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Management of root-knot nematode (*Meloidogyne incognita* (Kofoid and White) Chitwood) in ashwagandha (*Withania somnifera* Dunal.) and senna (*Cassia angustifolia* Vahl.) using non-chemicals

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Abstract

Experiments were conducted for the management of root knot nematode, *Meloidogyne incognita* using non-chemicals under controlled and field conditions in medicinal crops *viz.,* ashwagandha (*Withania somnifera*) and senna (*Cassia angustifolia*). All the treatments comprising of bioagents, organic amendments and humic acid were effective to suppress *M. incognita* population and to increase the plant biomass and yield of economic parts of these crops. Among the treatments, the use of plant growth promoting rhizobcaterium, *Pseudomonas fluorescens* available commercially in talc formulation (2.6 X 10^6 cfu g^{-1}) at 2.5 kg ha^{-1} as soil application recorded the lowest nematode population accompanied with highest economic yield.

Key words: *Cassia angustifolia, Meloidogyne incognita, Pseudomonas fluorescens, Withania somnifera,* non-chemicals

Introduction

In recent years, there has been an increased interest in the cultivation of medicinal plants to meet the requirements of pharmaceutical and cosmetic industries and to earn foreign exchange through export (Husain, 1983). Attention has also been given on plant parasitic nematodes which have been recognized as serious constraints in the productivity of medicinal plants (Alam *et al.,* 1978; Butool and Hasseb, 1993). Pandey (1998) proved that the root knot nematode, *Meloidogyne incognita* (Kofoid and White) Chitwood is widespread in medicinal crops and causes both qualitative and quantitative yield loss. Hence, the present study was undertaken for the management of *M. incognita* using non-chemicals considering the export value of the medicinal crops *viz.,* ashwagandha (*Withania somnifera* Dunal.) and senna (*Cassia angustifolia* Vahl.).

Materials and methods

Glasshouse experiment: The seeds, surface sterilized with mercuric chloride (0.5%), were sown in pots (10 kg capacity) filled with steam sterilized pot mixture. The established plants were thinned to two per pot at 21 DAS (days after sowing) followed by the inoculation of second stage juveniles (J2) of *M.*

Table 1. Management of *M. incognita* in Ashwagandha (*W. somnifera*) under glasshouse conditions

Treatments	Shoot length (cm)	Shoot weight (g)	Root length (cm)	Economic yield of root weight per plant (g)	No. of galls g^{-1} of root	No. of females g^{-1} root	No. of eggs per egg mass	Gall index	Soil nematode population (200 cc)
T_1 - Soil application of *P. fluorescens* @ 2.5 kg ha^{-1}	52.1a	55.7a	22.5a	10.7a	2.0a	1.0a	186.7a	1.0a	45.7a
T_2 - Soil application of *T. viride* @ 2.5 kg ha^{-1}	45.0b	49.0b	16.6b	7.0cde	2.7a	1.7a	220.0b	1.7a	65.7a
T_3 - Combined application of *P. fluorescens* + *T. viride* (each @ 1.25 kg ha^{-1})	49.7a	53.7a	20.8a	9.0b	2.3a	1.3a	190.0a	1.3a	54.0ab
T_4 - Soil application of neem cake @ 1 ton ha^{-1}	43.3bc	40.7c	12.4c	8.3bc	8.0b	8.7b	266.7c	3.3b	136.7b
T_5 - FYM with recommended dosage of fertilizers	43.4bc	34.7de	11.6cd	7.7bcd	9.3bc	9.0bc	290.0cd	3.7bc	313.3c
T_6 – Soil drenching with 4% Panchkavya	41.5cd	35. 3d	13.6bc	6.7de	10.7cd	9.7bc	300.0d	4.3cde	336.7c
T_7 – Foliar application of Panchkavya @ 4%	40.0d	30.3f	11.9cd	6.0e	11.3cd	10.0c	296.7d	4.7de	366.7c
T_8 – Application of humic acid at 1%	36.9e	30.7ef	12.3c	5.7e	12.7d	10.0c	283.3cd	4.0bcd	293.3c
T_9 - control	30.6f	20.3g	8.4d	3.3f	18.3e	16.0d	336.7e	5.0e	536.7d

Means in columns followed by the same letter are statistically not significant (Duncan's multiple range test, P=0.05)

incognita (one g^{-1} soil). The treatments were given as furnished in Table 1. All the treatments were replicated thrice in a completely randomized design and watered regularly.

Observations were made on yield attributes at the time of termination of the experiment at 180 DAS. Nematode population was assessed in soil and roots in terms of number of galls and females g^{-1} of root and number of eggs per eggmass (Cobb, 1918; Schindler, 1961; Taylor and Sasser, 1978).

Field experiments: The above experiments were conducted in nematode prone area under field conditions with initial population of *M. incognita* at more than one J2 g^{-1} soil, to confirm the results of earlier experiments. The plot size was 9 m^2 and the design adopted was RBD. The data collected were subjected to statistical analysis (Gomez and Gomez, 1984).

Results and discussion

All the treatments recorded significantly higher growth parameters *viz.,* shoot length and weight, root length and weight as economic yield by lowering the nematode population under glasshouse as well as field conditions in the present study. Among the treatments, *P. fluorescens* at 2.5 kg ha^{-1} as soil application at 21 DAS registered the lowest nematode population in soil and roots and the highest growth parameters and economic yield of the crop. It was followed by the combined application of *P. fluorescens* + *T. viride* (each at 1.25 kg ha^{-1}). The other non-chemicals *viz.,* neem cake, FYM, panchakavya and humic acid evaluated in the present study were also effective but not as effective as bioagents *viz., P. fluorescens* and *T. viride* in the suppression of *M. incognita* population and to improve the plant growth (Table 1 to 4).

Table 2. Management of *M. incognita* in Ashwagandha (*W. somnifera*) under field conditions

Treatments	Shoot length (cm)	Shoot weight (g)	Root length (cm)	Economic yield of root weight per plant (g)	No. of galls g^{-1} of root	No. of females g^{-1} root	No. of eggs per egg mass	Gall index	Soil nematode population (200 cc)
T_1 - Soil application of *P. fluorescens* @ 2.5 kg ha^{-1}	66.7a	43.3a	27.7a	15.0a	2.0a	1.0a	186.7a	1.0a	45.0a
T_2 - Soil application of *T. viride* @ 2.5 kg ha^{-1}	61.7a	40.7a	24.0b	14.0ab	2.7a	1.3a	203.3a	1.3a	63.3ab
T_3 - Combined application of *P. fluorescens* + *T. viride* (each @ 1.25 kg ha^{-1})	65.0a	43.3a	26.3a	14.3a	2.3a	1.3a	193.3a	1.0a	51.7ab
T_4 - Soil application of neem cake @ 1 ton ha^{-1}	60.0a	38.3ab	22.3b	12.7b	9.0bc	8.0bc	263.3b	3.3b	126.7b
T_5 - FYM with recommended dosage of fertilizers	43.3b	33.3bc	19.0c	10.7c	10.7cd	10.0cd	290.0bcd	4.3c	306.7c
T_6 – Soil drenching with 4% Panchkavya	43.3bc	31.7c	18.0cd	10.0cd	10.0bcd	8.7bc	290.0bcd	5.0d	326.7c
T_7 – Foliar application of Panchkavya @ 4%	41.7c	31.7c	18.7cd	10.0cd	10.3bcd	9.0bc	293.3cd	5.0d	360.0c
T_8 – Application of humic acid at 1%	45.0bc	39.3bc	19.7c	10.7c	8.0b	7.3b	273.3bc	4.7cd	300.0c
T_9 - control	41.7c	30.0c	17.0d	9.00d	12.3d	12.0d	306.7d	5.0d	533.3d

Means in columns followed by the same letter are statistically not significant (Duncan's multiple range test, P=0.05)

Table 3. Management of *M. incognita* in Senna (*C. angustifolia*) under glasshouse conditions

Treatments	Shoot length (cm)	Shoot weight (g)	Root length (cm)	Root weight (g)	Economic yield per plant		No. of galls g^{-1} of root	No. of females g^{-1} root	No. of eggs per egg mass	Gall index	Soil nematode population (200 cc)
					Leaf (g)	Pod (g)					
T_1 - Soil application of *P. fluorescens* @ 2.5 kg ha^{-1}	50.2a	14.4a	26.5a	7.2a	122.6a	65.8a	6.7a	4.3a	233.3a	1.3a	23.3a
T_2 - Soil application of *T. viride* @ 2.5 kg ha^{-1}	41.0b	13.0bcd	22.1c	6.7bc	118.4bc	61.1c	8.3a	5.0a	256.7b	2.3ab	66.7bc
T_3 - Combined application of *P. fluorescens* + *T. viride* (each @ 1.25 kg ha^{-1})	46.8a	13.7ab	24.7b	7.0ab	120.2ab	63.4b	7.3a	4.3a	245.0b	1.7a	36.7ab
T_4 - Soil application of neem cake @ 1 ton ha^{-1}	41.5b	12.7cd	20.6cd	6.4c	116.3cd	60.6c	13.0b	11.7b	300.0bc	3.3bc	100.0c
T_5 - FYM with recommended dosage of fertilizers	38.4bc	12.5cd	12.3ef	5.8d	114.1de	57.9d	13.3cd	15.7c	286.7bc	4.0cd	243.3d
T_6 – Soil drenching with 4% Panchkavya	36.6c	13.2bc	18.2f	5.3e	112.9e	55.5e	18.3d	16.3c	310.0bc	4.7d	306.7e
T_7 – Foliar application of Panchkavya @ 4%	39.1bc	13.1bc	19.0def	5.9d	116.3cd	59.4cd	16.0c	17.3c	280.0bc	4.3cd	280.0de
T_8 – Application of humic acid at 1%	35.4c	12.3d	19.9de	5.5de	115.6cde	58.4d	17.0cd	16.0c	276.7bc	4.3cd	300.0e
T_9 - control	30.7d	10.2e	16.1g	3.7f	104.4f	50.7f	23.0e	20.7d	323.3c	5.0d	430.0f

Means in columns, followed by the same letter are statistically not significant (Duncan's multiple range test, P=0.05)

Table 4. Management of *M. incognita* in Senna (*C. angustifolia*) under field conditions

Treatments	Shoot length (cm)	Shoot weight (g)	Root length (cm)	Root weight (g)	Economic yield per plant		No. of galls g^{-1} of root	No. of females g^{-1} root	No. of eggs per egg mass	Gall index	Soil nematode population (200 cc)
					Leaf (g)	Pod (g)					
T_1 - Soil application of *P. fluorescens* @ 2.5 kg ha^{-1}	58.7a	18.5a	31.7a	9.6a	223.3a	76.7a	6.3a	5.0a	230.0a	1.7a	15.0a
T_2 - Soil application of *T.viride* @ 2.5 kg ha^{-1}	53.2b	15.5c	28.7b	9.2ab	171.7b	73.3a	6.7a	5.0a	246.0ab	2.3b	60.0a
T_3 - Combined application of *P. fluorescens* + *T.viride* (each @ 1.25 kg ha^{-1})	52.2bc	16.9b	29.3b	8.7bc	176.7b	73.3a	6.0a	4.3a	170.7a	2.0ab	46.7a
T_4 - Soil application of neem cake @ 1 ton ha^{-1}	50.2c	16.7b	25.3c	8.3c	150.0c	65.0b	13.3b	12.0b	266.7bc	4.0c	168.3b
T_5 - FYM with recommended dosage of fertilizers	45.2de	13.5d	24.7cd	7.2d	120.0d	65.0b	17.0bc	15.0bc	211.0de	5.0e	340.0c
T_6 – Soil drenching with 4% Panchakavya	47.12d	13.5d	24.0cd	7.0d	125.0d	46.7c	18.0c	16.3cd	266.7cd	4.7de	366.7c
T_7 – Foliar application of Panchakavya @ 4%	44.2e	13.0de	23.3d	6.7 e	120.0d	45.0c	18.7c	17.7cd	280.0cd	5.0e	356.6c
T_8 – Application of humic acid at 1%	47.2d	13.3d	24.7cd	6.9de	121.7d	45.0c	17.0bc	16.7cd	286.7cd	4.7cd	326.6c
T_9 - control	41.3f	12.3e	19.7e	6.2e	118.3d	43.3c	20.7c	19.3d	313.3e	5.0e	426.6d

Means in columns followed by the same letter are statistically not significant (Duncan's multiple range test, P=0.05)

Earlier, several studies have proved the efficacy of *P. fluorescens* in suppressing *M. incognita* in many field crops *viz.,* tomato (Jonathan *et al.,* 2000), chickpea (Khan *et al.,* 2001) and turmeric (Srinivasan *et al.,* 2001). Several mechanisms were attributed to the suppression of phytonematodes by the application of *P. fluorescens* such as induced systemic resistance, production of antibiotics and siderophores, competition for nutrients and alteration of specific root exudates such as polysaccharides and amino acids which modify nematode behaviour (Oostendorp and Sikora, 1990; Aalten *et al.,* 1998).

Thus, the present study indicated that the use of *P. fluorescens* treatment is effective to reduce *M. incognita* population and to enhance the yield. Hence *P. fluorescens* can be used as an efficient and eco-friendly bionematicide in ashwagandha and senna.

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