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ECOLOGY OF PLANT PARASITIC NEMATODES ASSOCIATED WITH SUNFLOWER IN KARNATAKA

B.S. AMARANATHA1 and K. KRISHNAPPA

Department of Plant Pathology, University of Agricultural Sciences, G.K.V.K., Bangalore 560 065, India.

In a random survey, 51 soil and root samples collected from different localities belonging to eight major sunflower growing districts of Karanataka revealed the association of six major plant parasitic nematodes with sunflower viz., *Meloidogyne incognita*, *Rotylenchulus reniformis*, *Helicotylenchus multicinctus*, *Aphelenchus avenae*, *Tylenchorhynchus dubius* and *Aphelenchoides* sp. Distribution, density and frequency of these nematodes were influenced by various ecological factors such as agroclimatic zones, soil types, type of farming, cultivar, previous crop and time sampling.

Keywords : Ecological factors; Plant parasitic uematodes; Sulflower; Population; Frequency of occurrence.

Introduction

Ecology is a complexity of dynamic, interacting environmental factors. In agro-ecosystem there is a lack of homogenity of soil environment both horizontally and vertically (Norton, 1978). The diversity of the community and relative success of the individual species are dependent upon many different factors like its dissemination, climite, edaphic factors, cropping patterns, best suitability, reproductive capacity, persistence and interactions with other organisms.

The sunflower, *Helianthus annuus* L., a member of the Compositae is one of the world important oilseed crop. Karnataka is one among the major sunflower growing states of India. Pests and diseases are the limiting factors in any successful production of crops. Among pests, many plant parasitic nematodes are now reported to occur on sunflower (Gupta, 1986). The association of plant parasitic nematodes with sunflower has not been reported so far in Karnataka. Therefore, a study involving survey was carried out to

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know the influence of various ecological factors on the occurrence and density of plant parasitic nematodes on sunflower in Karnataka.

Material and Methods

A composite sample of 250 g soil and 5g root were collected from each place in a random survey in eight sunflower growing districts of Karnataka. Information regarding soil type of farming (rainfed/irrigated), name of the cultivar, previous crop, and age of the crop were also collected from the farmers at the time of sampling. Samples were processed by Combined gravity and Baermann funnel method for soil (Christie and Perry, 1951) and Blending and sieving method for roots (Ayoub, 1977). Direct observation was also made using stereo-binocular microscope before processing roots to take the counts of sedentery nematodes, if any, present. Estimation of the population was done in 5 ml of the nematode suspension and identification up to generic level was made as per the standard keys (Taylor, 1967; Mai and Lyon, 1975). Results obtained from the survey were analysed to know the influence of various ecological factors such as agro-climatic zones, soil type, cultivar, type of forming, previous crop, age of the crop and time of sampling on density and frequency of occurrence of different plant parasitic nematodes associated with sunflower in Karnataka.

Results and Discussion

Results of survey indicate that among the nematode genera studied, *Rotylenchulus reniformis* was the most predominant in population and frequency of occurrence both in soil (69.7 and 84%) and root samples (47.1 and 50.98%) (fig. 1 and 2). The population of other nematodes like *Helicotylenchns multicinctus*, *Aphelenchus avenae*, *Aphelenchoides* sp. *Tylenchorhynchus dubius* was minimum in soil and root samples. Whereas, the population and frequency of *Meloidogyne incognita* in root samples was maximum next to *Rotylenehulus reniformis*. The population of minor parasitic nematodes, *Hoplalaimus* sp., *Pratylenchus* sp., *Iylenchus* sp. and *Xiphinema* spp. were few in numbers and were recorded together as minimum for populatian and frequency of occurrenc in both soil (1.4 and 21.57%) and root samples (1.7 and 5.88%) (Fig. 1 and 2). Results of survey were further analysed toknow the influence of various ecological factors.

Agro-climatic zones—In case of soil northern dry zone recorded maximum population of *Meloidogyne incognita* (130), *Rotylenchulus reniformis*(2020) and *Helicotylenchus multicinctus*as against no population of *M. incognita*

and *Tylenchorhyanchus dubius* in northern transition zone, while minimum populations *R. reniformis* (150) and *H. multicinctus* (50) were recorded in northern transition zone and southern transition zone respectively. The population of *Aphelenchus avenae* was highest in eastern dry zone as against the nil in southern transition zone. *Aphelenchoides* sp. was maximum (50) in both southern transistion zone and southern dry zone, while minimum (7.89) in central dry zone. Population of *T. dubius* (265) and other parasitic nematodes (160) was maximum in eastern dry zone compared to nil population in both northern and southern transition zone. With respect to frequency, *M. incognita* was maximum (86.87%) in northern dry zone, while *R. reniformis* was present in all the zones at more than 70.0 per cent frequency of occurrence. Similarly, frequency of *H. multicinctus* (75) and *A. avenae* (75%) were maximum in northern zone. With respect to *Aphelenchoides* sp , it was present in all the zone but was more frequent in eastern dry zone (40%) and southern transition zone (50%). *T. dubius* (40%) and other parasitic nematodes (50%) were maximum in eastern dry zone. In case of root samples, population of *R. reniformis* (110), *A. avenae* (70) in northern dry zone, *M. incognita* (139.4) and *T. dubius* (265) in eastern dry zone was maximum. The population of *M. incognita*, *A. avenae*, *A. phelenchoides* sp. *T. dubius* was absent in northern transition zone. With respect to frequency, *R. reniformis*, *H. multicinctus* were less in northern dry zone (33%) and central dry zone (5 26%) respectively. Whereas *H. multicinctus* in southern transition zone and *T. dubius* in eastern dry zone, Southern transition zone and southern dry zone were completely absent. On an average, the population of total parasites was maximum in northern dry zone (286.6) and minimum in northern transition zone (37.5).

Similar variations in the distribution and frequency of different plant parasitic nematodes in various agroclimatic zones have been reported by Lakshmana Murthy (1983) and Krishnappa *et al.* (1984) in Karnataka, India. This variation in distribution of plant parasitic nematodes may be due to the influence of interacting factors such as time, crop, soil type, topography and environmental factors.

Soil types—In case of soil samples, populations of *M. incognita* (115.38), *A. avenae* (142.31), *Aphelenchoides* sp. (26 92), *T. dubius* (207.90) and other parasitic nematodes (126 92), were maximum in red soil. Whereas, *R. reniformis* (1623.68) and *H. multicinctus* (136.84) were maximum in mixed red and black soil. With

respect to frequency, *M. incognita* (68.42%) *H. multicinctus* (57.89) and *A. avenae* (52.63%) were more in mixed red and black soil, while *R. reniformis* (92.31%) *Aphelenchoides* sp. (46.15%), *T. dubius* (38 46%) and other parasitic nematodes (46.15%) were more frequent in red soil (Table 1). On an average mixed red and black soil (1976 31) followed by red soil (1488.46) were having more population compared to deep black soil (292.31) and red loamy soil (291.67).

In case of root samples, samples from red soil recorded populations of *M. incognita* (120.15), *R. reniformis* (242.31), *H. multicinctus* (19.23) and other parasitic nematodes (15 30) in maximum numbers. Whereas, deep black soil recorded minimum populations for all the namatode genera. The frequency of *M. incognita* (47.36%) and *A. avenae* (47 37%) in mixed red and black soil, while, *R. reniformis* (84.61%) and other parasitic nematodes (23.08%) in red soil were maximum. Minimum frequency of occurrence of *H. multicinctus* (7.69%) and *T. dubius* (7.69%) was noticed in deep black soil, while, *M. incognita* (16.67%) and *A. avenae* (16.67%) were less frequent in red loamy soil. On an average, the total nematode parasites were maximum in red soil (424) compared to minimum in deep black soil (61.53). Present findings are in conformity with Koshy *et al.* (1978), who reported that *Radopholus* population in banana plantations was minimum in black clayey soils. Similarly, Mukherji and Jagmohan (1980) reported less prevalence of root-knot nematodes in clayey soils than sandy soil.

Cultivars—In case of soil samples, maximum population of *M. incognita* (125) and *Aphelenchoides* sp. (50) was recorded on EC68415. Whereas *R. reniformis* (2766 67) and *A. avenae* (155 55) on BSH 1. *H. multicinctus* (212.50) on Mahyco, *T. dubius* (132.14) and other parasitic nematodes (71.43) on morden were maximum (Table 1). On an average, BSH 1 had the maximum total parasites (3122.22) compared to minimum in EC 68415 (425) where it recorded minimum or no population of many of the nematodes. With respect to frequency, Mahyco recorded maximum frequency of *M. incognita* (75%), *H. multicinctus* (62.5%), *A. avenae* (50%), *T. dubius* (50%) and other parasites (37.5%), while BSH 1 and EC 68415 had the *R. reniformis* in maximum frequency (100%).

Populations of *M. incognita* (53.78), *R. reniformis* (128.33) on root samples of BSH 1, while, *A. avenae* (75), *T. dubius* (31.25) on Mahyco were maximum and they were minimum on Morden. Average total parasites in root samples of Mahyco was highest (268.75) as against lowest in Morden (85.71)

M. incognita (62 50%), *H. multicinctus* (25.0%) were more frequent on Mahyco,while *T. dubius* (14 28%) and *R. reniformis* (64.38%) on Morden were maximum (Table 1). Barker (1982) and Freckman and Caswell (1985) also observed variations in the distribution and frequency of parasitic nematodes on different cultivars.

Type of farming—Maximum populations of *M. incognita* (82.43), *R. reniformis* (914.76). *H. multicinctus* (101.35), *A. avenae* (81.19), *Aphelenchoides* sp. (17.57). *T. dubius* (104.05) and other parasitic nematodes (52.70) were recorded in soil samples collected from irrigated fields. Similarly, frequency of all the nematodes except *Aphelenchoides* sp. (28 57%) recorded maximum in the irrigated fields. Average total nematode parasites were more (1362.16) in samples from irrigated fields than from rainfed fields (860.70).

In case of root samples, both population and frequency of *M. incognita* (63.35 and 40.59%), *H. multicinctus* (14.86 and 16.22%), *A. avenae* (39.19 and 29.73%) and *T. dubius* (52.70 and 27.03%) were maximum in irrigated fields, but both population and frequency of *Aphelenchoides* sp. (8.11 and 8.11%) were maximum in rainfed fields. Though population of *R. reniformis* was more in irrigated fields (121.64) its frequency was highest in ranifed fields (64.28%) compared to irrigated fields (45.94%). On average, total nematode parasites were far more in roots of irrigated fields (260.65) compared to rainfed fields (129.86). In the present investigation showing more *Aphelenchoides* population in rainfed fields is in conformity with Wallace (1973), who opined that some nemadoes can escape from the soil and with their highly developed ability to resist desiccation and chances of dispersal are correspondingly greater but, for the endoparasites and ectoparasitic nematodes thet attack roots such opportunities rarely occur.

Previous crop—Maximum populations of *R. reniformis* (1580.55) *T. dubius* (80.55) and other parasitic nematodes (41.67) observed in soil samples when sunflower preceded the sunflower crop, while populations of *H. multicinctus* (166.67) and *Aphelenchoides* sp. (33.34) were maximum when maize preceded sunflower. Similarly the populations of *M. incognita* (275) and *A. avenae* (75) were maximum observed respectively when ragi with cowpea and Jowar were grown as previous crops. Minimum population of *R. reniformis* (66.66) and no populations of *M. incognita*, *A. avenae* *Aphelenchoides* sp. *T. dubius* and other parasitic nematodes were recorded when field was fallow previous to sunflower crop. With respect to frequency, *R. reniformis* was observed in all the samples (100%)

when jowar, maize, ragi with cowpea and fallow preceded the sunflower. Frequency of *M. incognita* was more (100%) when sunflower was the previous crop, whereas. *H multicinctus* maximum (66.66%) when preceding crop was maize (Table 2).

In case of root samples maximum population of *R reniformis* (187 5), *H. multicinctus* (37 5) and *A. avenae* (75) were seen when cotton preceded sunflower while population of *M incognita* (275), *Aphelenchoides* sp. (25) and other parasitic nematodes (25) were maximum when ragi with cowpea were grown as previous crops. No nematode except *A. avenae* (16.67) was present in the field that was fallow previous to sunfower.

Maximum average parasitic nematodes in soil (1947.22) and root samples (337.5) were recorded when sunflower and cotton preceded sunflower crop respectively. Minimum number of nematodes were encountered when fallow preceded the sunflower both in soil (88.33) and root samples (16 66).

Influence of crops such as peanut, corn, wheat and sorghum when planted prior to tobacco significantly reduced the incidence of *M. incognita* as reported by Muro (1975). Varaprasad (1986) also reported reduced populations of *Rotylenchulus* spp. on pineapple under irrigated fallow conditions which is in conformity with present investigation showing low population of the nematode when fallow preceded the sunflower.

Age of the crop—In case of soil samples populations of *M. incognita* (139.28) and *R. reniformis* (2385.71) were maximum on 2–3 months old sunflower crop. Whereas, *H. multicinctus* (300) and *A. avenae* (340) were maximum on plants aged more than 3 months. While, *T. dubius* (212.5) and other parasitic nemadodes (100) were more on plants less than one month old. Minimum populations of *R. reniformis* (119.23), *H. multicinctus* (44.23) and other parasitic nematodes (5.77) were noticed on crop with age group between 1–2 months, while, minimum population of *M. incogniia* (25) and no population of *Aphelenchoides* sp. was observed on less than one month old crop. With respect to frequency *M. incogniia* (100%), *R. reniformis* (100%), *H. multicinctus* (80%), *A. avenae* (80%) and other parasitic nematodes (40%) were more frequent on crop aged more than 3 months, while, *R. reniformis* (100%) and *T. dubius* (35.71%) were maximum on the crop with an age group between 2–3 months. Frequency of *M. incognita* (25%) was less observed on less than one month old crop.

In case of root samples, crops with an age group between 2-3

months recorded maximum population of *M. incognita* (130.5) and *R. reniformis* (153.51) while, crop more than 3 months showed higher populations of *H. multicinctus* (20), *A avenae* (120), *Aphelenchoides* sp. (30) and *T. dubius* (50). Minimum populations of *M. incognita* (12.5) *A. avenae* (12 5) and no populations of *Aphelenchoides* sp. and *T. dubius* were noticed on less than one month old crop. Whereas population of *H. multicinctus* was minimum on crop with an age group between 2-3 months. *R. reniformis* was minimum (60) on crop aged more than 3 months. With respect to frequency, *M. incognita* (60%), *A. avenae* (80%), *Aphelenchoides* sp. (20%) and *T. dubius* (50%) were maximum on the crop of more than 3 months old, while the crops with an age group of 2-3 months recorded *R. reniformis* in more number of samples (92.86%). Minimum frequency of *R. reniformis* (30.76%) and *H. multicinctus* (11.54%) and complete absence of other parasitic nematodes were observed on 2-3 months old crop. On an average, total parasitic nematodes were maximum in the soil (2853 5) and root samples (336 8) from 2-3 months and more than 3 months old crops respectively. While, minimum in soil samples of 1-2 months old (328.84) and root samples of less than one month old crops (150). Increase of nematode population with the age of crop has been reported by Abawi and Mai (1981) and Barker (1985). Distribution of nematode within the crop of different age groups are most probably influenced to a greater extent by preferences for particular type of tissues as reported by Wallace (1973).

Time of sampling Maximum populations of *R. reniformis* (1284.62) and *H multicinctus* (119.23) were recorded in soil samples collected during March, while *T. dubius* (283.33) and other parasitic nematodes (133.33) were maximum in December. *M. incognita* (100) and *Aphelenchoides* sp. populations (100) were more in samples collected during May. Similarly, *A. avenae* was maximum (256.25) in February. Minimum number of *R. reniformis* (75) and no population of *A. avenae* were seen in samples collected during June while, minimum populations of *H. multicinctus* (5 56), *Aphelenchoides* sp. (11.11) and no populations of *T. dubius* were observed in samples collected during November. *M. incognita*, *A. avenae* and other parasitic nematodes were absent during October.

Soil samples collected in Fabruary recorded maximum frequency of *R. reniformis* (100%). *H multicinctus* (75%), *A. avenae* (75%), *Aphelenchoides* sp. (37.5%) while, *M. incognita* (100%), *T. dubius* (50%) and other

parasitic nematodes (50%) being maximum found in samples collected during June.

In case of root samples, maximum populations of *R. reniformis* (293.75) and *H. multicinctus* (37.5) were observed in February, while, *M. incognita* (605), *A. avenae* (100) and *Aphelenchoides* sp. (50) were maximum during June, May and October respectively. *T. dubius* (15.28) was present only in March. *M. incognita, H. multicinctus, T. dubius* and other nematodes were absent in October. Population of *H. multicinctus* also absent during May, June, October and December as against *Aphelenchoides* which was absent during February, May and June. With respect to frequency, *R. reniformis* was present in all the samples collected during October and December. Similar type of variations in the population of various nematodes with the change in seasons in respect of several crops has been reported by Laughlin and Williams (1971) and Pinochet and Cisnerow (1984). Fluctuations in nematode numbers occur during growing season and often correlated with major divergences in temperature and moisture (Norton, 1978).

In general, it can be inferred that various ecological factors such as agroclimatic zone, soil type, cultivar, previous crop, type of farming, age of the crop and time of sampling have influenced the density and frequency of different plant parasitic nematodes on sunflower in Karnataka Thus, the information generated from these studies may be best utilised for development of effective integrated management programme in Karnataka.

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Table 1. Influence of soil types and cultivars on the average density and Karnataka

Soil type	Total samples		Average density (D) and frequency of Meloidogyne incognita		Rotylenchulus reniformis		Helicotylenchus multicinctus		Aphelenchus avenae	
			Soil	Root	Soil	Root	Soil	Root	Soil	Root
Deep black soil	13	D	23.08	11.53	100.00	15.38	46.16	3.84	34 61	15.38
		F	30.76	23.08	78 57	38.46	38 46	7.68	30.76	30.76
Red soil	13	D	115.38	120.15	823.08	242.31	46.15	19.23	142.31	19.23
		F	61.54	46.15	92 31	84.61	46.15	15.38	38.46	23 08
Red loam	6	D	41.67	16 67	116.67	58.33	83 33	8.33	16.67	16.67
		F	16.67	16.67	83.33	83.33	50.00	16.67	33 33	16 67
Mixed red and black soil	19	D	102.63	47.36	1623.68	89 47	136.84	13.16	60 53	57.89
		F	68.42	47 36	78.94	31.58	57.89	15.79	52.63	47.37
Total	51		4000	2712	43550	5400	4300	600	3550	1650
cultivars' BSH-1	9	D	33 33	53.78	2766.67	122 23	72.22	11 11	155 55	22.22
		F	33.33	33 33	100.00	44.44	55.55	11.11	22.22	22.22
Morden	14	D	53.57	21.43	253.59	32.14	85 71	7.14	64.28	10.71
		F	35.70	21.43	85.57	64.28	50 00	14.28	50.00	21.43
Mahyco	8	D	112.50	37.50	1031.29	97 50	212 50	18.75	50.00	75 00
		F	75.00	62 50	87 50	37.50	62 50	25.00	50.00	75.00
EC 68415	2	D	125.00	50 00	225.00	75.00	25.00	—	—	75.00
		F	50.00	50.00	100.00	50.00	50.00	—	—	100.00
Total	33		2200	1184	37150	2400	3600	350	2700	1100

* Others include *Hoplolaimus, Pratylenchus. Tyienchus* and *Xiphinema*

(—) *No population*

frequency of occurrence of plant parasitic nematodes associated with sunflower in

nematodes (F)/250 ml of soil or 5 g of root

Aphelenchoides sp.		Tylenchorynchus dubius		Others*		Total		Average	
Soil	Root	Soil	Root	Soil	Root	Soil	Root	Soil	Root
3.85	7.69	84.61	7.69	—	—	3800	800	292.31	61.53
7.69	15.38	38.46	7.69	—	—				
26.92	7.69	207.70	—	126.92	15.38	19350	5512	1488.46	424
46.15	15.38	38.46	—	46.15	23.08				
25.00	16.67	—	8.33	8.33	—	1750	750	291.67	125
33 33	33.33	—	16.67	16.67	—				
15.79	10.53	21.05	13.16	15.79	—	37550	4400	1976.31	231.58
26.31	10.53	21.05	5,26	21.05	—				
850	500	4200	400	2000	200	62450	11462		
—	16.67	94.44	—	—	—	28100	2034	3122.22	226
—	33.33	22.22	—	—	—				
14.28	3.57	132.14	7.14	71.43	3.57	9450	1200	675	85.71
21.43	7.14	21.43	14.28	21.43	7.14				
12.50	18.75	37.50	31.25	31.25	—	11900	2150	1487.5	268.78
25.00	12.50	50.00	12.50	37.50					
50.00	—	—	—	—		850	400	425	200
50.00	—	—	—	—					
400	350	3000	350	1250	50	50300	5784		

Table 2 Influence of previous crop on the average density and frequency of

Previous crop	Total samples		Average density (D) and frequency of *Meloidogyne incognita*		*Rotylenchulus reniformis*		*Helicotylenchus multicinctus*		*Aphelenchus avenae*	
			Soil	Root	Soil	Root	Soil	Root	Soil	Root
Sunflower	18	D	75.00	47.22	1580.55	91.67	119.44	8.33	38.89	38.89
		F	61.11	44.44	61.11	44.44	50 00	11.11	50.00	33.33
Cotton	4	D	125.00	12.50	137.50	187.50	137.50	37.50	12.50	75.00
		F	50.00	25.00	50.00	100.00	50.00	50.00	25.00	50.00
Jower	4	D	62.50	25.00	137.50	62.50	50.00	—	75 00	50.00
		F	25.00	25 00	100.00	25.00	50.00	—	50 00	75.00
Groundnut	4	D	62.50	25.00	137.50	12 50	50.00	—	50.00	12.50
		F	50.00	50.00	75.00	25.00	25.00	—	25.00	25.00
Ragi+ Cowpea	2	D	275.00	84.00	625 00	75.00	—	—	—	25.00
		F	100.00	100.00	100.00	100.00	—	—	—	50.00
Maize	3	D	50.00	16.67	100.00	33.33	166.67	16.67	16.67	33.33
		F	33.33	33.33	100.00	66.66	66.66	33.33	33.33	33.33
Fallow	3	D	—	—	66.66	—	16.66	—	—	16.66
		F	—	—	100.00	—	33.33	—	—	33.33
Total			3050	1318	31850	2950	3650	350	1300	1450

* Others include *Hoplolaimus, Pratylenchus, Tylenchus* and *Xiphinema*

(—) No population

occurrence of plant parasitic nematodes associated with sunflower in Karnataka

nematodes (F)/250 ml of soil or 5 g of root

Aphelenchoides sp		*Tylenchorhynchus dubius*		Others*		Total		Average	
Soil	Root	Soil	Root	Soil	Root	Soil	Root	Soil	Root
11.11	16.67	80.55	13.89	41.67	5.55	35050	4000	1947.22	222.22
22.22	22.22	27.78	5.55	27.78	5.55				
—	12.50	12.50	12.50	12.50	—	1750	1350	437.5	337.5
—	25.00	25.00	25.00	25 00					
25.00	12.50	—	—	—	–	1400	600	350	150
50.00	25.00	—	—	—	—				
—	—	37.50	—	—	—	1350	200	337.5	50
—	—	50.00	—	—	—				
25.00	25.00	—	—	—	25.00	1850	468	925	234
50.00	50.00	—	—	—	50.00				
33.34	—	—	—	16.67	—	1150	300	283.33	100
66.67	—	—	—	33.33	—				
—	—	—	—	—	—	250	50	83.33	16.67
—	—	—	—	—	—				
450	450	1650	300	850	150	42800	6968		