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**Swatilekha Mohanta**
College of Agriculture,
Odisha University of Agriculture and Technology, Chiplima, Sambalpur, Odisha, India

**Corresponding Author:**
**Swatilekha Mohanta**
College of Agriculture,
Odisha University of Agriculture and Technology, Chiplima, Sambalpur, Odisha, India

# Comparative efficacy of Bio-control agents for management of *Meloidogyne incognita* in Turmeric

**Swatilekha Mohanta**

**Abstract**
Odisha's tribal farmers mainly depend on the valuable cash crop turmeric (*Curcuma longa* L.) for their livelihood. In spite of the favorable agro climatic conditions, Odisha's turmeric productivity is very low due to different biotic and abiotic factors. Among different biotic factors, root knot nematode infection is very important as it not only decrease the yield but also reduce the curcumin content of the turmeric. As there is increasing demand for organic turmeric, a field experiment was carried out in the College of Agriculture, OUAT, Chiplima, Sambalpur to investigate bio-control potentials of *Paecilomyces lilacinus* and *Pochonia chlamydosporia* along with nematicide carbofuran 3G and a standard check for management of *Meloidogyne incognita* in turmeric (cv. Rajendra Sonia). Application of all the treatments significantly enhanced plant growth, rhizome yield and decreased root-knot index including population of nematodes in soil and root over check. Among all the treatments, *Pochonia chlamydosporia* @ 2.5 kg/ha was most effective with highest plant height, rhizome yield and lowest infectivity of turmeric to *M. incognita.*

**Keywords:** Turmeric, *Meloidogyne incognita*, *Pochonia chlamydosporia*, *Paecilomyces lilacinus*, carbofuran, management

## Introduction
Turmeric (*Curcuma longa* L.) is one of the most important and ancient spices of India, known as "Indian saffron". India has the distinction to become largest producer, consumer and exporter of turmeric in the world market and as such there is a huge demand for Indian turmeric and more specifically to Odisha turmeric due to it's pesticide free organic production. The yield of this high value cash crop is decreasing day by day due to several biotic and abiotic stresses. Among all biotic stresses, the root-knot nematode, *Meloidogyne incognita* is a major problem in turmeric cultivation (Bai *et al.* 1995 and Ray *et al*. 1995) [1]. *M. incognita* is an obligate parasite has been found to be frequently associated in almost all the turmeric growing tracts of India. Considering the ban on many nematicides and increasing demand for organic turmeric, the present study was undertaken to manage *M. incognita* in turmeric with bio-control agents.

## Materials and Methods
A replicated field trial was conducted during 2021-22 in a *M. incognita* pre-infested field in the College of Agriculture, O.U.A.T., Chiplima. Pre irrigation of the field was done followed by ploughing, pulverization of soil and labeling by laddering. Composite soil samples were taken from the entire field to estimate the mean number of *M. incognita* juveniles / 250 g soil. The entire field was divided into five blocks having four beds each measuring 4×1 $m^2$ raised to a height of 0.15 m. Basal fertilizers @ 30 kg $P_2O_5$/ha and 45 kg $K_2O$/ha were applied in all the beds. Four treatments comprising of untreated check ($T_1$), Carbofuran @ 1.5 kg a.i / ha (T2), *Paecilomyces lilacinus* @ 2.5 kg/ha ($T_3$), *Pochonia chlamydosporia* @ 2.5 kg / ha ($T_4$) were selected for comparison. Prior to the application of *Pochonia chlamydosporia* and *Paecilomyces lilacinus*, the recommended dosages of both the bio-control agents were mixed with recommended dose of FYM (5t/ha) and pre incubated by covering with a black polythene sheet in shade for 15 days followed by turning at 5 days interval for aeration. The incubated biocontrol agents along with the carbofuran 3G and standard check were randomly applied in the beds in each block independently. FYM as such was applied in the beds receiving carbofuran and check treatments. Healthy turmeric rhizomes (cv. Rajendra Sonia) of 15 - 20 g having at least two buds were planted in the beds with a spacing of 30 cm × 20 cm at 5 cm depth during April followed by mulching and irrigation.

All intercultural operations and nitrogen top dressing @ 30 kg / ha were taken up at 45 days and 90 days after planting. Observation on plant height was recorded at the maximum growth stage of the plants (150 days after planting). Rhizome yield, root-knot index, final soil and root nematode population were recorded after harvesting. Data on different parameters were statistically analyzed after suitable transformation specific to data in a two factor randomized block design and percentage increase or decrease over check was calculated.

**Results and Discussion**

Effect of the bio-control agents and chemical nematicide on plant height, rhizome yield, root-knot index, population of nematodes in soil and root were presented in Table-1 and Fig.-1. The initial *M. incognita* population in soil as recorded in all beds prior to application of different treatments exhibited significant differences among themselves which ranged between 1696.20 and 2163.40. Perusal of data indicated increase in plant height, rhizome yield and decrease in root-knot index, final soil and root population of *M. incognita* over check in different treatments. Maximum plant height (2.03 m) and rhizome yield (2.56 kg/m$^2$) was recorded in T4 (*Pochonia chlamydosporia* @ 2.5 kg / ha) followed by T3 (*Paecilomyces lilacinus* @ 2.5 kg / ha) and T2 (carbofuran @ 1.5 kg a.i / ha) which were significantly different from check excepting plant height recorded in carbofuran treatment. The increase in plant height and rhizome yield over check ranged from 3.82 to 29.30 and 30.70 to 80.49 per cent respectively. Final soil nematode population estimated after harvest exhibited significant decline over initial soil population as well as check. The maximum decrease in root-knot index (1.8), final soil nematode population (575.20) and nematode population in root (2180.40) was recorded in T4 (*Pochonia chlamydosporia* @ 2.5 kg/ha) followed by T3 (*Paecilomyces lilacinus* @ 2.5 kg/ha) and T2 (carbofuran @ 1.5 kg a.i/ha). The decrease in root-knot index ranged from 50.00 to 62.50 per cent, final soil nematode population from 40.56 to 74.82 per cent and nematode population in root from 31.17 to 84.90 per cent over check. Bontempo *et al*. (2014) [2], Dias-Arieira *et al*. (2011) [4], Dhawan and Satyendra (2009) [3] and Eapen *et al*. (2008) [5] have reported increase in crop quality and yield and decrease in *M. incognita* reproduction factors and final nematode population in soil by application of *Pochonia chlamydosporia* isolate Pc-10 in carrot, lettuce, okra and turmeric respectively similar to the present study. Likewise Kieenick and Sikora (2006) [6] and Pau *et al*. (2012) [8] reported reduction in root galling, nematode population in root and other nematode parameters by application of *Paecilomyces lilacinus* in tomato and black pepper respectively as reported in the present investigation. Increase in plant height and reduction in the rhizome yield and root-knot index in turmeric due to application of carbofuran is in confirmity with the findings of Mohanta and Swain (2014) [7].

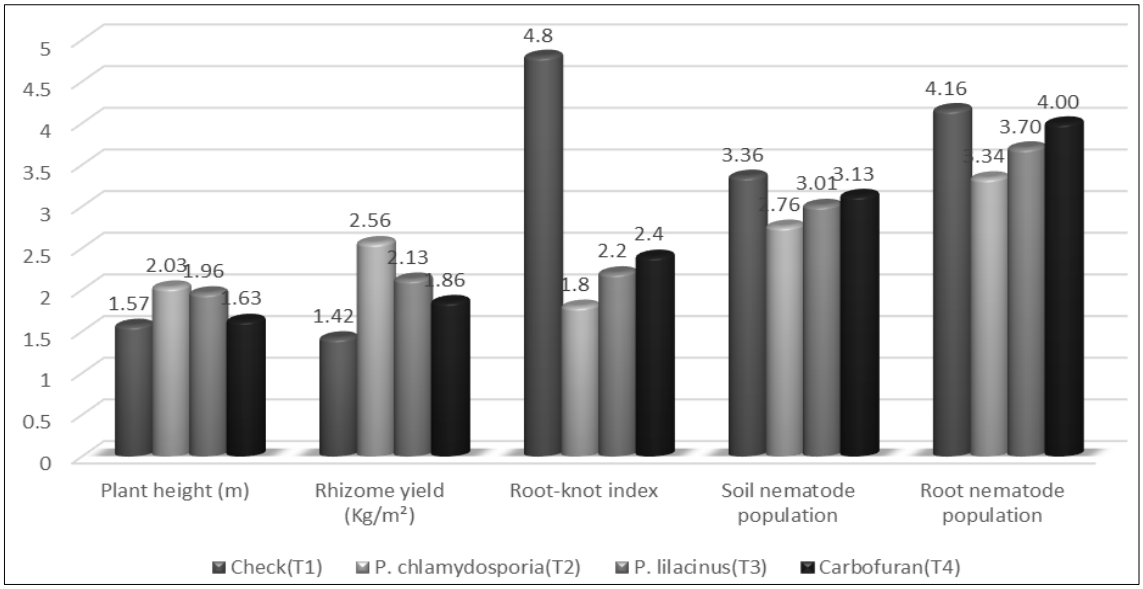


**Fig 1:** Histogram showing effects of nematicide and biocontrol agents on plant growth, yield and nematode parameters in turmeric infected with *M. incognita*

**Table 1:** Effect of biocontrol agents and nematicide on plant growth, yield and infectivity of turmeric to *M. incognita*

| Treatments | Initial nematode population/ 250 cc soil | Plant height (m) | % increase | Rhizome yield (Kg/m$^2$) | % increase | Root-knot index | % decrease | Final Soil nematode population (250 cc) | % decrease | Root population (0.5 g) | % decrease |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Check ($T_1$) | 1980.80 (3.29) | 1.57 | - | 1.42 | - | 4.80 | - | 2284.8 (3.36) | - | 14437.60 (4.16) | - |
| Carbofuran ($T_2$) | 1696.20 (3.23) | 1.63 | 3.82 | 1.86 | 30.70 | 2.40 | 50.00 | 1356.0 (3.13) | 40.65 | 9937.60 (4.0) | 31.17 |
| *P. lilacinus* ($T_3$) | 1877.00 (3.27) | 1.96 | 24.84 | 2.13 | 49.56 | 2.20 | 54.17 | 1027.20 (3.01) | 55.04 | 5025.20 (3.70) | 65.19 |
| *P. chlamydosporia* ($T_4$) | 2163.40 (3.33) | 2.03 | 29.30 | 2.56 | 80.49 | 1.80 | 62.50 | 575.20 (2.76) | 74.82 | 2180.40 (3.34) | 84.9 |
| Mean | (3.28) | 1.80 | | 1.99 | | 2.80 | | (3.07) | | (3.80) | |
| SE(m) | (0.02) | 0.02 | | 0.03 | | 0.24 | | (0.02) | | (0.02) | |
| CD(5%) | (0.06) | 0.06 | | 0.10 | | 0.73 | | (0.05) | | (0.05) | |
| CV | (1.33) | 2.61 | | 3.63 | | 19.01 | | (1.27) | | (1.02) | |

*Figures in parentheses indicate log transformed value

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