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Management of root-knot nematode, *Meloidogyne hapla* infecting two solanaceous crops in Kashmir valley

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Abstract
Pot experiments were conducted to evaluate the efficacy of neem products, *Azarirachta indica* and two chemicals *viz*., Dimethoate 30 EC and Chlorpyriphos 20 EC for the management of root-knot nematode, *Meloidogyne hapla* infesting two solanaceous crops, tomato and brinjal. A significant ($P \leq 0.05$) reduction of around 88 per cent in root galls per root system was observed over untreated control in both tomato and brinjal plants, grown in pot soil incorporated with neem seed powder @ 50 gm per kg soil. Maximum reduction in egg masses per root system was 89.10 and 87.93 per cent, eggs per egg mass was 74.80 and 69.73 per cent on tomato and brinjal plants, respectively, grown in pot soil treated with neem seed powder. Reduction in final soil population of nematode was also maximum with neem seed powder treated soil. Pre-transplanting root dip treatment of tomato and brinjal seedlings with Dimethoate 30 EC @ 0.03 per cent was the next best treatment followed by Neemarin @ 0.2 per cent and Chlorpyriphos @ 0.02 per cent that caused significant ($P \leq 0.05$) reduction in galls and egg masses per root system, eggs per egg mass and final soil population of nematode over untreated control. Plant growth parameters was maximum for both the crops grown in soil incorporated with neem seed powder.

Keywords: *Meloidogyne hapla*, tomato, brinjal, neem seed powder, chemical

1. Introduction
Tomato (*Lycopersicon esculentum* Mill) and brinjal (*Solanum melongena* L.) are important solanaceous crops of Kashmir valley. They are nutritive vegetables, rich in minerals, vitamins and serve as an additional source of earning profit for the growers. Among several pests and diseases, root-knot nematode, *Meloidogyne* spp. are considered one of the major constraints causing severe economic damage to vegetable production including tomato and brinjal around the world [1, 5, 24]. They are soil borne microorganisms that pierce their stylet into the root, withdraw the cell contents of the affected tissue and thereby cause deficiency in nourishment. Feeding by *Meloidogyne* spp. lead to formation of galls on the plant roots and the conductive tissues responsible for the translocation of nutrients and water to the tops are often blocked at the site of infestation. The plants show stunted growth and often exhibit wilting symptoms during warmer part of the day. Though, several plant protection measures have been developed to manage root-knot nematodes in different crops but the crops are still suffering severely both in terms of quality and quantity [4, 7, 8, 13].

In Kashmir valley, attack of *Meloidogyne hapla* on tomato and brinjal are spreading gradually and steadily over the last few years. Therefore, the present study was undertaken at Division of Entomology, Faculty of Horticulture, SKUAST-Kashmir, Srinagar in *Kharif* season during the year 2017-18 to assess the effect of *M. hapla* infestations on growth parameters of tomato and brinjal plants, besides management of this pest by means of chemicals and botanicals.

2. Materials and methods
2.1 Mass culture of root-knot nematode, *Meloidogyne hapla*
Egg masses of root-knot nematode, *M. hapla* [10] were collected from brinjal and tomato plants grown in pure culture beds. For the correct identification of nematode species perineal patterns of adult females was perpared [9]. Egg masses were excised from the galled roots with the help of sterilized forcep and then washed in distilled water and placed on aluminium net layered with tissue paper. The aluminium net was placed over a petri dish containing water to such a level that remain always in touch with the bottom of the net. It was left for hatching at room temperature (22-25 ^{o}C).

A series of such sets were maintained to obtain heavy population of second stage juveniles (J_2) required for inoculation. After every 24 hours, the juvenile suspension collected from the petri dish was poured in a beaker and thereafter, fresh water was added to the petri dish till three days. The second stage juveniles (J_2) of *M. hapla* present in the suspension were counted with the help of a counting dish placed under stereoscopic microscope and the concentration of J_2 was standardized.

2.2 Soil treatment with neem seed powder

The experiment was conducted in 15 cm earthen pots filled with 1kg autoclaved soil (field soil + compost 3:1). Before filling the soil in pots, for one treatment, neem seed powder was incorporated in the soil @ 50 gm per kg soil. Three weeks old seedlings of tomato cultivar, Shalimar-1 and brinjal cultivar, Shalimar Brinjal Hybrid-1 obtained from vegetable nursery of SKUAST-Kashmir, Srinagar was transplanted in the pots. A day before transplantation 4 ml nematode suspension containing 2000 *M. hapla* J2 was mixed in the top soil layer in each pot so that juveniles could distribute uniformly in the soil.

2.3 Seedlings bare root dip treatment

Prior to transplantation, the root portions of uniform size seedlings of tomato and brinjal were immersed separately in Chlorpyriphos 20 EC @ 0.02 per cent and Dimethoate 30 EC @ 0.03 per cent concentrations for 20 minutes, whereas, the roots were dipped for 30 minutes in neem formulation, Neemarin @ 0.2 per cent concentration. *M. hapla* was inoculated in the pot soil with the same method as mentioned under section 2.2. Besides, one untreated control (2000 J_2/ kg soil) was also maintained for comparison. Thus, there were five treatments and each treatment was replicated five times. One plant was maintained in each pot. The pots were arranged in a completely randomized block design.

2.4 Observations

2.4.1 Galls, egg masses and eggs per egg mass

After 60 days plants were uprooted very carefully to prevent the damage to the root system. The root system were gently washed in slow stream of water to remove soil debris and visually observed to record the number of galls and egg masses. To make ease the counting of egg masses, roots were stained with 0.015 per cent phloxine-B solution [11]. Eggs per egg mass was counted by observing the egg mass under stereoscopic microscope.

2.4.2 Nematode population

Population of root-knot nematode, *M. hapla* was determined by Cobb's decanting and sieving method (modified) followed by Baermann funnel technique [20]. After uprooting the plants, pot soil was mixed thoroughly and 250 g soil from each pot was analyzed. The nematode suspension recovered was collected in a beaker and the counting of nematode was performed in a counting dish under stereoscopic microscope with the help of hand tally counter.

2.4.3 Plant growth parameters

For the observation of fresh weights, the shoot and root were weighed after uprooting the plants and then placed in the oven at 70 ºC. After 72 hours they were taken out from the oven and weighed with the help of electronic balance for their dry weights.

Statistical analysis

Observations taken for single parameter were averaged to calculate mean. The data were analyzed by one way, single factor analysis of variance (ANOVA) and critical difference (CD) was calculated using OP STAT to identify significant effect of a treatment at probability levels of $P \leq 0.05$ per cent variation over control.

3. Results

3.1 Effect on galls, egg masses and eggs per egg mass

All the treatments showed significant reduction in number of galls, egg masses per root system and eggs per egg mass as compared to untreated control in both the test plants, tomato and brinjal (Table 1). There was a significant ($P \leq 0.05$) reduction of around 88.0 per cent in root gall formation of both tomato and brinjal plants over untreated control in the treatment where soil was treated with neem seed powder @ 50 gm per kg soil. It was followed by root dip treatments with Dimethoate 30 EC @ 0.03 per cent, Neemarin @ 0.2 per cent and Chlorpyriphos 20 EC @ 0.02 per cent that reduced root gall formation by 73.73, 55.87 and 66.59 per cent, respectively in tomato plants and 70.87, 46.91 and 63.96 per cent, respectively in case of brinjal plants. Among all the treatments, production of egg mass per root system was lowest on the plants grown in pots where soil was treated with neem seed powder. The roots immersed in dimethoate was the next best treatment followed by neemarin and chlorpyriphos as they supported significantly lesser ($P \leq 0.05$) number of egg mass production per root system of both tomato and brinjal plants than untreated control. Similar trend was observed for the number of eggs per egg mass. As compared to untreated control, the highest reduction in eggs per egg mass was 74.80 and 69.76 per cent in case of tomato and brinjal plants, respectively grown in pots soil treated with neem seed powder. The roots immersed in chlorpyriphos was found least effective in terms of per cent reduction in eggs per egg mass and it was recorded 65.59 and 57.77 per cent for tomato and brinjal, respectively.

Table 1: Effect of different treatments on the development of galls, egg masses, eggs/ egg mass and soil population of root-knot nematode, *Meloidogyne hapla* in the rhizosphere of tomato and brinjal seedlings.

Treatments	Galls/ root system		Egg masses/ root system		Eggs/ egg mass		Nematode population/ 250 g soil	
	Tomato	Brinjal	Tomato	Brinjal	Tomato	Brinjal	Tomato	Brinjal
Neem seed powder (50 gm/ kg soil) + 2000 second stage juveniles (J_2)/ kg soil	9.40* (88.02)	9.60 (88.15)	8.00 (89.19)	9.20 (87.93)	32.8 (74.80)	38.4 (69.76)	64.00 (96.68)	86.00 (95.32)
Neemarin @ 0.2% (seedling root dip treatment) + 2000 J_2/ kg soil	26.20 (66.59)	29.20 (63.96)	23.20 (68.35)	25.40 (66.67)	41.6 (67.84)	49.0 (61.41)	113.00 (94.14)	135.80 (92.61)
Chlorpyriphos 20 EC @ 0.02% (seedling root dip treatment) + 2000 J_2/ kg soil	34.60 (55.87)	38.00 (46.91)	33.00 (55.41)	34.80 (54.34)	44.8 (65.59)	53.4 (57.77)	210.00 (89.11)	245.20 (86.67)
Dimethoate 30 EC @ 0.03% (seedling root dip treatment) + 2000 J_2/ kg soil	20.60 (73.73)	23.60 (70.87)	17.80 (75.95)	19.20 (74.81)	37.0 (71.58)	44.8 (64.72)	81.00 (95.80)	96.60 (94.75)
Untreated control (2000 J_2/ kg soil)	78.40	81.00	74.00	76.20	130.2	127.0	1928.80	1840.00
CD ($P \leq 0.05$)	7.23	5.80	5.90	4.28	6.74	8.79	32.16	33.05

Each value is mean of five replications
Figures in parenthesis are percent decrease (-) over control
Design: CRD
Replication: 5
Tomato Variety: Shalimar-1
Brinjal Variety: Shalimar Brinjal Hybrid-1

3.2 Effect on nematode population

The final population of root-knot nematode, *M. hapla* in pot soil of tomato and brinjal plants was significantly reduced ($P \leq 0.05$) in all the treatments, however, the maximum reduction over untreated control was observed in the soil treated with neem seed powder followed by root treatments with dimethoate, neemarin and chlorpyriphos (Table 1).

3.3 Effect on plant growth parameters

All the treatments resulted in significant increase ($P \leq 0.05$) in plant growth parameters *viz*., length of shoot and root as well as fresh and dry weight of shoot and root of both the solanaceous crops, tomato and brinjal (Table 2). Maximum increase in shoot and root length over untreated control was recorded where soil was treated with neem seed powder followed by root dip treatment with dimethoate, neemarin and chlorpyriphos. Similar trend was observed with fresh and dry weight of shoot and root. It was maximum with the plants grown in neem seed powder treated soil followed by root dip treatment with dimethoate, neemarin and chlorpyriphos.

Table 2: Effect of different treatments on growth parameters of tomato and brinjal seedlings inoculated with root-knot nematode, *Meloidogyne hapla* under pot condition.

Treatments	Root length (cm)		Shoot length (cm)		Fresh shoot weight (g)		Dry shoot weight (g)		Fresh root weight (g)		Dry root weight (g)	
	Tomato	Brinjal	Tomato	Brinjal	Tomato	Brinjal	Tomato	Brinjal	Tomato	Brinjal	Tomato	Brinjal
Neem seed powder (50 gm/ kg soil) + 2000 second stage juveniles (J_2)/ kg soil	40.73	46.29	34.2	35.41	32.16	22.37	6.17	4.10	28.42	24.53	2.72	2.10
Neemarin @ 0.2% (seedling root dip treatment) + 2000 J_2/ kg soil	35.66	40.23	30.68	31.52	29.30	19.40	5.60	3.73	25.12	22.38	2.51	1.70
Chlorpyriphos 20 EC @ 0.02% (seedling root dip treatment) + 2000 J_2/ kg soil	33.59	39.14	27.44	28.60	27.77	18.20	5.24	3.54	22.47	22.05	2.39	1.61
Dimethoate 30 EC @ 0.03% (seedling root dip treatment) + 2000 J_2/ kg soil	38.50	42.55	31.15	34.49	31.0	20.88	5.78	3.85	26.10	23.19	2.60	1.84
Untreated (2000 J_2/ kg soil)	8.20	10.37	9.40	8.16	5.15	3.68	2.24	0.88	2.91	2.26	0.35	0.24
CD ($P \leq 0.05$)	2.16	2.74	2.83	1.94	2.10	2.20	0.43	0.28	2.00	1.49	0.22	0.14

Each value is mean of five replications
Design: CRD
Replication: 5
Tomato Variety: Shalimar-1
Brinjal Variety: Shalimar Brinjal Hybrid-1

4. Discussion

In the present study, soil treatment with neem seed powder and seedling root dip treatment with neemarin decreased the development of galls and production of egg mass on root system and increased the growth parameters of tomato and brinjal. The treatments also decreased the soil population of *M. hapla* in soil. The findings confirm the report of other workers [10] who observed reduction in soil population of nematode and gall formation on roots when the tomato seedlings were treated with neem products. Similar were the findings of other research workers on tomato [3], tomato, brinjal and chilly [19] and brinjal [14] where growth parameters of plant also increased signicantly. Incorporation of neem products in soil has also been reported to reduce the infestation of root-knot nematode on other crops such as cowpea [21, 22] and pigeonpea [6]. The nematicidal activity of neem seed powder and neemarin may be due to the presence of active substances like azadirachtin and nimbidin present in neem, *Azadirachta indica* that might be absorbed by the plant roots which changed the chemical composition of plants and such roots excreted some influence on pathogenesis of root-knot nematode [17].

Seedling root dip treatment with chemicals *viz*., dimethoate and chlorpyriphos resulted in reducing the production of galls, egg mass formation on roots, soil population of *M. hapla* while on the other hand, increased the growth parameters of tomato and brinjal plants. Management of root-knot nematode in tomato and brinjal by using chemicals that also resulted in increasing the growth parameters of plants has been reported by several other workers [2, 12, 15, 16, 23].

5. Conclusion

The experimental results advocates that incorporation of neem seed powder in soil is highly effective and a cost-effective method in reducing the infestation of root-knot nematode, *M. hapla* on tomato and brinjal plants. Root dip treatment with neem product and chemicals also exhibited encouraging results. Generally, nematicidal chemicals are costly and prove hazardous when incorporated in soil. Under such circumstances, root dip treatment with chemicals seems to be a suitable option as it require little amount of chemicals and are safe and cost-effective in the management of root-knot nematode. Though, the findings of the present investigation are encouraging but further trials need to be conducted under field conditions to validate the tactics and include them into integrated nematode management programmes.

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7. References

1. Abd-Elgawad MMM, Askary TH. Impact of phytonematodes on agriculture economy. In: Askary TH, Martinelli PRP. (Eds.), Biocontrol Agents of Phytonematodes. CABI Publishing, Wallingford, UK 2015,3-49.
2. Ahuja S. Chemical control of root-knot nematode in nursery beds of tomato and egg plant and its effect on yield in the field. Tropical Pest Management 1982;28:313-315.
3. Akhtar M, Mahmood I. Prophylactic and therapeutic use of oil cakes and leaves of neem and castor extracts for the control of roo-knot nematode on chilli. Nematologica Mediterranea 1994;22:127-129.
4. Ali SS, Askary TH. Taxonomic status of phytonematodes associated with pulse crops. Current Nematology 2001;12:75-84.
5. Anwar SA, Zia A, Hussain M, Kamran M. Host suitability of selected plants to *Meloidogyne incognita* in the Punjab, Pakistan. International Journal of Nematology. 2007; 17:144-150.
6. Askary TH, Abd-Elgawad MMM. Key Nematode Pests of Pigeonpea: Systematics, Biology and Disease management. Lambert Academic Publishing, Germany. 2019.
7. Askary TH, Haidar MG. Plant parasitic nematodes associated with forest nurseries. Indian Journal of Nematology 2010;40:239-240.
8. Askary TH, Waliullah MIS, Gupta S. Population fluctuation of plant parasitic nematodes associated with pome, stone and nut fruit nurseries. Annals of Plant Protection Sciences 2012;20:265-267.
9. Barkar KR. Nematode extractions and bioassays. In: Barker KR, Carter CC, Sasser JN. (Eds.), An Advanced Treatise on *Meloidogyne*. Methodology, Voll. II. North Carolinia State University Graphics, Raleigh 1985,19-35.
10. Chitwood BG. Ring nematodes (Criconematidine) a possible factor in decline and replanting problems of peach orchads. Proceedings of Heliminthological Society, Washigton 1949;16:6-7.
11. Daykin M, Hussey R. Staining and histopathological techniques in nematology. In: Barker KR, Carter CC, Sasser JN. (Eds.), An Advanced Treatise on *Meloidogyne*. Methodology, Voll. II. North Carolinia State University Graphics, Raleigh 1985,39-48.
12. Gurjar HR, Sharma MK, Bhargava S, Srivastva AS. Management of root-knot nematode *Meloidogyne incognita* infecting tomato (*Lycopersicon esculentum* Mill) with chemicals using different application methods. Indian Journal of Nematology 2017;47:173-178.
13. Haidar MG, Askary TH, Nath RP. Nematode population as influenced by paddy based cropping sequences. Indian Journal of Nematology 2001;31:68-71.
14. John A, Hebsy B. Bare root dip of brinjal seedlings in phytochemicals for the management of root-knot nematode (*Meloidogyne incognita*). Journal of Tropical Agriculture 2000;38:69-72.
15. Mahajan R. Efficacy of spot treatment with nematicides for the control of *Meloidogyne incognita* in egg plant (*Solanum melongena* L.). Indian Journal of Nematology 1982;12:375-377.
16. Patel N, Patel AD. Management of root-knot nematodes (*Meloidogyne* spp.) using different chemicals in tomato nursery. Indian Journal of Nematology 2018;48:243-245.
17. Rao KN, Parmar BS. A compendium of chemical constituents of neem. Neem News Letter 1984;1:39-46.
18. Saravanapriya B, Sivakumar M. Management of root-knot nematode *Meloidogyne incognita* on tomato with botanicals. Natural Product Radiance 2005;4:158-161.
19. Sivakumar M, Gunasekaran K. Management of root knot nematodes in tomato, chilli and brinjal by neem oil formulations. Journal of Biopesticides 2011;4:198-200.
20. Southey JF. Laboratory methods for work with plant and soil nematodes. Her Majesty's Stationary Office, Ministry of Agriculture, Fisheries and Food, London, UK 1986.
21. Umamaheswari R, Sundarababu R. Efficacy of neem leaf extract on root-knot nematode *Meloidogyne incognita* infectiing cowpea. Indian Journal of Nematology 2001a;31:126-128.
22. Umamaheswari R, Sundarababu R. Management of root-knot nematode *Meloidogyne incognita* infectiing cowpea by *Calotropis* leaf extract. Indian Journal of Nematology 2001b;31:133-135.
23. Upadhyaya KD, Singh G, Pandey RC. Relative efficacy of certain chemicals alone and in combination against the root-knot nematode, *Meloidogyne javanica* attacking tomato crop. Indian Journal of Nematology 1979;9:176-177.
24. Williamson VM, Hussey RS. Nematode pathogenesis and resistance in plants. Plant Cell 1996; 8:1735-1745.