

Management of root-knot nematodes (*Meloidogyne* spp.) in ashwagandha (*Withania somnifera* Dunal.), using different organic amendments in pot conditions

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ABSTRACT: A pot experiment was conducted to study the efficacy of different organic amendments in varying doses for management of root-knot nematodes, *Meloidogyne* spp. in Ashwagandha, (*Withania somnifera* Dunal.). Results indicated that neem cake, poultry manure and mustard cake application proved to be more effective in improving plant growth characters and thereby reducing root-knot disease and final nematode population. Among the doses tested, higher dose of 5 % (w/w) was more effective than lower doses.

Key Words: Organic amendments, Ashwagandha, *Meloidogyne* spp., management.

Ashwagandha [*Withania somnifera* Dunal.], an important medicinal plant species of Solanaceae family is an adoptogenic herb and its roots, seeds and leaves are used in Ayurvedic and Unani medicines (Nigam and Kandalkar, 1995). Ashwagandha roots contain several pyrazole alkaloids like withasomnine, withaferin A, withanolides, withaninol and steroidal lactones, starch and reducing sugars. Withaferin is the chief constituent (0.13 to 0.31%) having bacteriostatic and antitumorous properties. It is considered to be one of the best rejuvenating agents in Ayurveda (Farooqi *et al.*, 2003). As an alternative to chemical pesticides especially for the purpose of protecting crops against phytonematodes and also for the conservation of biodiversity, organic amendments can stand as the most promising sources of bioactive products of plant origin. However, occurrence of root-knot nematodes on ashwagandha adversely affects both yield as well as quality of the produce. Use of chemical nematicides to control these nematodes always poses a serious threat to the health. The use of organic amendments possessing antifeedant properties offers a harmonious approach to nematode management. Hence, attempts were made to manage the nematodes using organic amendments under pot conditions.

Materials and Methods

A pot experiment was conducted at Department of Nematology, Anand Agricultural University, Anand in earthen pots of 15 cm diameter disinfected with 4% formaldehyde (Formalin 40 EC). After drying, pots were filled with nematode infested soil (coarse sand 1.3%, fine sand 63%, silt 15% and clay 20%) accommodating 1.5 kg soil/pot having 237 J₂/100 cc soil mixed with required quantity of different organic amendments *viz.*, T₁ – castor cake, T₂ – neem cake, T₃ – mustard cake, T₄ – Jatropha cake and T₅ – poultry manure each at 1 (D₁), 3 (D₂) and 5 (D₃) % (w/w) making fifteen treatments of organic amendments and one control (without any

amendment). Thus, total sixteen treatments were tried in Completely Randomized Design keeping four repetitions. The pots were watered regularly for proper decomposition. After 30 days, three seeds of root-knot nematode susceptible ashwagandha cv. WS 134 were sown/pot. On germination plants were thinned down to one/ pot. Watering and recommended plant protection measures were adopted as per the requirement. The plants were removed carefully after 60 days of sowing and observations on plant growth characters, root-knot index and soil and root nematode population were recorded and statistically analyzed using appropriate method.

Results and Discussion

Effect of organic amendments (A)

Perusal of data in Table-1 revealed that all the treatments were found significantly superior over control. Maximum plant height was recorded in neem cake (T₂), where as minimum was in castor cake (T₁) treatment. Rest of the treatments had mediocre effect on plant height. As compared to control, all organic amendments were found significantly superior for fresh shoot weight over control. Maximum fresh shoot weight was recorded in neem cake (T₂), which differed significantly from rest of the treatments. Poultry manure (T₅) was next best treatment but statistically on par with mustard cake (T₃). Shoot weight recorded in castor cake (T₁) treatment was at par with Jatropha cake (T₄). Fresh root weight was also significantly more in all the treatments over control. Maximum fresh root weight was obtained in neem cake (T₂) followed by poultry manure (T₅), both being significantly differing from each other. Minimum fresh root weight was recorded in castor cake (T₁) and it was statistically at par with Jatropha cake (T₄) and mustard cake (T₃).

Significant reduction in root-knot index was recorded in all the treatments compared to control. Low-

Table-1: Effect of different organic amendments on plant growth characters of ashwagandha.

Treatment	Plant growth characters			
	Germination count/pot	Plant height, cm	Fresh weight, g	
			Shoot	Root
Organic amendments (A)				
T ₁	3	15.62	13.05	1.73
T ₂	3	22.36	18.59	2.62
T ₃	3	18.96	14.88	1.94
T ₄	3	17.30	14.13	1.81
T ₅	3	20.27	15.84	2.21
S.Em±	0.07	0.57	0.46	0.08
C.D.0.05	NS	1.62	1.30	0.23
Doses (D)				
1% (D ₁)	3	13.88	11.07	1.26
3% (D ₂)	3	17.05	15.03	1.96
5% (D ₃)	3	27.30	19.78	2.97
S.Em				
C.D.0.05				
Interaction A x D	0.05	0.44	0.35	0.06
	NS	1.25	1.01	0.18
	NS	S	S	S
Interaction (A x D)				
T ₁ D ₁	2.75	12.50	8.85	0.99
T ₁ D ₂	3.00	14.50	13.84	1.55
T ₁ D ₃	3.00	23.08	16.47	2.66
T ₂ D ₁	2.75	15.20	12.46	1.75
T ₂ D ₂	3.00	19.18	18.03	2.50
T ₂ D ₃	3.00	32.69	25.28	3.62
T ₃ D ₁	2.75	14.13	10.97	1.09
T ₃ D ₂	3.00	16.31	14.51	1.98
T ₃ D ₃	3.00	26.46	19.14	3.04
T ₄ D ₁	3.00	12.75	10.64	1.02
T ₄ D ₂	3.00	16.25	14.04	1.68
T ₄ D ₃	3.00	25.24	17.69	2.74
T ₅ D ₁	3.00	14.82	12.42	1.46

T ₅ D ₂	3.00	19.00	14.76	2.11
T ₅ D ₃	3.00	27.00	20.33	3.07
S.Em	0.11	0.98	0.79	0.15
C.D.0.05	NS	1.20	2.25	0.07
Control Vs Rest	2.95	12.00	15.30	2.07
	2.75	19.41	1.22	0.49
S.Em	0.09	0.71	0.56	0.10
C.D.0.05	NS	2.00	1.59	0.29
C.V.%	8.5	10.2	10.6	14.1

Table-2: Effect of different organic amendments on multiplication of root-knot nematodes, *Meloidogyne* spp. on Ashwagandha in pots.

Treatment	RKI (0-5)* ($\sqrt{x+1}$)	Nematode population/plant		
		Root		Soil nematode population (Log X)
		Females (Different stages) (\sqrt{x})	Eggs (Log X+1)	
Organic amendments (A)				
T ₁	2.01 (3.04)	3.25 (10.56)	2.67 (466.73)	2.13 (134.90)
T ₂	1.58 (1.50)	2.52 (6.35)	1.56 (35.31)	1.78 (60.26)
T ₃	1.78 (2.17)	2.98 (8.88)	2.11 (127.82)	2.16 (144.54)
T ₄	1.79 (2.20)	2.90 (8.41)	2.41 (256.03)	2.26 (181.97)
T ₅	1.66 (1.76)	2.75 (7.56)	1.96 (90.20)	1.80 (63.10)
S.Em±	0.06	0.06	0.04	0.01
C.D.0.05	0.17	0.16	0.13	0.04
Doses (D)				
1% (D ₁)	2.04 (3.16)	3.57 (12.74)	2.50 (315.23)	2.29 (194.98)
3% (D ₂)	1.75 (2.06)	3.11 (9.67)	2.12 (130.83)	2.12 (131.83)
5% (D ₃)	1.51 (1.28)	2.13 (4.54)	1.81 (63.56)	1.67 (46.77)
S.Em	0.05	0.04	0.03	0.01
C.D.0.05	0.13	0.12	0.10	0.03
Interaction				
A x D	NS	S	S	S
Interaction (A X D)				
T ₁ D ₁	2.18 (3.75)	3.84 (14.75)	2.92 (830.76)	2.34 (218.78)
T ₁ D ₂	1.99 (2.96)	3.45 (11.90)	2.79 (615.60)	2.18 (151.36)

T ₁ D ₃	1.87 (2.49)	2.45 (6.00)	2.30 (198.53)	1.88 (75.86)
T ₂ D ₁	1.79 (2.20)	3.27 (10.69)	1.76 (56.54)	2.20 (158.49)
T ₂ D ₂	1.65 (1.72)	2.73 (7.45)	1.69 (47.98)	1.90 (79.43)
T ₂ D ₃	1.31 (0.72)	1.87 (3.49)	1.22 (15.60)	1.25 (17.78)
T ₃ D ₁	2.12 (3.49)	3.84 (14.75)	2.57 (370.54)	2.32 (218.78)
T ₃ D ₂	1.72 (1.95)	3.12 (9.73)	2.02 (103.71)	2.29 (194.98)
T ₃ D ₃	1.49 (1.22)	2.17 (4.71)	1.74 (53.95)	1.75 (56.23)
T ₄ D ₁	2.18 (3.75)	3.74 (13.99)	2.83 (675.08)	2.38 (239.88)
T ₄ D ₂	1.72 (1.96)	3.31 (10.96)	2.30 (198.53)	2.33 (213.80)
T ₄ D ₃	1.50 (1.25)	2.28 (5.20)	2.09 (122.03)	1.86 (72.44)
T ₅ D ₁	1.93 (2.72)	3.35 (11.22)	2.40 (250.19)	2.18 (151.36)
T ₅ D ₂	1.65 (1.72)	2.96 (8.76)	1.76 (56.54)	1.91 (81.28)
T ₅ D ₃	1.39 (0.93)	1.93 (3.72)	1.72 (51.48)	1.71 (51.29)
S.Em	0.10	0.10	0.08	0.02
C.D. 0.05	NS	1.54	0.22	0.06
Control Vs Rest	1.76	2.94	2.14	2.03
	2.44	12.60	3.23	2.94
S.Em	0.24	0.09	0.06	0.02
C.D. 0.05	0.68	0.25	0.16	0.05
C.V. %	11.18	6.78	6.78	2.25

*0 = Free; 5 = Maximum disease intensity.

Figures in parentheses are re-transformed values of $\log x$, $\log X+1$, \sqrt{x} and $\sqrt{x+1}$ transformation.

est root-knot index (1.58) was recorded in neem cake application (T₂); however, it was at par with poultry manure (T₅) (1.66). Poultry manure (T₅) did not differed significantly from mustard (T₃) and Jatropha cakes (T₄). Among the various amendments maximum root-knot index was recorded in castor cake (T₁) (Table 2).

Number of females/plant were significantly less in all the treatments as compared to control. Neem cake application (T₂) was found most effective which had significantly less number of females than other treatments, followed by poultry manure (T₅). It was statistically at par with Jatropha cake (T₄). Maximum

number of females was recorded in castor cake treatment (T₁).

In case of number of eggs/ plant also, all the treatments were found significantly superior over control. However, all the treatments differed significantly from each other. Application of neem cake (T₂) turned out as most effective which had significantly less number of eggs. Maximum numbers of eggs were noticed in castor cake (T₁) treatment. Minimum soil nematode population was recorded in neem cake (T₂) followed by poultry manure (T₅) both being statistically at par with each other. Maximum soil nematode population was recorded in Jatropha cake (T₄), while treatments

of mustard cake (T₃) and castor cakes (T₂) were statistically at par with each other.

Effect of Doses (D)

With regard to doses of different organic amendments, there was non-significant effect on germination count indicating that none of the cakes was toxic on seed germination but had significant effect on plant height, fresh shoot and root weights, root-knot index, root and soil nematode population. There was gradual increase in plant height with an increase in dose of organic amendments. Maximum plant height was recorded in highest dose of 5% (w/w), while minimum in lowest dose of 1% (w/w). The dose of 3% (w/w) had intermediate effect on plant height (Table 1). Shoot weight increased with an increase in the doses. Minimum shoot weight was recorded in lowest dose 1% (w/w) where as maximum shoot weight was noticed in higher dose of 5% (w/w). Interaction effect between organic amendments and doses was significant. Similarly root weight was observed to be increased with an increase in the doses. Maximum root weight was recorded in 5% followed by 3% dose. Minimum root weight was recorded in the lowest dose of 1% (w/w). Differences for root weight between doses were also significant. Interaction effect between organic amendments and doses were found significant (Table 1).

Root-knot index was inversely related with doses of organic amendments. As the organic amendments dose increased, there was corresponding decrease in root-knot index and they differed significantly from each other.

Different doses had significant effect on nematode population. Negative correlation was observed for number of females / root and dose of organic amendments. Less number of females were recorded in higher

dose. Doses differed significantly from each other for number of females / root. Higher dose was more effective in reducing population of female over lower doses (Table-2). Almost same trend was also observed for egg/ root and soil nematode population.

Interaction effect (A x D)

Interaction effect was non-significant for germination count only. Treatments of neem cake at 5% (T₂D₃) showed maximum plant height, fresh shoot and root weights. Higher dose of poultry manure i.e. 5% (w/w) (T₅D₃) and mustard cake (T₃D₃) were next best treatments and they were significantly at par with each other. Number of females, eggs and soil nematode population was found significantly least in highest dose of neem cake (T₂D₃). Interaction effect for root-knot index was found non-significant (Table 2). The overall results indicated that among different organic amendments, neem cake, followed by poultry manure proved to be best in improving plant growth and development and reducing host infestation. The effectiveness of organic amendments was increased with an increase in their doses. Among three doses, the higher dose of 5% (w/w) proved to be more effective over others.

Application of neem cake @ 10g/ kg autoclaved soil was found best treatment for enhancement of *Ammi majus* growth and reduction in *M. incognita* population (Pandey, 2002). Pandey (2005) also found soil application of Neem cake and Mustard cake each @ 1,000 kg/ ha to *Mentha arvensis* to be the best in increasing herbal yield (q/ha), % oil content and oil yield (kg/ha) and reducing root-knot indices caused by *M. incognita*. Similarly, neem cake @ 200 kg N/ ha proved to be effective as it significantly increased growth characters and decreased *M. incognita* infestation in betelvine (Rana *et al.*, 1991). When organic amendments are applied in the soil, they get decomposed and cause toxic effect on nematodes. They also reduce frequency of pathogenic fungi and increase saprophytic fungi in soil (Tiyagi and Alam, 1996); increase phenol content in roots and thereby induce certain degree of resistance (Alam *et al.*, 1977). As a result of oil cake decomposition, formaldehyde is produced that causes nematode mortality (Alam *et al.*, 1978) and Sitaramaiah and Singh, 1997). Ammonia is also liberated which kills nematodes (Khan *et al.*, 1974).