



Nematicidal potential of oilcake against plant nematodes associated with *Coriandrum sativum* L. in Balochistan, Pakistan

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Abstract

Ten geneta of plant nematode associated with coriander (*Coriandrum sativum* L.) were isolated and identified in ten different localities of Balochistan, Pakistan. The most common was *Meloidogyne javanica* followed by *Basiria* spp. Principal component analysis (PCA) and cluster analysis using Ward's method were performed. The results of the two methods supported each other. Castor and mustard oilcakes and carbofuran, a chemical nematicide were used in treatments against *Hoplolaimus Columbus* and *M. javanica* larvae. Mustard oilcake was found to be more effective on *H. Columbus* while castor oilcake showed effective control on *M. javanica*.

Received: 24 March 2020

Revised: 28 July 2020

Accepted: 16 March 2021

DOI: <https://doi.org/10.3329/bjisir.v56i1.52697>

Keywords: Management; Survey; Control; Mustard oilcake; Castor oilcake

Introduction

Coriander (*Coriandrum sativum* L.) is a well-known ayurvedic herb having all parts of plant edible, but fresh leaves and dried seeds are the most commonly used, among biotic stresses plant-parasitic nematodes, stem-rot, powdery mildew cause substantial damage to crop that is widely grown in Balochistan, Pakistan (Khan *et al.*, 2019). Earlier Anwar and McKenry (2012) had recorded *Hoplolaimus columbus* and *Paratrichodorus minor* from Punjab, Pakistan. Nasr-Esfahani *et al.* (2008) reported several species of root-knot nematodes (*Meloidogyne* sp.) attacking coriander in Esfahan, Iran. There is great variation in the distribution of plant genera associated with it. Some crops may have few nematodes while others have numerous genera associated with the crop. Swapna *et al.* (2017) suggested that nematodes

damage is often underestimated as symptoms are less obvious when compared to other pests. Many plant nematodes feed on the roots of plants and derive their nutrients from living root cells which are altered due to pharyngeal gland secretions prior to food ingestion or by migrating in the infected tissue thereby destroying it (Nicol *et al.*, 2002). Hence the feeding process damages the root system and its ability to absorb water and nutrients (Lambert and Bekal, 2002) and thus provide opportunity for other plant pathogens to invade plant roots which further weakens the plant. Direct damage to plant tissues by root feeding nematodes include distortion of plant parts, vigor and death of tissues which are infected depending on type of nematode species whether ecto-parasitic or endoparasitic.

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Simultaneously due to higher temperatures, humidity and use of high agronomic inputs such as chemical fertilizers and plant growth promoters has resulted in complete crop losses in many areas of the province. The most important symptoms observed in coriander were chlorosis of leaves and stunting (Ravindra *et al.*, 2016). Singh and Gupta (2011) found heavy infestation of root-knot nematode associated with coriander in Gharana Village and some farms of Jammu district. The plant nematodes may cause up to US \$ 100 billion loss per year to world agriculture (Kayani *et al.*, 2017). Feldmesser *et al.* (1971) have estimated damage caused by vegetable crops losses to be 11%. Singh and Kumar (2015) estimated vegetable crop losses due to vegetables in Uttar Pradesh was 23.70% during 2012 to 2015.

The current survey was the first to be taken in Balochistan, Pakistan reporting nematodes associated with coriander alongwith an experiment to evolve control strategy using organic amendments and for comparison a chemical nematicide was used. Those amendments were selected which are easily available by the farmers from the localities surveyed.

Materials and methods

In total 120 rhizosphere soil samples were randomly collected from 10 different areas of Balochistan, Pakistan namely 1. Sakran, 2. Hub, 3. Kalat, 4. Surab, 5. Lasbela, 6. Khundi, 7. Khuzdar 8. Piromal 9. Wadh and 10. Winder. Each sample was a composite of 5-20 random sub-samples taken in the same location, to a depth of 0-15 cms, using a small shovel. Between samples the shovel was thoroughly rinsed with water and properly dried to stop contamination. The rhizosphere soil was thoroughly mixed on a polythene sheet and 200 g was used for extraction of plant parasitic nematodes.

The samples were stored in Polythene bags and kept at 6°C in a refrigerator for not more than two weeks. Extraction of soil nematodes was done according to Cobb's sieving and decanting method followed by modified Baermann's funnel technique (Goodey, 1957; Southey, 1986). Species identification was done of Root-knot nematodes (*Meloidogyne* spp.) by preparation of perineal sections of the females after dissecting out from galled roots, observed under compound microscope (Jepson, 1987). For counting nematode population per 200 g multi-chambered counting dish was used under a stereoscopic microscope particular genus was counted and identification confirmed with Taxonomic keys (Siddiqi, 2000).

Analysis of variance was (ANOVA) performed in accordance with Rosner (2006). Two dimensional ordination using

principal component analysis (PCA) and agglomerative cluster analysis by Ward's method were performed in accordance with Stevens (1996).

The soil was tilled twice within a week before; applying the treatments so as to facilitate the release of any residual fumigant left of any prior experiment. The amendments were incorporated five days before sowing to a depth of 5-10 cm in microplots measuring 1m². The soil was irrigated once a week. Carbofuran at a rate of 10 kg/ha (1 g/m²) and mustard and castor oil-cake 800 kg/ha (80 g/m²) were used. All treatments were applied in accordance with the recommendations of Plant Protection, Pakistan. Weeding was done every 2 weeks. After 12 weeks population of both nematodes was recorded using Baermann Funnel technique. Results were analysed using ANOVA, least significant level (L.S.D.) (Zar, 2008).

Results and discussion

A total of 10 genera of nematodes were recorded from the 10 localities surveyed namely *Basiria* Siddiqi, 1959 spp; *Boleodorus filiformis* Husain and Khan, 1977; *B. pakistanensis* Siddiqi, 1963; *Helicotylenchus dihystra* (Cobb, 1893) Sher, 1961; *H. indicus* Siddiqi, 1963; *Hoplolaimus columbus* Sher, 1963; *H. pararobustus* (Schuurmans Stekhoven and Teunissen, 1938) Sher, 1963; *Meloidogyne incognita* (Kofoid and White, 1919) Chitwood, 1949; *M. javanica* (Treub, 1885) Chitwood, 1949; *Merlinius khuzdarensis* Handoo *et al.*, 2007; *Pratylenchus pratensis* (de Man, 1880) Filipjev, 1936; *Psilenchus hilarus* Siddiqi, 1963; *Tylenchorhynchus annulatus* (Cassidy, 1930) Golden, 1971; *T. brassicae* Siddiqi, 1961 and *Xiphinema* Cobb, 1913 spp. (Table I). The results of principal component analysis (PCA) are shown in Table II. The first, second and the third components explained 60.147, 22.948 and 10.447 percent of total variance respectively in the data set. Together they contributed 93.54% of the total variance. The first component was primarily a function of *Meloidogyne javanica*, *Hoplolaimus columbus* and *Boleodorus pakistanensis*.

The second component was chiefly regulated by *Boleodorus pakistanensis*; *Basiria* spp. and *Meloidogyne javanica* while the third component was basically dependent on species *Hoplolaimus columbus*, *Psilenchus hilarus* and *Meloidogyne javanica*. Fig. 1 shows the 2-dimensional ordination of localities; the localities that are similar are placed together in the ordination. Fig. 2 shows the dendrogram derived from agglomerative cluster analysis of the ten localities with respect to their nematode composition. The chaining is obvious although the method employed (Ward's method with Euclidean distance) is expected to yield spherical neat

Table I. Plant nematodes associated with *Coriandrum sativum* L. in ten different localities of Balochistan, Pakistan

S. No.	Localities	Nematodes
1	Sakran	<i>Pratylenchus pratensis</i> (de Man, 1880) Filipjev, 1936; <i>Xiphinema</i> spp. Cobb, 1913; <i>Hoplolaimus pararobustus</i> (Schuurmans Stekhoven & Teunissen, 1938) Sher, 1963; <i>Tylenchorhynchus annulatus</i> (Cassidy, 1930) Golden, 1971; <i>Meloidogyne javanica</i> (Treub, 1885) Chitwood, 1949, larvae; <i>Psilenchus hilarus</i> Siddiqi, 1963
2	Hub	<i>Hoplolaimus columbus</i> Sher, 1963; <i>M. javanica</i> , larvae; <i>Meloidogyne incognita</i> (Kofoid and White, 1919) Chitwood, 1949 larvae.
3	Kalat	<i>H. columbus</i> ; <i>M. javanica</i> larvae
4	Surab	<i>M. javanica</i> larvae
5	Lasbela	<i>Boleodorus pakistanensis</i> Siddiqi, 1963; <i>P. pratensis</i> ; <i>Xiphinema</i> spp.; <i>Tylenchorhynchus brassicae</i> Siddiqi, 1961
6	Khundi	<i>Helicotylenchus indicus</i> Siddiqi, 1963; <i>Basiria</i> Siddiqi, 1959 spp.; <i>Helicotylenchus dihystra</i> (Cobb, 1893) Sher, 1961; <i>Merlinius khuzdarensis</i> Handoo <i>et al.</i> , 2007
7	Khuzdar	<i>Boleodorus pakistanensis</i> ; <i>Basiria</i> spp.
8	Piromal	<i>B. pakistanensis</i> ; <i>B. filiformis</i> ; <i>H. indicus</i> ; <i>Basiria</i> spp.; <i>H. dihystra</i> ; <i>M. khuzdarensis</i>
9	Wadh	<i>B. pakistanensis</i> ; <i>H. columbus</i> ; <i>Xiphinema</i> sp.; <i>T. brassicae</i> ; <i>P. pratensis</i> ; <i>H. pararobustus</i> ; <i>Basiria</i> spp.; <i>M. incognita</i> larvae; <i>M. javanica</i> larvae; <i>P. hilarus</i>
10	Winder	<i>Basiria</i> spp.; <i>Boleodorus filiformis</i> Husain and Khan, 1977

Table II. Results of principal component analysis showing eigenvalues, eigenvector coefficients and associated variables

S. No.	Eigenvalue	% variance	First 3 eigenvector coefficients	Variable
1	7117.93	60.147	0.8929	<i>M. javanica</i>
			0.37708	<i>H. columbus</i>
			-0.21848	<i>B. pakistanensis</i>
2	2715.72	22.948	0.96633	<i>B. pakistanensis</i>
			0.1796	<i>M. javanica</i>
			-0.0952	<i>Basiria</i> spp.
3	236.34	10.447	0.8853	<i>H. columbus</i>
			0.4984	<i>P. hilarus</i>
			-0.3469	<i>M. javanica</i>
		93.54		

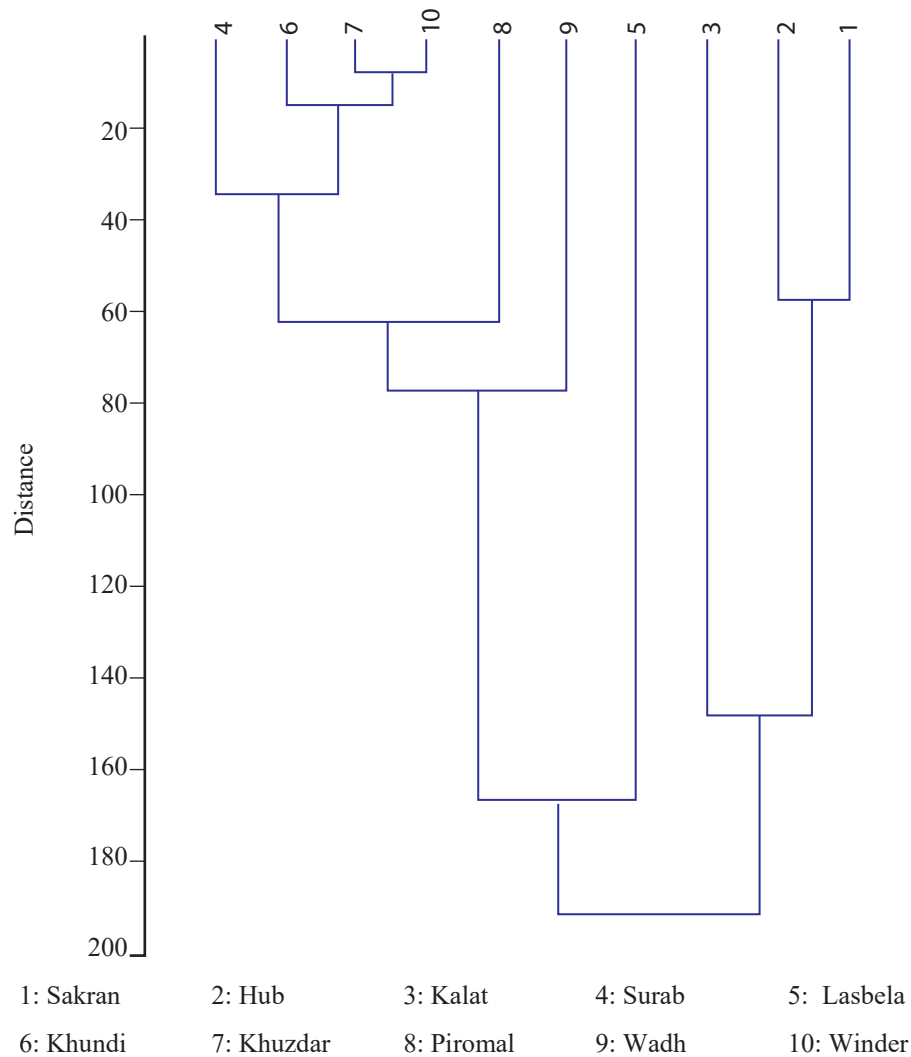


Fig. 1. Dendrogram derived from cluster analysis of 10 localities

groups. A small group of localities 6, 7 and 10 is characterized by the occurrence of *Basiria*. A small sub-group contains *Basiria* and *Boleodorus*. A group composing of localities 1 and 2 that have *Meloidogyne javanica* and *Hoplolaimus columbus* in common. Localities 5 and 9 have *Boleodorus pakistanensis*, *Pratylenchus pratensis*, *Xiphinema* spp. and *Tylenchorhynchus brassicae*, owing to this it joins the group on the left.

The suppression of nematode using oilcake showed that *Hoplolaimus columbus* was significantly ($p < 0.001$) controlled in all the treatments namely mustard oil-cake, castor oilcake and the chemical nematicide carbofuran. When comparing the two oilcakes, mustard oilcake was more effective as compared to castor oil-cake.

Similarly *Meloidogyne javanica* was also significantly ($p < 0.01$) controlled by all the treatments. Castor oilcake was more effective as compared to mustard cake (Table III and IV).

This study provides preliminary information and management of nematodes associated with coriander in Balochistan, Pakistan. Mixed population of nematodes were observed in all the ten localities surveyed. Surface symptoms of nematode infection were usually stunted plants and yellowing of leaves. Migratory nematodes (*Pratylenchus* sp.) feeding on roots of crop cause cavities which lead to bloated tissue, root necrosis resulting in stunted growth and decreased yield. *Xiphinema* sp. which is capable of transmitting virus (Brown *et al.*, 2004) was also encountered in the present survey.

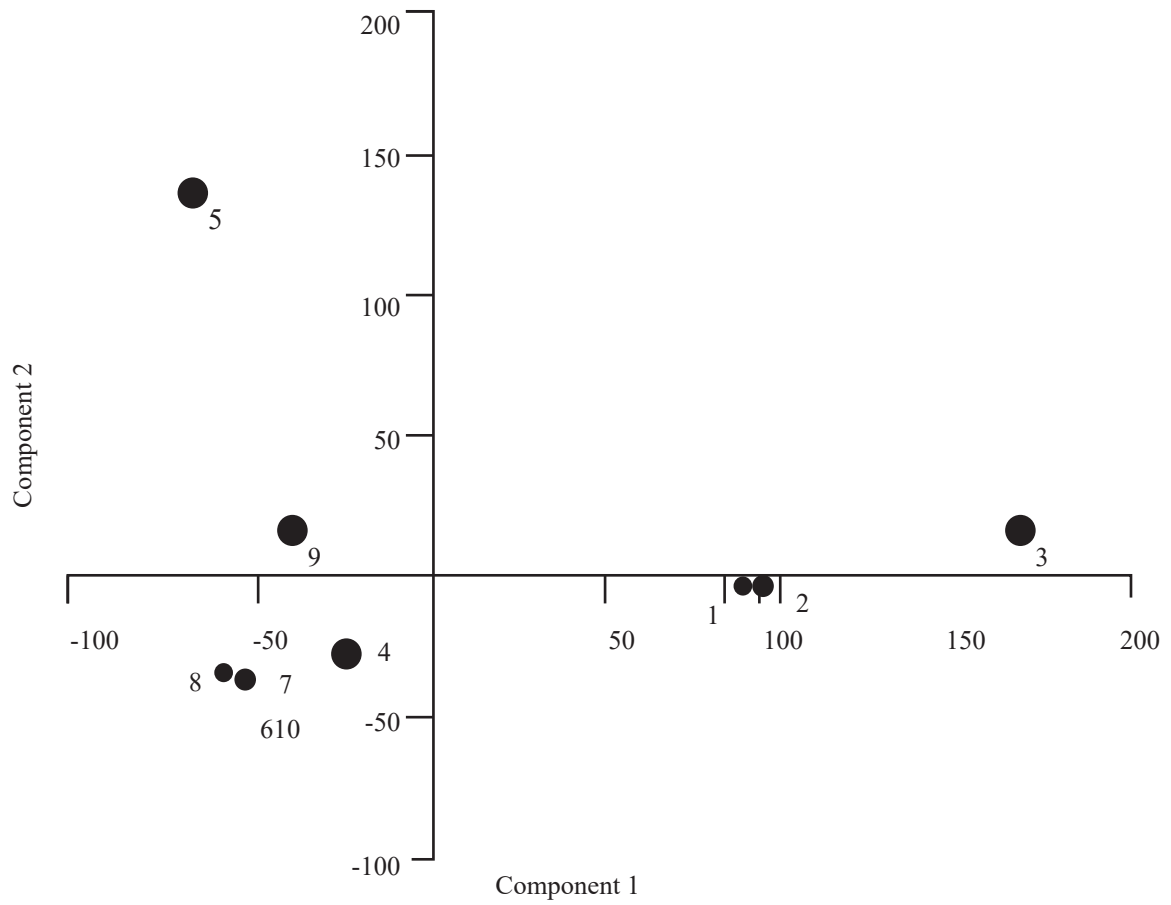


Fig. 2. Two-dimensional PCA ordination of 10 localities from which samples were collected.

Table III. ANOVA table for suppression of *Hoplolaimus columbus* Sher, 1963

	SS	Df	MS	F
Treatment	76176.18	3	2539.20	53.58
Error	5686.75	12	473.89	$p < 0.001$
Total	81863	15		

Table IV. ANOVA table for suppression of *Meloidogyne javanica* (Treub, 1885) Chitwood, 1949

	SS	Df	MS	F
Treatment	272159.18	3	90719.72	8.38
Error	129822.75	12	10018.56	$p < 0.01$
Total	401981.98	15		

Presence of root-knot nematodes, *Meloidogyne javanica* in six localities and *Meloidogyne incognita* in two localities suggest that it is most common parasite of coriander crop (Sheela *et al.*, 2003). Oilcakes derived from castor and mustard were found to be affective in nematode control.

Moreover the cultivation of coriander in Balochistan is common whereas the research on this plant is still limited, management using oilcakes which are helpful in plant growth due to their capability of promoting *Pseudomonas fluorescens* (Rizvi *et al.*, 2012) were used.

Oilcakes are easily available amendments that cause vigorous growth of beneficial organisms, limiting population of nematode and in turn benefitting the crop in various ways (Sumbul *et al.*, 2015). The oilcakes are rich in proteins and minerals and can be applied directly to the soil in the form of powder or pellets, watered and allowed to decompose. With the passage of time decomposition effect increases (Youssef and El-Nagdi, 2010). Now a days the growers are forced to use the options of nematode control which do not cause pollution or lead to undesirable side effects such as hazard of human health, deterioration of environment and are helpful to non target organisms (Abbas *et al.*, 2015).

The results of this survey provide not only insight concerning important nematode associated with coriander in Balochistan but also an indication of the distribution potential leading to crop damage and suitable control using common oilcakes. In addition the survey results are important information to extension staff as suggested by Khan *et al.* (2019) for determining the importance alongwith accurate nematode identification when planning effective management strategies.

Conclusion

Numerous phytonematodes have been recorded associated with coriander roots. In view of the nature of this medicinal plant more research can be done in order to increase the yield of this plant. *Meloidogyne* spp. was found in 6 localities from the 10 surveyed. This group of nematodes causes serious threat to coriander crop in Balochistan province and most probably throughout Pakistan in general. Management using oilcakes which are biodegradable alternates to chemical nematicides for control of plant nematodes are recommended.

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