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Evaluation of the efficacy of different bio-agents for the management of root knot nematode, *Meloidogyne incognita* on Chilli (*Capsicum frutescens* L.) in field conditions

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Abstract
Capsicum frutescens is a species of the plant genus *Capsicum* which is known to have its origin in Mexico. Chilli is considered as one of the important commercial spice crops. Root-knot nematodes are a major threat in the production of various crops, widely distributed in all over the world. Root-knot nematodes (*Meloidogyne* spp.) attack different kinds of crops all over the world and cause enormous crop damage. In cases where seedling infection has taken place numerous plants die in the seed bed and seedlings do not survive. Different bio-agents viz., *Purpurocillium lilacinum, Pseudomonas fluorescens* were used to control the root-knot Nematode, *Meloidogyne incognita*. Three doses (2, 4 and 8 g/m^2) were taken for the evaluation of these bioagents. Experiment was conducted in micro stripes at RCA Instructional farm during *Kharif,* 2018. Observation of nematode reproduction parameters viz., Number of females in 5 gm roots, Number of egg masses in 5 gm roots, Number of eggs and larvae per egg mass, final nematode population and yield of the chilli crop were recorded. Best results was recorded in the case of *Purpurocillium lilacinum* @8 g/m^2 followed by *Pseudomonas fluorescens* @ 8 g/m^2.

Keywords: Root knot nematode, chilli, bio-agents, micro stripes, *Capsicum frutescens, Meloidogyne incognita, Purpurocillium lilacinum, Pseudomonas fluorescens, Trichoderma viride*

Introduction

Capsicum frutescens is a species of the plant genus *Capsicum* which is known to have its origin in Mexico. Chilli is considered as one of the important commercial spice crops. A number of nematode problems of national importance have emerged. Root knot nematodes are prevalent in 90% of agricultural crops and considered to be the major problem. Root-knot nematodes are a major threat in the production of various crops, widely distributed in all over the world. Several nematodes are known to be associated with chili, out of which *Meloidogyne* spp., *Rotylenchulus* spp., *Heterodera* spp., *Pratylenchus* spp., *Tylenchorhynchus* spp., *Helicotylenchus* spp. and *Hoplolaimus* spp. are most common (Jatala p., 1985) [3]. Among these Root knot nematode i.e., *Meloidogyne incognita* is considered to be the more serious pest causing not only direct losses but also indirectly by interacting with other pathogens. Plant parasitic nematode caused 12.2% loss on production of chili on global scale (Sasser and Frekman, 1987) [8]. Root knot disease caused by *Meloidogyne incognita* is thus one of the limiting factors in the production of chilli. A national loss due to this nematode pest was worked out 12.85% and in monetary terms has been worked out to be 210 million rupees (Jain *et al.,* 2007) [3]. In view of the many management practices that have been developed and included in package of practices, however, work on biological management of *Meloidogyne incognita* on chilli is lacking and is essential.

Materials and methods

For the evaluation of efficacy of bio-agents bhagya lakshmi variety of chilli are sown in nursery and transplanted on micro stripes later on. The root knot nematodes population was measured by sieving and decanting technique given by Cobb, 1918 [2] followed by Baermann's funnel technique which was earlier mentioned in Christie and Perry, 1951 [1] before transplanting of chilli seedlings. The infested roots were washed thoroughly and stained with 0.1% acid fuschin lacto phenol at 80 ^{o}C for 2-3 minutes as per method given by Mc Beth *et al.* 1941 [6]. Thereafter infested roots was washed in tap water and kept in clear lacto phenol for 24 hours and examined under stereoscopic binocular microscope. The females was teased out from the roots after stained and perineal pattern were prepared (Taylor and Netscher, 1974) [10] compared and recognized as *Meloidogyne incognita* with the help of 'key' given by Taylor *et al*. (1955) [9].

The experiment was conducted using bio-agents *i.e. Purpurocillium lilacinum* and *Pseudomonas fluorescens* were used in different treatments at 2, 4 and 8 g applied along with FYM and the mixture was applied around the transplanted plants of chilli. A standard check of *Trichoderma viride* and untreated check was also maintained for comparison of experimental results.

The experiment was laid out in randomized block design in micro stripes and all the treatments were replicated three times. Data was analyzed using analysis of variance (ANOVA) as per standard method of randomized block design.

Results

The results of experiments showed that the different bio-agents namely *Purpurocillium lilacinum* and *Pseudomonas fluorescens* had significantly reduced the number of females per 5 g root, number of egg masses per 5 g root, number of egg and larval masses per egg mass & final nematode population/200 cc soil and considerably increase the yield (kg/plot) of chilli crop as compared to standard check (*Trichoderma viride*). Among both bio-agents, *Purpurocillium lilacinum* was better as compared to *Pseudomonas fluorescens* for the management of *Meloidogyne incognita* on chilli crop. The yield of chillies in kg/ plot was calculated by 3 pickings during the crop period till harvest to determine the effect of different bio-agents. The mean yield was ranged between 0.92 kg/ plot to 1.54 kg/ plot from Table.1. Different bio-agents were found to influence the nematode reproduction and plant yield to a varied degree. However *Purpurocillium lilacinum* @ 8 g/m^2 was found better as compared to *Pseudomonas fluorescens* at 8 g/m^2 in terms of the reduction of number of females per 5 g root, number of egg masses per 5 g root, number of egg and larvae per egg mass & final nematode population/ 200cc soil and considerably increased the yield (kg/plot) of chilli crop from Fig.1.

Our results showed maximum similarity with previous researchers work namely shanmuga and kumar (2006) [7] who studied the biological control potential of talc based formulation of *Purpurocillium lilacinus* at 4 g/3kg soil on *Meloidogyne incognita* on tomato under glass house conditions as soil application. It recorded the lowest nematode population and higher yield on tomato. Same trends were found with kiewinck and sikora (2006) [5] who used *Paecilomyces lilacinus* strain 251 to control the root-knot nematode *Meloidogyne incognita* who recorded reduction in root galls by 66%, number of egg masses by 74% and the final nematode population in the roots by 71% compared to the inoculated control on tomato on growth chamber experiments at pre-planting soil treatment.

Table 1: Efficacy bio-agents against root-knot nematode, *Meloidogyne incognita* as soil application on chilli

Sr. No	Details of treatment	Number of females per 5 g root	Number of egg masses per 5g root	Number of eggs and larvae per egg mass	Final nematode population/200cc soil	Yield (kg/plot)
1.	*Purpurocillium lilacinum* @ 2g/m^2	18.00 (15.61)	15.67 (22.92)	56.33 (41.32)	833.33 (18.30)	1.31 (42.39)
2.	*Purpurocillium lilacinum* @ 4g/ m^2	17.33 (18.75)	15.00 (26.21)	56.00 (41.66)	806.67 (20.91)	1.45 (57.60)
3.	*Purpurocillium lilacinum* @ 8g/m^2	16.67 (21.84)	12.67 (35.91)	47.33 (50.69)	796.67 (21.89)	1.48 (60.86)
4.	*Pseudomonas fluorescens* @ 2g/m^2	19.33 (9.37)	17.00 (16.37)	63.33 (34.03)	836.67 (17.97)	1.23 (33.69)
5.	*Pseudomonas fluorescens* @ 4g/ m^2	17.67 (17.15)	16.00 (21.29)	59.67 (37.84)	813.33 (20.26)	1.40 (52.17)
6.	*Pseudomonas fluorescens* @ 8g/m^2	17.00 (20.30)	14.67 (27.84)	54.00 (43.75)	800.00 (21.56)	1.45 (57.60)
7.	*Trichoderma viride* @ 2.5 kg/ha	12.67 (40.60)	10.67 (47.51)	46.00 (52.08)	773.33 (24.18)	1.54 (67.39)
8.	Untreated	21.33	20.33	96.00	1020.00	0.92
CD		0.92	0.67	2.37	36.09	0.10
SEm±		2.62	1.95	6.94	105.59	0.31

*figures in (parenthesis) are% inc/dec over control
Data are the average of three replication
Size of the plot is 3 Sq m
Initial nematode population is 480 larvae/200cc soil

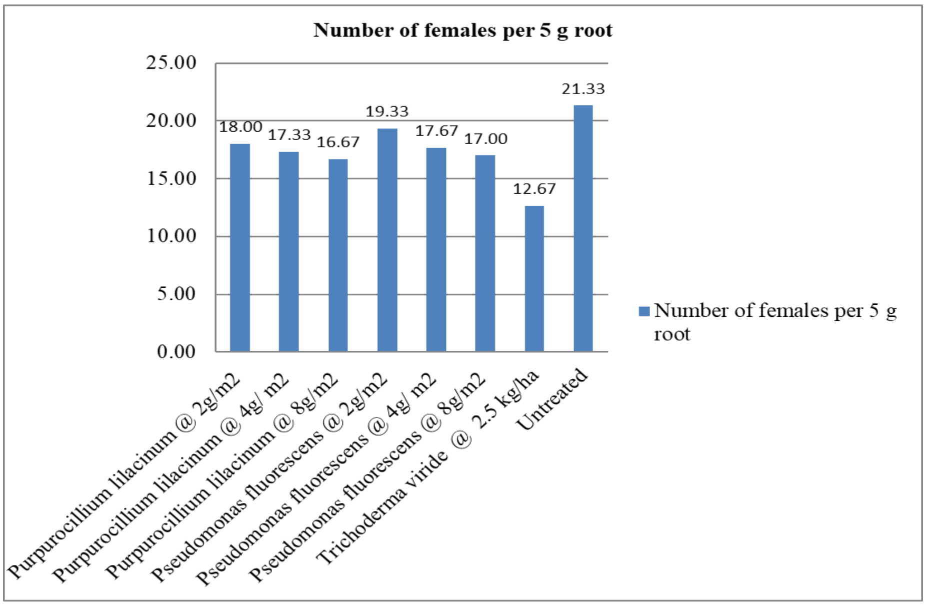

Fig 1(a): Efficacy of bio-agents as soil application against root-knot nematode, *Meloidogyne incognita* on Chilli (On X- axis- Details of treatment, Y- axis - Number of females per 5 g root)

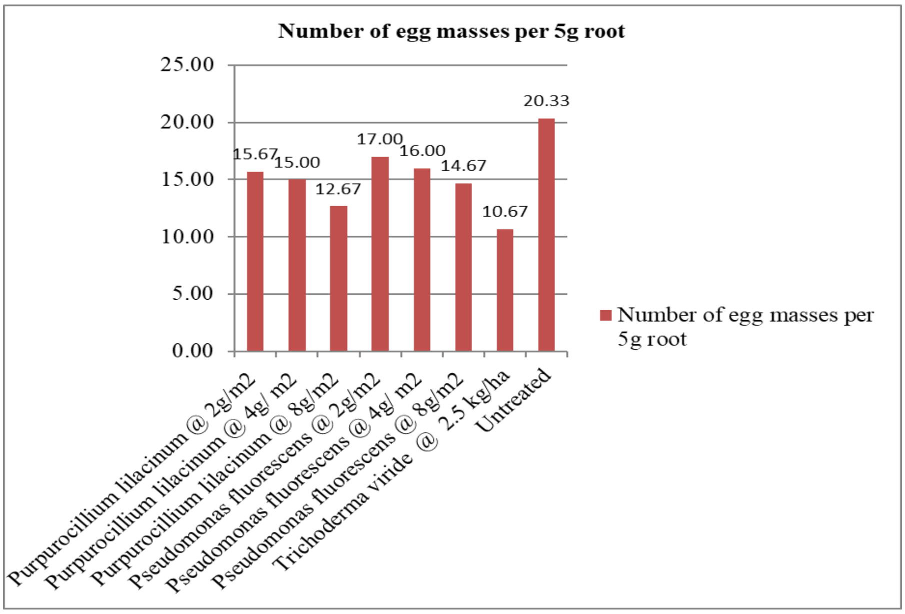

Fig 1(b): Efficacy of bio-agents as soil application against root-knot nematode, *Meloidogyne incognita* on Chilli (On X- axis- Details of treatment, Y- axis- number of egg masses per 5 g root)

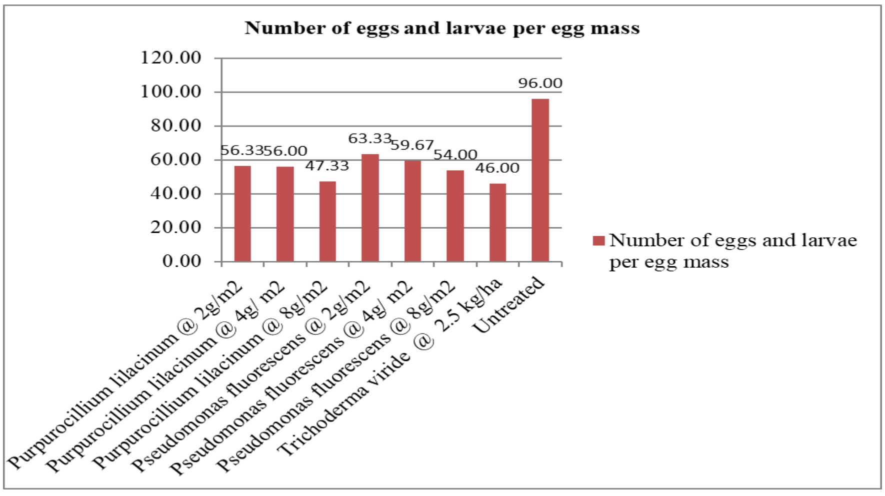

Fig 1(c): Efficacy of bio-agents as soil application against root-knot nematode, *Meloidogyne incognita* on Chilli (On X- axis- Details of treatment, Y- axis - number of egg and larvae masses per egg mass)

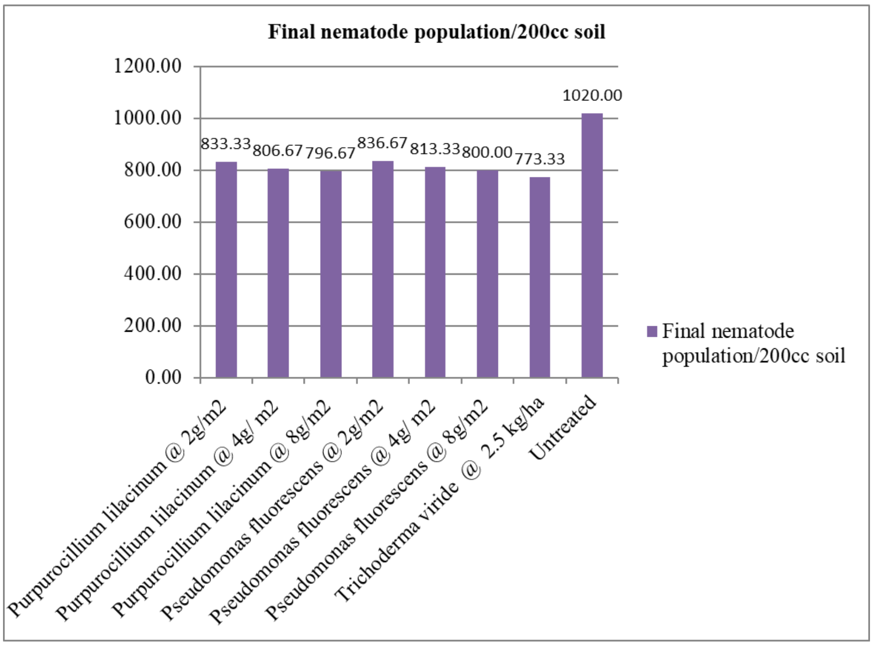

Fig 1(d): Efficacy of bio-agents as soil application against root-knot nematode, *Meloidogyne incognita* on Chilli (On X- axis- Details of treatment, Y- axis - Final nematode population/200 cc soil)

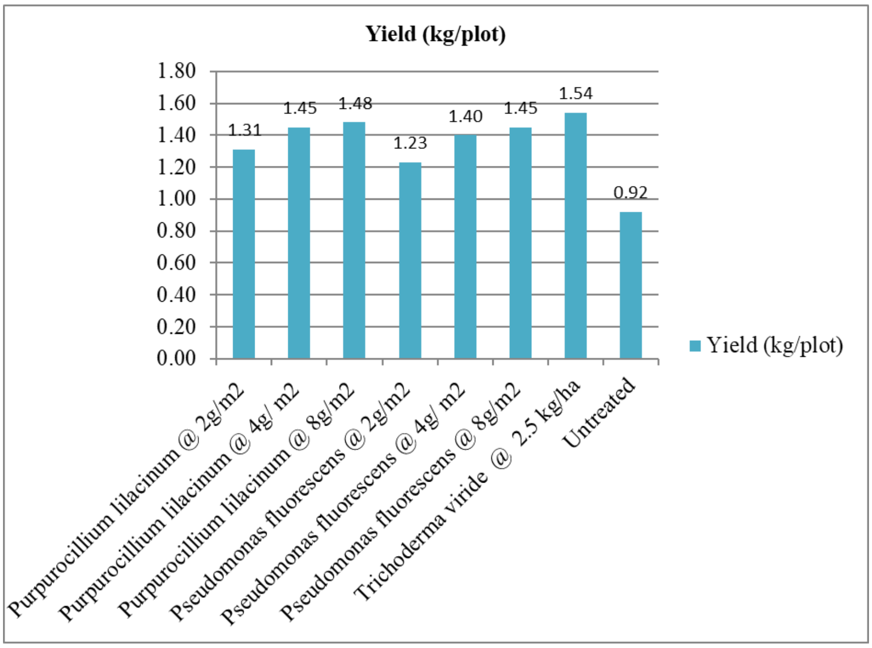

Fig 1(e): Efficacy of bio-agents as soil application against root-knot nematode, *Meloidogyne incognita* on Chilli {On X- axis- Details of treatment, Y- axis- yield (kg/plot) }

Fig 1: Efficacy of bio-agents as soil application against root-knot nematode, *Meloidogyne incognita* on Chilli

Conclusion

The present investigation reveals that there is a potential scope for the utilization of different fungal and bacterial bio-agents for the nematode control. However further research should be carried out to test the efficacy of such bio-agents for controlling plant parasitic nematodes. Likewise plants which release toxic root exudates must be grown as intercrops and mixed crops and they can also be included in crop rotation depending upon the regional cropping pattern for nematode management.

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