizobacteria, namely *Azotobacter chroococcum* (103, MSX-9, HT-54 and BNR-6), *Gluconacetobacter diazotrophicus* (CO 99-70, 35-47 and 760-50), *Bacillus spp.* (91 and 65), *Pseudomonas fluorescens* and *Pseudomonas maltophilia* were used in the experimentation.

Untreated check (water dipped for 5 minutes) was maintained for comparison. All the strains had 1×10^7 spores/ml. Inoculation of the rhizobacteria was done by soaking the seeds of rice with bacterial suspension in petri plates for five minutes. Treated seeds were sown in 15 cm earthen pots filled with one kg

infested soil of *Meloidogyne graminicola* having initial population of 1.5 larvae/g soil. After germination, one plant was retained in each pot. There were twelve treatments and each treatment was replicated four times. Pots were arranged in completely randomized design. Observations were recorded after 45 days of sowing. The experimental data were statistically analysed by "Analysis of Variance" procedure as advocated by (Fisher, 1948).

Results and Discussion

The results in Table 1 indicated that out of eleven rhizobacterial strains tested, two strains namely, *Bacillus spp.* strain 91 and *G. diazotrophicus* strain 760-50 performed best in improving plant height significantly and maximally up to 6.75cm in comparison to 4.50 cm in untreated check. Similarly these strains were also found to enhance fresh plant weight by 0.93g and 0.89g, respectively in comparison to 0.38g in untreated check. Among the *A. chroococcum* strains BNR-6 was found the only strain to improve plant height. However, rest of the three strains could not improve the plant height over untreated check. Among the *G. diazotrophicus* strains, 760-50 followed by CO 99-70 improved plant height and weight significantly.

None of *Pseudomonas* strain could improve plant height, however, plant weight was recorded to be significantly higher over untreated check in both the species. Jafri *et al.*, 2015 also found positive effects of bacterial strain in improving tomato growth parameters against *Meloidogyne incognita*. Bacterial strains remarkably suppressed nematode infestations because they act as growth inhabiting agents for juveniles that stimulate metabolic activities in the roots causing root growth which also help plant to absorb more nutrients by causing root proliferation.

Table.1 Effect of rhizobacterial inoculation on plant growth and number of galls on rice infected with *Meloidogyne graminicola*

Treatments	Plant height (cm)	Plant weight (g)	Number of galls/plant
<i>Azotobacter chroococcum</i> 103	5.20 (15.5)	0.51 (34.2)	20.00 (2.56)
<i>A. chroococcum</i> MSX 9	4.55 (1.1)	0.49 (28.9)	13.75 (-29.5)
<i>A. chroococcum</i> BNR-6	5.50 (22.2)	0.59 (55.3)	9.25 (-52.7)
<i>A. chroococcum</i> HT-54	4.75 (5.5)	0.52 (36.8)	13.50 (-30.9)
<i>Gluconacetobacter diazotrophicus</i> Co 99-70	5.70 (26.7)	0.84 (121.0)	12.25 (-35.9)
<i>G. diazotrophicus</i> 35-47	4.75 (5.5)	0.41 (7.9)	10.75 (-44.9)
<i>G. diazotrophicus</i> 760-50	6.75 (50.0)	0.89 (134.2)	5.75 (-70.5)
<i>Bacillus. sp.</i> 91	6.75 (50.0)	0.93 (144.7)	12.75 (-34.7)
<i>Bacillus sp.</i> 65	4.75 (5.5)	0.45 (18.4)	16.00 (-18.0)
<i>Pseudomonas fluorescens</i>	4.75 (5.5)	0.52 (36.8)	13.50 (-30.8)
<i>P. maltophila</i>	5.25 (16.6)	0.62 (63.2)	14.75 (-24.4)
Untreated check	4.50	0.38	19.50
CD at 5%	0.79	0.09	2.88

Figures within parenthesis denote increase (+)/decrease (-) over control

Table.2 Effect of rhizobacterial inoculation on multiplication of *Meloidogyne graminicola* in rice

Treatments	Nematode population in			R.f.
	Root	Soil (Kg ⁻¹)	Total	
<i>Azotobacter chroococcum</i> 103	1062.5	890.0	1952.5	890.0
<i>A. chroococcum</i> MSX 9	800.0	700.0	1500.0	700.0
<i>A. chroococcum</i> BNR-6	318.8	595.0	913.8	595.0
<i>A. chroococcum</i> HT-54	662.5	700.0	1362.5	700.0
<i>Gluconacetobacter diazotrophicus</i> Co 99-70	546.3	685.0	1231.3	685.0
<i>G. diazotrophicus</i> 35-47	405.0	665.0	1070.0	665.0
<i>G. diazotrophicus</i> 760-50	180.0	615.0	795.0	615.0
<i>Bacillus sp.</i> 91	726.3	645.0	1371.3	645.0
<i>Bacillus sp.</i> 65	1020.0	780.0	1800.0	780.0
<i>Pseudomonas fluorescens</i>	715.0	640.0	1355.0	640.0
<i>Pseudomonas maltophila</i>	876.3	670.0	1546.3	670.0
Untreated check	1450.0	810.0	2260.0	810.0
CD at 5%	309.4	147.5	374.5	0.2

The data in Table 2 showed that except *A. chroococcum* 103, all the strains in general have significantly decreased root-knot nematode multiplication in rice ranging between 0.5-1.2 times in comparison to 1.5 times nematode multiplication in untreated check after 45 days of sowing seed. Out of the ten effective rhizobacterial strains, *G. diazotrophicus* 760-50 was found most effective in reducing nematode population upto 0.5 times of initial population, followed

by *A. chroococcum* strain BNR-6 (0.6) and 35-47 (0.7). Among the isolates of *A. chroococcum*, BNR-6 reduced final nematode population at the end of the experiment. While *G. diazotrophicus* 760-50 was best among *G. diazotrophicus* strains, and *Bacillus* 91, *P. fluorescens* was found to be at par in reducing the final nematode population.

These results confirm the findings of Bansal *et al.*, 2005. Our results are also in an

agreement with Anita and Rajendran, 2005 who observed highest reduction in *M. graminicola* population in rice treated with rhizobacterial strain *P. fluorescens*. It seems that *G. diazotrophicus* 760-50 inoculation reduced root-knot disease severity by reducing the nematode population through reduced hatching by diminishing larval movement thus causing reduced entry/penetration of nematode juveniles into root.

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How to cite this article:

Ram Sharan, Gurpreet Singh, Rajkumar and Sumit. 2018. Management of Root-Knot Nematode, *Meloidogyne graminicola* in Rice Using Bacterial Strains. *Int.J.Curr.Microbiol.App.Sci*. 7(1): 3592-3595. doi: <https://doi.org/10.20546/ijcmas.2018.701.421>