



# Management of Root-Knot Nematode, *Meloidogyne incognita* Infecting Tuberose by Using Bioformulations under Field Condition

Pranjal Pratim Neog <sup>a\*</sup> and Pal Deka <sup>b</sup>

<sup>a</sup> Department of Nematology, Biswanath College of Agriculture, Assam Agricultural University, India.

<sup>b</sup> Department of Agricultural Statistics, Biswanath College of Agriculture, Assam Agricultural University, India.

## Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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## ABSTRACT

**Aims:** To evaluate the effectiveness of different bioformulations for management of root-knot nematode, *Meloidogyne incognita* infecting tuberose under field condition.

**Study Design:** Randomized Block Design.

**Place and Duration of Study:** Biswanath College of Agriculture, AAU, Biswanath Chariali, Assam during summer season 2024.

**Methodology:** Bulbs of tuberose cultivar Prajwal were planted in root-knot nematode infested sick plot. In this experiment seven treatments were considered and the treatments were replicated thrice. Bioformulations viz., Neem cake, Neem leaf power, Biover, Biozium, Biomonas and AAU-

\*Corresponding author: E-mail: [pranjal.neog@aau.ac.in](mailto:pranjal.neog@aau.ac.in);

Bioguard were applied treatment wise and mixed with soil before planting of bulbs. Observations on plant height and floral characteristics viz. spike length, rachis length, spike weight, number of floret per spike, floret length and nematode multiplication parameters like number of galls, egg masses per root system and final nematode population in soil were recorded.

**Results:** Upon observation results showed that all the treatments were significantly effective in increasing the plant height, floral characteristic and reducing the number of galls, eggmasses and final nematode population in soil as compared to that of untreated control. Highest plant height(46.50cm), spike length (66.33cm), spike weight (37.33g), rachis length(32cm), number of florets per spike(25.26) and floret length(4.66cm) was recorded in the treatment with Biover@5kg enriched with FYM 5t/ha, which was followed by the treatment with Biozium @5kg enriched with FYM 5t/ha and neem cake @ 1t/ha. Maximum reduction of number of galls (35.18%), eggmasses (31.79%) and final nematode population in soil (39.65%) was recorded in the treatment with Biover@5kg enriched with FYM 5t/ha.

**Conclusion:** From this experiment it can be concluded that all the bioformulations were found to be effective for increasing plant height, floral characteristic and reducing the nematode multiplication and these can be incorporated in root-knot nematode management programme. Among the bioformulations Biover was found to be most effective.

**Keywords:** Bioformulation; root-knot nematode; *Meloidogyne incognita*; tuberose.

## 1. INTRODUCTION

“Tuberose, *Agave amica* (Medik.) Thiede & Govaerts (Synonym *Polygonatum tuberosum* L.) is one of the most important bulbous ornamental plants, perennial in nature, belongs to the family Asparagaceae and sub-family Agavoideae. It is mainly cultivated for fragrant flowers; loose flowers used as garlands, floral decorations, extraction of tuberose oil and spikes as cut-flowers. In India tuberose is commercially cultivated in an area of about 21,970 ha, with a loose flower production of 1, 21,860 metric tonnes and cut flower production of 93,680 metric tonnes” [1]. “Among the states of India, tuberose is mainly cultivated in West Bengal, Karnataka, Tamil Nadu, Maharashtra, Orissa, Assam and Uttar Pradesh. Tuberose is very much prone to attack by several pests and diseases. Plant parasitic nematodes are considered as one of the important production constraints of tuberose cultivation. Among the plant parasitic nematodes, mostly three nematodes viz., root-knot nematode (*Meloidogyne* spp.), reniform nematode (*Rotylenchulus reniformis*) and foliar nematode (*Aphelenchoides besseyi*) are found to be pathogenic to tuberose cultivation” [2,3]. Root-knot nematode, *Meloidogyne incognita* has been considered as one of the limiting factor for commercial cultivation of tuberose [4]; which is responsible to cause 10-14% reduction in flower number and spike weight [5]. “Problems of root-knot nematode infestation in tuberose are widespread in most of tuberose growing fields of North and South Indian states” [6]. Root-knot

nematode infested plant show characteristic symptoms viz., production of heavy root galling (Fig. 1a & 1b), general stunting and chlorosis of leaves [7,8]. “The infestation of root-knot nematodes makes the tuberose plants more susceptible to attack by *Fusarium oxysporum* f.sp. *dianthi*” [9] “Nematodes also predispose the roots to easy entry of other soil borne fungal pathogens and the resulting nematode disease complex is responsible for drastic reduction in yield and financial loss to the growers. Plant parasitic nematodes can effectively be managed by application of synthetic nematicides, but indiscriminate use of nematicides has caused immense damages to the entire ecosystems. Therefore, in recent times, emphasis has been made on ecofriendly, non chemical methods of management of crop pests and diseases” [10,11]. Keeping these facts in view the present investigation was undertaken with the objective to evaluate the effectiveness of various bioformulations for management of root-knot nematode infecting tuberose.

## 2. MATERIALS AND METHODS

The experiment was conducted during April-September, 2024 in a naturally infested field with root-knot nematode, *M. incognita* at Biswanath College of Agriculture, AAU, Biswanath Chariali, Assam located at 26.7° (26°42') N latitude, 93.5° (93°30') E longitude and altitude of 105m AMSL. Details of the treatments are as mentioned in List 1.



Fig. 1a &1b. Galls on the roots of Tuberose

List 1. Treatments details

Sl. No.	Treatments
T <sub>1</sub> :	Neem cake@1t/ha (120g/plot)
T <sub>2</sub> :	Biozium ( <i>Trichoderma harzianum</i> ) @5kg enriched with FYM 5t/ha (0.6g enriched with FYM 0.6 kg/plot)
T <sub>3</sub> :	Biover ( <i>Trichoderma viride</i> )@5kg enriched with FYM 5t/ha (0.6g enriched with FYM 0.6 kg/plot)
T <sub>4</sub> :	Biomonas ( <i>Pseudomonas fluorescens</i> ) @5kg enriched with FYM 5t/ha (0.6g enriched with FYM 0.6 kg/plot)
T <sub>5</sub> :	AAU-Bioguard ( <i>Bacillus subtilis</i> ) @5kg enriched with FYM 5t/ha (0.6g enriched with FYM 0.6 kg/plot)
T <sub>6</sub> :	Neem leaf powder@5g/plant (60g/plot)
T <sub>7</sub> :	Untreated control.

The experiment was laid out in 1m x 1.2m plots (Fig. 2) with three replications per treatment following Randomized Block Design (RBD). Initial nematode population on the field was recorded before experimentation (240J<sub>2</sub>/200cc of soil). Land was thoroughly prepared by harrowing and laddering; plots were laid out as per the design of experiment. Each plot was separated from each other by 0.5m wide space. Bulbs of tuberose (var. Prajwal) were planted in each plot at a spacing of 30 cm from row to row and 30cm from plant to plant. All the bioformulations were applied treatment wise and mixed with soil before planting of bulbs. All other recommended practices were followed as per package of the crop.

“Observations on plant height and floral characteristics viz. spike length, rachis length, spike weight, number of floret per spike, floret length and nematode multiplication parameters

like number of galls, egg masses per root system and final nematode population in soil were recorded. From each plot randomly six plants were selected for recording the plant height and different floral characters and average were taken. For recording number of galls and eggmasses, from each plot six plants were uprooted randomly and numbers were calculated then average was taken. For estimation of population of *M. incognita*, soil samples consisting 10 cores were collected during the time of uprooting at a depth of 15-20cm from each plot using khurpi. Cores were composited and 200cc soil was used for nematode extraction by modified Cobb’s sieving and decanting technique” [12]. After extraction nematodes were counted in a counting dish using stereoscopic binocular microscope. Data were analyzed statistically using analysis of variance and Fisher’s least significant difference (FLSD) was calculated for separation of mean.



Fig. 2. View of the experiment

### 3. RESULTS AND DISCUSSION

Data presented in Table 1 indicated that all the treatments were found to be significantly effective in increasing the plant height and floral characters viz. spike length, spike weight, rachis length (Fig. 3), number of florets per spike, floret length etc. as compared to that of untreated control. Highest plant height(46.50cm), spike length (66.33cm), spike weight (37.33g), rachis length(32cm), number of florets per spike(25.26) and floret length(4.66cm) was recorded in the treatment with Biover@5kg enriched with FYM 5t/ha, which was followed by the treatment with Biozium @5kg enriched with FYM 5t/ha and neem cake @ 1t/ha. Lowest plant height and floral characteristic were recorded in untreated control. This might be due to soil application of bioformulations which increases the height of plant as well as floral characteristic. The influence of nematode infection probably caused reduction in plant height and floral characteristics. This finding is in conformity with the findings of previous research work made in the evaluation of bioformulations for management of root-knot nematode infecting tuberose [13]. In this work tested bioformulations viz., *Paecilomyces lilacinus*, *T. harzianum*, *P. fluorescens*, *Pochonia chlamydosporia* and neem cake were found to be effective for reduction of root-knot nematode infestation, nematode population and enhancement of cut flower yield of tuberose. In the present study

maximum plant height and floral characteristic was found in the treatments receiving Biover is because of it is more rhizospheric competent and have their direct influence on either plant's growth or induction of plant defensive activity against pathogens [14,15]. Application of *Trichoderma* spp found to improve the plant growth parameters through enzymatic activities in the treated *Lycopersicon* spp. which ultimately reduced the biotic potentiality of *M. incognita* [16].



Fig. 3. Rachis length

**Table 1. Effect of some bio-formulations on plant growth and floral characteristics of tuberose infested by *Meloidogyne incognita***

Treatments	Mean of 3 replications					
	Plant height (cm)	Spike length (cm)	Spike weight (g)	Rachis length (cm)	Number of florets /spike	Floret length (cm)
T <sub>1</sub> : Neem cake @1t/ha	45.73 <sup>a</sup>	64.86 <sup>a</sup>	35.33 <sup>b</sup>	29.73 <sup>c</sup>	23.33 <sup>b</sup>	3.90 <sup>bc</sup>
T <sub>2</sub> : Biozium @5kg enriched with FYM 5t/ha	45.96 <sup>a</sup>	65.26 <sup>a</sup>	36.00 <sup>ab</sup>	30.83 <sup>b</sup>	23.83 <sup>b</sup>	4.03 <sup>b</sup>
T <sub>3</sub> : Biover@5kg enriched with FYM 5t/ha	46.50 <sup>a</sup>	66.33 <sup>a</sup>	37.33 <sup>a</sup>	32.00 <sup>a</sup>	25.26 <sup>a</sup>	4.66 <sup>a</sup>
T <sub>4</sub> : Biomonas@5kg enriched with FYM 5t/ha	43.26 <sup>b</sup>	62.26 <sup>b</sup>	31.96 <sup>c</sup>	29.23 <sup>c</sup>	21.50 <sup>c</sup>	3.70 <sup>bc</sup>
T <sub>5</sub> : AAU-Bioguard @5kg enriched with FYM 5t/ha	41.80 <sup>b</sup>	61.00 <sup>b</sup>	30.04 <sup>cd</sup>	29.03 <sup>cd</sup>	20.16 <sup>d</sup>	3.36 <sup>cd</sup>
T <sub>6</sub> : Neem leaf powder @5g/plant	39.03 <sup>c</sup>	60.13 <sup>b</sup>	28.93 <sup>d</sup>	28.06 <sup>d</sup>	18.66 <sup>e</sup>	3.10 <sup>de</sup>
T <sub>7</sub> : Control	35.46 <sup>d</sup>	53.43 <sup>c</sup>	22.46 <sup>e</sup>	26.56 <sup>e</sup>	17.20 <sup>f</sup>	2.76 <sup>e</sup>
S.E(d)	0.95	1.13	0.88	0.48	0.33	0.25
CD(P=0.05)	2.07	2.46	1.93	1.05	0.73	0.56

\*Means are grouped with Least Square Difference (LSD)

\*\* Mean followed by the same letter shown in superscript are not significantly different

**Table 2. Effect of some bioformulations on multiplication of *Meloidogyne incognita***

Treatments	Mean of 3 replications					
	Number of galls/plant	% decrease over control	Number of eggmasses /plant	% decrease over control	Final nematode population in soil (200cc)	% decrease over control
T <sub>1</sub> : Neem cake @1t/ha	27.96 <sup>bc</sup>	27.99	29.29 <sup>b</sup>	26.46	182.67 <sup>cd</sup>	35.91
T <sub>2</sub> : Biozium @5kg enriched with FYM 5t/ha	27.29 <sup>bc</sup>	29.72	28.96 <sup>b</sup>	27.29	176.00 <sup>d</sup>	38.25
T <sub>3</sub> : Biover@5kg enriched with FYM 5t/ha	25.17 <sup>c</sup>	35.18	27.17 <sup>b</sup>	31.79	172.00 <sup>d</sup>	39.65
T <sub>4</sub> : Biomonas@5kg enriched with FYM 5t/ha	28.62 <sup>bc</sup>	26.29	30.62 <sup>b</sup>	23.12	185.33 <sup>c</sup>	34.97
T <sub>5</sub> : AAU-Bioguard @5kg enriched with FYM 5t/ha	30.19 <sup>bc</sup>	22.25	32.19 <sup>b</sup>	19.18	195.00 <sup>c</sup>	31.58
T <sub>6</sub> : Neem leaf powder @5g/plant	31.86 <sup>b</sup>	17.95	33.16 <sup>b</sup>	16.75	214.33 <sup>b</sup>	24.79
T <sub>7</sub> : Control	38.83 <sup>a</sup>	-	39.83 <sup>a</sup>	-	285.00 <sup>a</sup>	-
S.E(d)	2.76		2.85		5.94	
CD(P=0.05)	6.09		6.28		13.08	

\*Means are grouped with Least Square Difference (LSD)

\*\* Mean followed by the same letter shown in superscript are not significantly different

“Results presented in Table 2 indicated that all the treatments were significantly effective in reducing the number of galls, eggmasses and final nematode population in soil as compared to that of untreated control. Maximum reduction of number of galls (35.18%), eggmasses (31.79%) and final nematode population in soil (39.65%) was recorded in the treatment with Biover@5kg enriched with FYM 5t/ha, which was followed by the treatment with Biozium @5kg enriched with FYM 5t/ha and neem cake @ 1t/ha. Similar findings were also recorded in different studies by the application of *T. viride* and *T. harzianum* against root-knot nematode infecting different field and horticultural crops” [17,18]. “The antagonistic effect of *T. viride* might be due to several actions, such as mycoparasitism, spatial and nutrient competition, induced systemic resistance, antibiosis by enzymes and secondary metabolites” [19]. “Soil application of *T. harzianum* induce defense-related enzymatic activity like peroxidase (PO), polyphenol oxidase (PPO), phenylalanine ammonia lyase (PAL) and total phenol content in tomato against *M. incognita* and as a result improved the plant growth parameters viz., plant height, fresh and dry weight and shoot and root” [20].

#### 4. CONCLUSION

The experimental findings clearly indicate that all the bioformulations were found to be effective in increasing the plant height, floral characteristic of tuberose and reducing the nematode multiplication. These bioformulations can effectively be used for root-knot nematode management strategies as ecofriendly approach. Among the bioformulations, Biover was found to be most effective and it can be easily mass multiplied in the laboratory for large scale use.

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Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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