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Varsha Phanan
Department of Nematology, Rajasthan College of Agriculture, Udaipur MPUAT, Udaipur, Rajasthan, India

Deepak Kumar Saini
Division of Plant Pathology, Rajasthan Agricultural Research Institute, Durgapura, SKN Agriculture University, Jobner, Rajasthan, India

Suman Maurya
Department of Plant Pathology, Rajasthan College of Agriculture, Udaipur MPUAT, Udaipur, Rajasthan, India

Narendra Kumar Bharati
Department of Soil Science, Bidhan Chandra Krishi Viswavidyalaya, West Bengal

Anita Saini
Department of Horticulture, College of Agriculture, Bikaner, SKRAU, Bikaner, Rajasthan, India

Corresponding Author:
Varsha Phanan
Department of Nematology, Rajasthan College of Agriculture, Udaipur MPUAT, Udaipur, Rajasthan, India

Evaluation of the integrated effect of different bioagents and oil cakes for the management of root knot nematode (*Meloidogyne incognita*) as soil application on chilli

Varsha Phanan, Deepak Kumar Saini, Suman Maurya, Narendra Kumar Bharati and Anita Saini

Abstract
The experiment was conducted for the management of root-knot nematode, *Meloidogyne incognita* through integrated effect of different Bio-agents and oil cakes as soil application infecting Chilli. The result showed- observations: number of egg masses per 5 g root, number of females 5 g root, number of egg and larval masses per egg mass & final nematode population/ 200 cc soil and yield are recorded at the time of harvest. Among the observations, *Purpureocillium lilacinum* at 4 g + castor oilcake at 30 g/m^2 was the best treatment followed by *Purpureocillium lilacinum* at 4 g + mahua cake at 30 gm /m^2 over control. While, chemical check (Carbofuran 3 G at 2 kg/ha) best to other treatment for enhancing plant yield of chilli and reducing nematode population.

Keywords: *Meloidogyne incognita,* bio-agents, combined effect chilli, root-knot nematode

Introduction
Chilli is one of the important commercial crop in all spices. India is the world largest in chili production followed by China and Pakistan. Chilli grows well in warm and humid climate. Ideal temperature range for good plant growth and fruit development is 15-30 °C. Capsaicin is a major pungency ingredient of the capsicum fruits. Some varieties of chilli are famous for the red colour because of the pigment being length width and skin thickness. Root-knot nematodes in all crops are prevalent in 90% of damage. In world a frequency estimate from 75 countries result showed that *M. incognita* is the most wide spread with 53% occurrence. In India over 350 plant speciesare known as the host of *Meloidogyne* spp (Sen and Das Gupta, 1982) [9] *Meloidogyne incognita* alone infecting about 250 and *M. javanica* about 150 genera of plants (Krisnappa, 1985) [7]. Therefore *M. incognita* has been recognized economically more important nematode as compared to other nematode nematodes. In India Root-knot nematode was first reported by Barber (1901) [3] on tea roots. In Rajasthan Arya (1957)[2] reported that nematode on tomato in Jodhpur. However in those plants that do survive flowering and fruit production is strongly reduced. Annually in India loss due to this root nematode pest was worked out 12.85%. (Jain *et al.,* 2007) [5].

Material and Methods
The experiment was conducted at RCA Udaipur field in randomized block design and all treatments were replicated three times in field conditions. The Bio agent *Purpureocillium lilacinum* and *Pseudomonas fluorescens* was used along with the combination of oil cakes *viz.*, castor, mahua and karanj cake. Half of the highest dose of bioagents was combined with the lower dose of oil cakes.At most right from transplanting till harvest of experiment for proper growth and development of plants and observations recorded.

Result and Discussion
I. Number of females per 5 gm of root
The presence of females per 5 gm of root was determined by using standard methodology at time of crop harvest to calculated the effect of different Bio agents and oilcakes. The results showed that *Purpureocillium lilacinum* at 4 g + castor oilcake at 30 g/m^2 with 12.67 mean number of females per 5 gm of root was the better treatment followed by *Purpureocillium*

lilacinum at 4 g + mahua oilcake at 30 g/m^2 with 14.00 mean number of females per 5 gm of root, *Purpureocillium lilacinum* at 4 gm + Karanj cake at 30 g/m^2 (14.33), *Pseudomonas fluorescens* at 4 g/m^2 + castor cake at 30 g/m^2 (16.33), *Pseudomonas fluorescens* at 4 g/m^2 + mahua cake at 30 g/m^2 (17.67), *Pseudomonas fluorescens* at 4 g/m^2 + karanj cake at 30 g/m^2 (19.33). However highest reduction in number of females was observed. carbofuran 3 G at 2 kg/ha (11.67) and lowest reduction was observed in untreated control (23.00) Highest percentage reduction over control was observed by the combined soil application of *Purpureocillium lilacinum* at 4 g/m^2 with castor cake at 30 g/m^2 (44.91%) followed by the combined application of *Purpureocillium lilacinum* at 4 g/m^2 with mahua cake at 30 g/m^2 (39.13%)

II. Number of the egg masses per 5 gm of root

The presence of egg masse per 5 gm of root was determined by using standard methodology at time of crop harvest to observed the effect of bioagents and oilcakes. The results showed that *Purpureocillium lilacinum* at 4 g/m^2 + castor oilcake at 30 g/m^2 with 11.00 mean number of egg masses per 5 gm of root was the better treatment followedby *Purpureocillium lilacinum* at 4 g/m^2 + mahua oilcake at 30 g/m^2 with 12.67 mean number of egg masses, *Purpureocillium lilacinum* at 4 g/m^2 + karanj cake at 30 g/m^2 (13.00), *Pseudomonas fluorescens* at 4 g/m^2 + castor cake at 30 g/m^2 (13.67), *Pseudomonas fluorescens* at 4 g/m^2 + mahua cake at 30 g/m^2 (15.33), *Pseudomonas fluorescens* at 4 g/m^2 + karanj cake at 30 g/m^2 (16.67). The highest reduction in observed by standard check carbofuran 3 G at 2 kg /ha (9.67) and lowest reduction was observed in untreated control (20.33). The highest percentage reduction overcontrol was observed by the combined soil application of *Purpureocillium lilacinum* at 4 g/m^2 with castor cake at 30 g/m^2 (45.89%) followed by the combined application of *Purpureocillium lilacinum* at 4 gm/m^{2}with mahua cake at 30 g/m^2 (37.67%)

III. The Number of eggs and larvae/ egg masses

The presence of eggs and larvae per egg mass was determined by using standard methodology at time of crop harvest to observed the effect of different bioagents and oilcakes. The results showed that *Purpureocillium lilacinum* at 4 g + castor oilcake at 30 g/m^2 with 46.33 mean the number of eggs and larvae per eggs mass was the better treatment followedby *Purpureocillium lilacinum* at 4 g/m^2 + mahua oilcake at 30 g/m^2 with 48.00 mean, *Purpureocillium lilacinum* at 4 g/m^2 +karanj cake at 30 g/m^2 (50.67), *Pseudomonas fluorescens* at 4 g/m^2+ castor cake at 30 g/m^2 (53.33), *Pseudomonas fluorescens* at 4 g/m^2 + mahua cake at30 g/m^2 (57.33), *Pseudomonas fluorescens* at 4 g/m^2+ karanj cake at 30 g/m^2 (60.67). However highest reduction in number of eggs and larvae was observed by standard check carbofuran 3 G at 2 kg/ha (42.00) and lowest reduction was observed in untreated check (81.00). The highest percentage reduction over control was observed by the combined soil application of *Purpureocillium lilacinum* at 4 g/m^2 with castor cake at 30 g/m^2 (42.80%) followed by the combined application of *Purpureocillium lilacinum* at 4 g/m^2 with mahua cake at 30 gm/m^2 (40.74%)

IV. The Final nematode population/ 200 cc

The final population of nematode per 200 cc soil was determined by using standard methodology at time of crop harvest to observe the effect of bioagents and oilcakes. esults showed that *Purpureocillium lilacinum* at 4 g/m^2 + castor oilcake at 30 g/m^2 was the better treatment with 753.33 mean final nematode population per 200 cc soil followedby *Purpureocillium lilacinum* at 4 g + mahua oilcake at 30 g/m^2 with 780.00 mean, *Purpureocillium lilacinum* at 4 g/m^2 + karanj cake at 30 g/m^2 (800.00), *Pseudomonas fluorescens* at 4 g/m^2+ castor cake at 30 g/m^2 (823.00), *Pseudomonas fluorescens* at 4 g/m^2 + mahua cake at 30 g/m^2 (830.00), *Pseudomonas fluorescens* at 4 g/m^2 + Karanj cake at 30 g/m^2 (846.67). The highest reduction in final nematode population was observed by standard check Carbofuran 3 G at 2 kg /ha (726.67) and lowest reduction was showed in untreated control (1026.67). The highest %reductionover control was observed by the combined soil application of *Purpureocillium lilacinum* at 4 g/m^2 with castor cake at 30 g/m^2 (26.62%) followed by the combined soil application of *Purpureocillium lilacinum* at 4 g/m^2 with mahua cake at 30 gm/m^2 (24.02%)

V. Yield (kg/plot)

The mean of yield between 0.92 kg/plot to 1.64 kg/plot. Results showed that *Purpureocillium lilacinum* at 4 g + castor oilcake at 30 g/m^2 was the better treatment with yield 1.42 kg/plot, followed by *Purpureocillium lilacinum* at 4 g + mahua oilcake at 30 g/m^2 with mean yield 1.40 kg/plot, *Purpureocillium lilacinum* at 4 g/m^2+karanj cake at 30 g/m^2 (1.37kg/plot), *Pseudomonas fluorescens* at 4 g/m^2 + castor cake at 30 g/m^2 (1.25 kg/plot), *Pseudomonas fluorescens* at 4 g/m^2 + mahua cake at 30 g/m^2(1.16 kg/plot), *Pseudomonas fluorescens* at 4 g/m^2 + Karanj cake at 30 g/m^2 (1.02 kg/plot). The highest yield was observed by standard check carbofuran at 2 kg /ha (1.64 kg/plot) and lowest yield was recorded in control (0.92 kg/plot). The highest percentage increase over control was observed by the combined soil application of *Purpureocillium lilacinum* at 4 gm/m^2 with castor cake at 30 gm/m^2 (54.34%) followed by the combined soil application of *Purpureocillium lilacinum* at 4 gm/m^{2}with mahua cake at 30 gm/m^2 (52.17%).

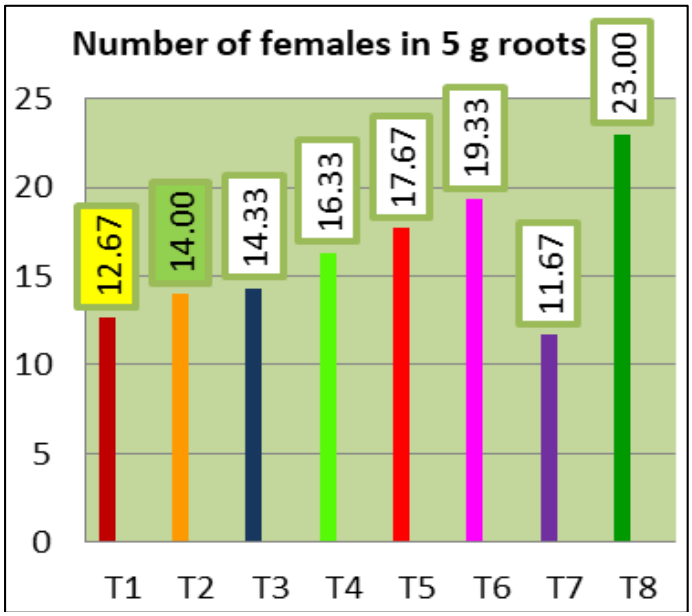
Discussion

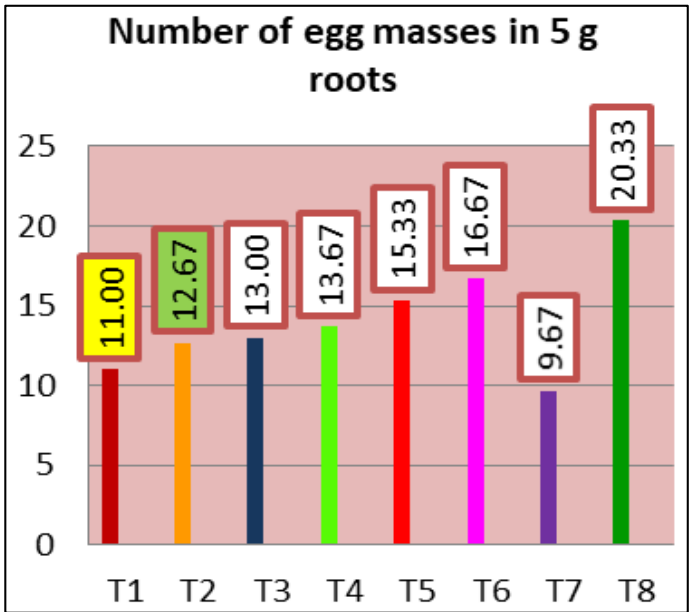
The bio-agents are applied to the field at the time of transplanting and oilcakes are applied on the field 15 days before transplanting. Among those *Purpureocillium lilacinum* at 4 g + castor oilcake at 30 g/m^{2}was the best treatment.

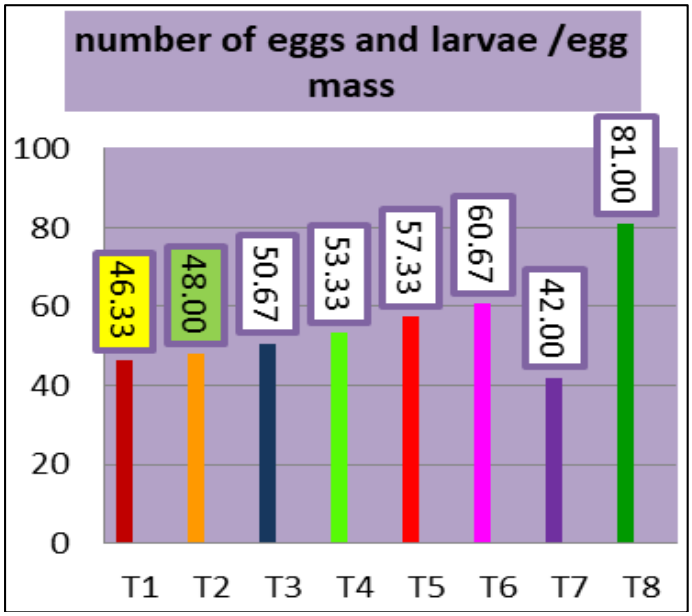
Our results are showed with Haseeb *et al*. (2007) [4] who indicated that Carbofuran 3 G at 2.0 kg each was highly effective against nematode of tomato under pot conditions. Our findings showed similarity with Kepenekci *et al*., (2017) [6] studied nematicidal effects of some biopesticides namely sesame oil Devalone, castor oil *Glomus* spp. The results showed that the best effect against RKN were observed in castor (77.92% and 73.61) and *Paecilomyces lilacinus* (61.03% and 55.55%). Our results showed similarity with Abd-El-Khair *et al.*, (2018) [1] applied *Trichoderma harazianum* and *Trichoderma vierns* as well as the oil cakes of olive combination were applied for controlling *Fusarium solani* and *Meloidogyne incognita* on eggplants in pots experiment. *M.incognita* in soil & roots and the numbers of galls & egg-masses) as well as increased the growth parameters of eggplants *viz*. shoot length compared with control. Results showed that the pots treated with Th or Tvr and then amended with Oc or CC highly reduced the J2 of *M. incognita* in soil and roots of egg plants the numbers of galls and egg masses in the ranges of 86-90; 92-95; 85-86 and 89-90%, respectively.

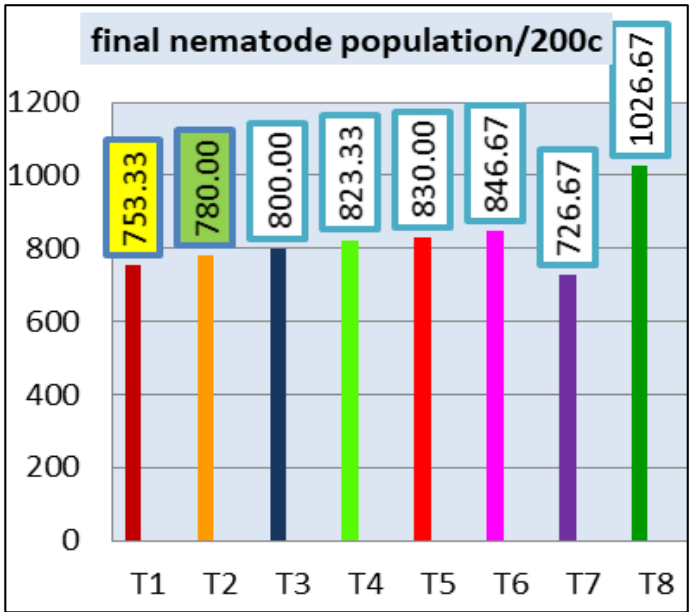
Table 1: Efficacy of integration of bioagents and oil cakes against Root Knot nematode *Meloidogyne incognita* on chilli

Sr. No.	Treatment	Number of females per 5 gm of root	Number of egg masses per 5 gm of root	Number of eggs and larvae per egg mass	Final nematode population/200 cc soil	Yield (kg/plot)
1	*Purpureocillium lilacinum* at 4 g + castor cake at 30 g/m^2	12.67(44.91)	11.00(45.89)	46.33(42.80)	753.33(26.62)	1.42(54.34)
2	*Purpureocillium lilacinum* at 4 g + mahua cake at 30 gm /m^2	14.00(39.13)	12.67(37.67)	48.00(40.74)	780.00(24.02)	1.40(52.17)
3	*Purpureocillium lilacinum* at 4 g + karanj cake at 30 gm/m^2	14.33(37.69)	13.00(36.05)	50.67(37.44)	800.00(22.07)	1.37(48.91)
4	*Pseudomonas fluorescens*at4 g + castor cake at 30 gm /m^2	16.33(29.00)	13.67(32.75)	53.33(34.16)	823.33(19.80)	1.25(44.56)
5	*Pseudomonas fluorescens*at 4 g + mahua cake at 30 gm/m^2	17.67(23.17)	15.33(24.95)	57.33(29.22)	830.00(19.15)	1.16(47.82)
6	*Pseudomonas fluorescens*at 4 g + karanj cake at 30 gm /m^2	19.33(15.95)	16.67(18.00)	60.67(25.09)	846.67(17.53)	1.02(43.47)
7	Carbofuran 3 G at 2 kg/ha	11.67(49.26)	9.67(52.43)	42.00(48.14)	726.67(29.22)	1.64(78.26)
8	Untreated	23.00	20.33	81.00	1026.67	0.92
S.Em±		1.30	1.28	2.38	32.19	0.19
CD at 5%		2.68	3.75	6.98	94.18	0.55









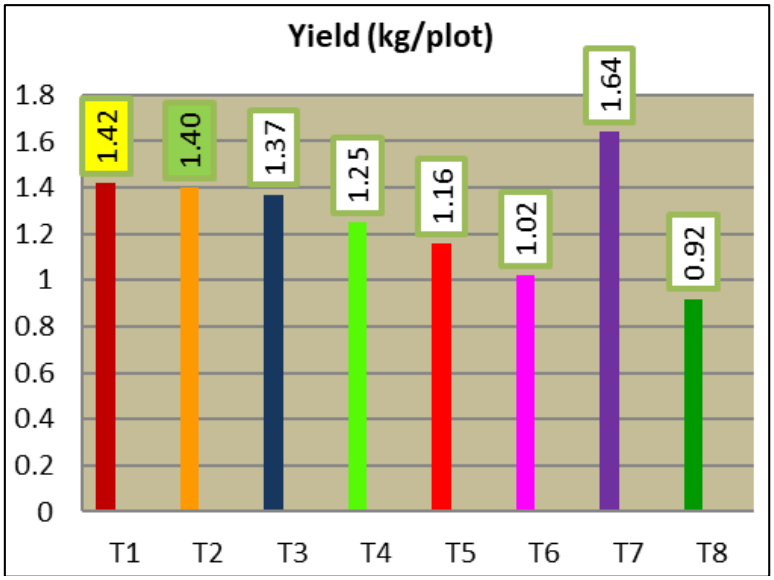


Fig 1: The Efficacy of integration of bioagents and oilcakes against Root-knot Nematodeon Chilli

Conclusion

On the basis of this experimentation it could be concluded that *Purpureocillium lilacinum* at 4 g + castor oil cake at 30 g/m^2 was the best treatment for enhancing plant yield of chilli and reducing *Meloidogyne incognita* population.

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