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Original Research Article

Eco Friendly Management of Root-Knot Nematode (*Meloidogyne incognita*) Infecting Okra in Odisha, India

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A B S T R A C T

A field experiment was conducted in root-knot nematode infested plot during kharif 2016 to evaluate the efficacy of liquid bioagents viz., *Purpureocillium lilacinum* and *Pochonia chlamydosporia* in integration with an organic bio fertilizer (vermicompost). Apart from that, a chemical treatment (Seed soaking with carbosulfan 25 EC @ 0.2% for 12 h before sowing + soil application of carbofuran @ 1 kg a.i./ha) was used as standard check. The result revealed that, all the treated plots along with chemicals significantly increased the plant growth parameters and reduced root knot nematodes multiplication over untreated check. Seed treatment with *Purpureocillium lilacinum* @ 5 ml/kg + soil application of vermicompost @ 2.5 ton/ha enriched with *P. lilacinum* (@ 10 ml/kg recorded highest increase of 51.28 %,87.0%, 55.53%, 67.62% in plant height, root length, shoot dry weight, root dry weight over untreated check recpectively with reducing final nematode population in soil (171.0 J_2/200cc soil) and in root of okra (41.25/ 5g. root) with the lowest root knot index (2.0) followed by seed treatment with *Pochonia chlamydosporia* @5 ml/ kg+ soil application of vermicompost @ 2.5 ton/ha enriched with *P. chlamydosporia* (@ 10 ml/kg. Moreover, seed treatment with *P. lilacinum* @ 5 ml/kg + soil application of vermicompost @ 2.5 ton/ha enriched with *P. lilacinum* (@ 10 ml/kg gave the highest fruit yield (7.19 ton/ha) which was 36.6% higher than un treated plot (5.26 ton/ha) and performed as the most economical treatment than other treatments except chemicals for root-knot nematode management in okra with highest incremental cost-benefit ratio of 2.75.

Keywords

Purpureocillium lilacinum, *Pochonia chlamydosporia*, okra and *M. incognita*

Introduction

Okra, *Abelmoschus esculentus* (L) Moench is of tropical African origin and belongs to family Malvaceae. It is generally marketed in fresh state but sometimes, in canned or dehydrated form also. Besides supporting a complex of insects and other pests, okra is also susceptible to nematode attack. Root knot nematodes occasionally cause complete crop loss under adverse growing conditions, but even in an ideal environment losses up to 50% or more are not uncommon. The damage results in the reduction of qualitative and quantitative production of okra. Yield losses to the extent of 90% in okra by root knot nematode infestation have been reported from India (Bhatti and Jain 1977). The estimated overall annual yield loss in okra due to *Meloidogyne incognita* only has been reported more than Rs. 480.00 million in terms of monetary loss (Jain *et al.*, 2007). Management practices involving chemicals is not economical besides its toxic effects in soil, plant and ground water and is rarely followed in subsistence crops like

pulses as these crops are predominantly grown in marginal lands with low input supply. To manage the nematode chemicals proved effective but their hazardous effects and non judicious use has enhanced the development of biological control strategies for management of plant parasitic nematodes with various types of antagonistic organisms (Jatala, 1986). Hence, a promising alternative is the use of ecofriendly bio-control agents like *Purpureocillium lilacinum* and *Pochonia chlamydosporia* in liquid formulation. The present study explores the efficacy of liquid bioagents viz., *Purpureocillium lilacinum* and *Pochonia chlamydosporia* in integration with an organic bio fertilizer (vermicompost) for management of *Meloidogyne incognita* in okra.

Materials and Methods

A field experiment was conducted in sick plots to evaluate the study the efficacy of *Purpureocillium lilacinum* and *Pochonia chlamydosporia* in liquid formulation towards management of root-knot nematode, *Meloidogyne incognita* infesting okra.The experiment was conducted in Randomised Block Design with five treatments and four replications. The five treatments comprising of treatments such as, T_1-Seed treatment with *Purpureocillium lilacinum* @ 5 ml/kg followed by soil application of vermicompost @ 2.5 ton/ha enriched with *P. lilacinum* (@ 10 ml/kg), T_2 - Seed treatment with *Pochonia chlamydosporia* @5 ml/ kg followed by soil application of vermicompost @ 2.5 ton/ha enriched with *P. chlamydosporia* (@ 10 ml/kg), T_3 - Seed treatment with *P. lilacinum* @ 2.5 ml/kg + *Pochonia chlamydosporia* @ 2.5 ml/kg followed by soil application of vermicompost @ 2.5 ton/ha enriched with *P. lilacinum* and *Pochonia chlamydosporia* (each @ 5 ml/kg), T_4 -Seed soaking with carbosulfan 25 EC @ 0.2% for 12 h before sowing followed by soil application of carbofuran @ 1 kg a.i./ha, T_5 -Untreated control. The bio-agents (*Purpureocillium lilacinum* and *Pochonia chlamydosporia* each at cfu 2x 10^6) in liquid formlation were collected from AICRP centre, Assam (Jorhat) and applied in appropriate dosage as per the treatments designed. Seed treatment with *P. lilacinum* and *P. chlamydosporia* formulations in two different doses of 5 ml/kg seeds individually and in a combination of 2.5ml + 2.5ml /kg seeds. One chemical check with carbosulfan 25 EC @ 0.2% and another untreated check were kept for comparison. Seeds were soaked in 0.2% carbosulfan 25 EC for 12 h before sowing. Treated okra seeds (Utkal Gaurav) were partially dried under shade and sown in plots each of 3.0 X 2.0 m net area of nematode sick field. The average initial nematode population was estimated as 206 per 200cc soil before sowing of seeds. Ninety days after sowing, the crop was harvested and data on plant growth and nematode multiplication in soil as well as in roots (average of 10 plants in each replication, which were selected randomly) were recorded. At the time of termination, each plant was removed carefully from the soil and observation on different plant growth parameters viz. shoot length, root length, dry weight of shoots and roots and yield were taken. Incremental cost-benefit ratio (ICBR) of each treatment was calculated. Also different nematode growth parameters viz. number of galls per plant, final nematode population per 200 cc soil and 5g were recorded. Root knot index (1-5 scale) of each plant was calculated on the basis of number of galls per plant (1: No gall/ plant, 2:1-10 galls/ plant, 3: 11-30 galls/ plant, 4: 31-100 galls/ plant, 5: more than 100 galls/ plant). At the time of harvest, five grams infected root from each replication were stained in Acid fuchsin

stained lactophenol solution to count the final nematode population in root. Fisher's methods of analysis of variance at 5% level of significance were followed. The difference between two treatments means if greater than the LSD value indicated the significant difference between the treatments.

Results and Discussion

The effect bio agents, *Purpureocillium lilacinum* and *Pochonia chlamydosporia* in combination with an organic bio fertilizer (vermicompost) on root knot nematode (*Meloidogyne incognita*) infecting okra was estimated on the basis of the differential changes in plant growth parameters (shoot length, root length, dry shoot and root weight & yield) and nematode infection parameter as number of galls and the reproductive growth of nematode population. The observed data have been compiled in a tabular form and were subjected to statistical analysis in order to test the significance of various treatments on plant growth and the nematode population. Maximum average plant height (160.05 cm) was recorded in the treatment T_1 (seed treatment with *Purpureocillium lilacinum* @ 5 ml/kg followed by soil application of vermicompost @ 2.5 ton/ha enriched with *P. lilacinum* @ 10 ml/kg) with an increase of 51.28 % over untreated check (105.8 cm) and significantly differ from other treatments followed by T_2 (Seed treatment with *Pochonia chlamydosporia* @5 ml/ kg followed by soil application of vermicompost @ 2.5 ton/ha enriched with *P. chlamydosporia* (@ 10 ml/kg. Maximum root length of 51.80 cm was recorded in the treatment T_1 with an increase of 87.0 % over untreated check (27.70 cm) and significantly differ from rest treatments followed by T_2. The treatment (T_1) recorded highest dry weight of shoot (24.03g) and root (8.18g) with 55.53 % and 67.62 % increase over check (15.45g and 4.88g) respectively followed by T_2 (Table 1).

Table.1 Effect of bio-agents on plant growth parameters in okra (cv.Utkal Gaurav) infected by Meloidogyne incognita

Treatments	Plant height (cm)	% increas	Root length (cm)	% increas	Dry shoot wt (g)	% increas	Dry root wt (g)	% increas
T_1	160.05	51.28	51.80	87.00	24.03	55.53	8.18	67.62
T_2	147.05	38.99	45.28	63.47	23.38	51.33	8.05	64.96
T_3	140.70	32.99	38.93	40.54	21.15	36.89	6.67	36.68
T_4	133.20	25.90	34.70	25.27	18.38	18.96	6.21	27.25
T_5	105.80		27.70		15.45	55.53	4.88	67.62
S.E(m) ±	2.65		1.04		0.39		0.23	
CD (0.05)	8.16		3.19		1.21		0.71	

T_1-Seed treatment with *Purpureocillium lilacinum* @ 5 ml/kg followed by soil application of vermicompost @ 2.5 ton/ha enriched with *P. lilacinum* (@ 10 ml/kg), **T_2** - Seed treatment with *Pochonia chlamydosporia* @5 ml/ kg followed by soil application of vermicompost @ 2.5 ton/ha enriched with *P. chlamydosporia* (@ 10 ml/kg), **T_3** - Seed treatment with *P. lilacinum* @ 2.5 ml/kg + *Pochonia chlamydosporia* @ 2.5 ml/kg followed by soil application of vermicompost @ 2.5 ton/ha enriched with *P. lilacinum* and *Pochonia chlamydosporia* (each @ 5 ml/kg), **T_4** -Seed soaking with carbosulfan 25 EC @ 0.2% for 12 h before sowing followed by soil application of carbofuran @ 1 kg a.i./ha, **T_5** -Untreated control

Table.2 Effect of bio-agents on M. incognita growth parameters in okra(cv.Utkal Gaurav)

Treatments	Final Nematode Population				RKI	Yield (t/ha)	% increase over check	ICBR
	200 cc Soil	% decrease over check	5g Root	% decrease over check				
T_1	171.00 (13.04)*	52.9	41.25 (6.41)	60.2	2.00	7.19	36.7	2.75
T_2	216.25 (14.70)	40.5	54.06 (7.35)	47.8	2.75	7.10	34.9	2.62
T_3	246.50 (15.68)	32.2	66.75 (8.16)	35.6	3.25	6.97	32.5	2.44
T_4	202.50 (14.21)	44.3	42.13 (6.49)	59.3	2.50	6.02	14.4	3.04
T_5	363.75 (19.04)		103.75 (10.18)		4.50	5.26		
S.E(m) ±	**(0.39)**		**(0.02)**		**0.27**	**0.10**		
CD (0.05)	**(1.21)**		**(0.62)**		**0.83**	**0.31**		

*** Figures in parentheses are square root transformed values**

T_1-Seed treatment with *P. lilacinum* @ 5 ml/kg followed by soil application of vermicompost @ 2.5 ton/ha enriched with *P. lilacinum* (@ 10 ml/kg), **T_2** - Seed treatment with *P. chlamydosporia* @5 ml/ kg followed by soil application of vermicompost @ 2.5 ton/ha enriched with *P. chlamydosporia* (@ 10 ml/kg), **T_3** - Seed treatment with *P. lilacinum* @ 2.5 ml/kg + *P. chlamydosporia* @ 2.5 ml/kg followed by soil application of vermicompost @ 2.5 ton/ha enriched with *P. lilacinum* and *P. chlamydosporia* (each @ 5 ml/kg), **T_4** -Seed soaking with carbosulfan 25 EC @ 0.2% for 12 h before sowing followed by soil application of carbofuran @ 1 kg a.i./ha, **T_5** -Untreated control.

All the treatments including chemical significantly reduced the nematode multiplication over check as seen from number of galls, nematode population and root knot index (Table 2). The treatment (T_1) recorded lowest final nematode population in soil (171.0) with highest reduction (52.9%) over check (363.75) followed by T_4 - seed soaking with carbosulfan 25 EC @ 0.2% for 12 h before sowing and soil application of carbofuran @ 1 kg a.i. /ha (202.5). The reduction (60.24%) of nematode population in 5g root over check (103.75) was recorded in T_1 (41.25) followed by T_4 (42.13). Lowest root knot index (2.0) was recorded in T_1 followed by T_2 (2.5). On the other hand significantly highest fruit yield (7.19 t/ha) was recorded from T_1 followed by T_2 (7.10 t/ha) and T_3 (6.97 t/ha) which were at par. However highest ICBR 2.75 was obtained from T_1 among the bioagents followed by T_2(2.62) (Table 2). This finding was agreement with De Leiz *et al.*, (1993), who reported the significant reduction (80%) in nematode population by using *Paecilomyces lilacinus* against *Meloidogyne incognita* in tomato. It also corroborated with the findings of Shikora (2006), who reported that pre planting soil treatment of *Paecilomyces lilacinus* in tomato reduced root galling by 66%, number of egg masses by 74% and final nematode population in roots by 71% compared to the untreated check. Several authors have proved the efficacy of bacterial and fungal bioagents used as seed treatment

in reducing *M. incognita* populations (Kumar *et. al.,* 2012 and Sharma and Trivedi). *Purpureocillium lilacinum* degrades chitin and is strongly proteolytic (Endreeva *et al*, 1972) and the egg shell of *M. incognita* is made up of mostly protein and chitin (Bird and Mc Clure, 1976). Therefore, *P. lilacinus* is a promising egg parasitic fungus against root-knot nematodes as observed in this study, compared to other fungal bioagents. Goswami and Mittal (2002) reported greatest egg parasitizing efficiency of *Purpureocillium lilacinum*(80%) as compared to other fungi. Fungal propagules colonised on egg masses and eggs inside the egg masses were parasitized by fungus, due to which egg content was reduced and some eggs were found deformed. Similar types of results were also noted by Simon and Pandey (2010) in okra. *Pochonia chlamydosporia* was also reported to parasitize the eggs and egg masses of the root-knot nematodes (De Leij and Kerry, 1991; Kerry *et al.,* 1993). It also corroborated with the findings of Dhawan *et al.,* (2004), who reported that pre planting soil treatment of *Purpureocillium lilacinum*in tomato reduced root galling by 66%, number of egg masses by 74% and final nematode population in roots by 71% compared to the untreated check. Keeping in view above investigation, Seed treatment with *Purpureocillium lilacinum* @ 5 ml/kg + soil application of vermicompost @ 2.5 ton/ha enriched with *P. lilacinum* (@ 10 ml/kg could be used as a variable option to manage the root-knot nematode population in okra.

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