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SEASONAL VARIATIONS OF ROOT-KNOT NEMATODE POPULATION IN A CARDAMOM PLANTATION

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Abstract : Population dynamics of root knot nematodes (*Meloidogyne* spp.) in a cardamom plantation was studied for three years. Number of second stage juveniles of root knot nematodes in soil was highest during March-April. Nematode population in roots increased rapidly during the post monsoon period, declined gradually during summer and was lowest in monsoon months. Crop phenology appears to be the major factor influencing the fluctuations in nematode populations than ecological factors like rainfall and soil temperature.

Key words : Cardamom, *Elettaria cardamomum*, *Meloidogyne* spp., population dynamics , root-knot nematodes.

Cardamom (*Elettaria cardamomum*, Maton) cultivation in India is confined to the western ghats. It is grown as a monocrop and also as an intercrop with coffee and black pepper. Among the different nematode species infesting cardamom, root-knot nematodes (*Meloidogyne* spp.) are widespread in nurseries and plantations (Eapen, 1991). Although economic losses due to their attack are not precisely quantified in cardamom, they are found to cause severe damage to the growth and yield. Population density of nematodes varies considerably due to several factors like food availability, soil type, soil moisture, soil temperature and many other extrinsic factors (Norton, 1979). An understanding of the seasonal fluctuations of root-knot nematodes in cardamom plantations would help 1) to determine the appropriate time for controlling these nematodes, 2) to identify the optimum time for sampling and population assesment and 3) to limit the nematicide applications in an year.

MATERIALS AND METHODS

Soil and root samples were taken from randomly selected spots in a nematode infested and rainfed cardamom plantation (4-year old) in Coorg district, Karnataka, where the mean annual rainfall is around 230cm. Apart from cardamom, common shade trees like *Artocarpus heterophyllus, Dimocarpus longan, Erythrina lithosperma, Mimusops elengi, Terminalia tomentosa*, etc. were present in the above area. Soil is predominantly clayey loam, with a pH of 6.2. Sampling was done at monthly intervals for three years from January, 1988. Soil samples were drawn at three depths viz. 0-15, 16-30 and 31-45cms, with a 2.5cm diameter tube. Probes were taken around the plant from three spots, at each horizontal distance of 30 and 45cm away from the base of the plant. The corresponding vertical subcores at each distance collected from a plant were bulked and 250cm^3 aliquant was processed to extract nematodes from soil by a combination of bucket sieving method and a miniature version of Whitehead & Hemming (1965) tray method. About 15-20g of young roots were also collected from the root zone of each plant. Roots were washed thoroughly, cut into small pieces and stained in acid fuchsin-lactophenol (Daykin & Hussey, 1985). Nematodes were freed from the stained roots by maceration in a laboratory mixer and three one ml subsamples were removed from the suspension to obtain the population count (Marks & Mckenna, 1981).

Soil temperature was recorded daily at three depths (10, 20 and 30cm) and monthly rainfall data was obtained from the metereological records of the research centre. All nematode counts were log transformed (logX+1) and were subjected to analysis of variance. The means were separated by least significant difference test ($P<0.05$).

RESULTS AND DISCUSSION

The root-knot nematodes (*Meloidogyne* spp.) population in cardamom fields showed typical patterns in all the years of the study. In soil, the major nematode species found were to be *Meloidogyne incognita* and *M. javanica*. Other nematodes of common occurrence were *Helicotylenchus* spp., *Rotylenchulus* spp. and *Paratylenchus* spp. Root-knot nematode population in soil was comparatively low as only the second stage juvenile (J2) densities were assessed for convenience. Among the two sampling distances and three soil depths studied, samples collected at 30cm away from the base of the plant and at 30cm soil depth yielded significantly higher number of root-knot nematodes (Table 1). Hence this can be considered as the optimum zone for root-knot nematodes of cardamom.

The J2 densities in soil increased from December onwards and reached the peak during March (224.8/250cc) (Fig. 1). During this period the rainfall was minimum and the mean soil temperature in the upper 30cm of soil fluctuated between 15.6°C and 21.1°C (Fig. 2). The rapid increase in J2 densities in soil during these months suggests increased hatching of eggs. However, nematode densities in roots for the corresponding period were comparatively low. In roots, their densities reached maximum during November-December and the annual minimum densities were recorded during the monsoon season i.e. June-September (Fig. 1). The post monsoon build up in root-knot nematode population continued till December. Also noteworthy is the observation that from September to December nematodes extracted from roots were mainly in the egg and larval stages (Fig. 3).

TABLE 1 : Number of second stage juveniles of root-knot nematodes in soil samples collected at three soil depths and two distances away from the base of cardamom plants.

Distance (S)	Soil population per 250cc soil at three soil depths (D)*				
	15cm	30cm	45cm	Mean (S)	LSD (S) 0.05
30cm	0.947 (7.85)	1.027 (9.64)	0.950 (7.91)	0.975 (8.44)	
45cm	0.807 (5.41)	0.926 (7.43)	0.697 (3.98)	0.810 (5.46)	0.112
Mean (D)	0.877 (6.53)	0.976 (8.46)	0.823 (5.65)		0.195
LSD (D) 0.05		0.138			LSD (S x D) 0.05

* Log10 transformed nematode counts (average over 12 months, 3 years and 3 replications). Figures in parentheses are weighted means obtained after detransformation.

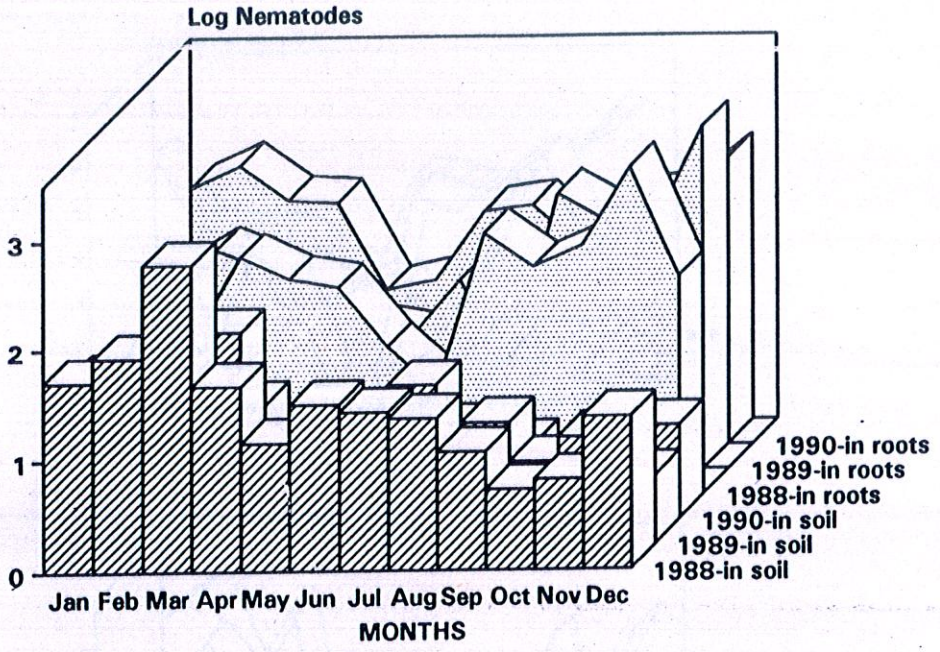

Fig. 1. Monthly fluctuations of root-knot nematode populations in soil and roots of cardamom plants.

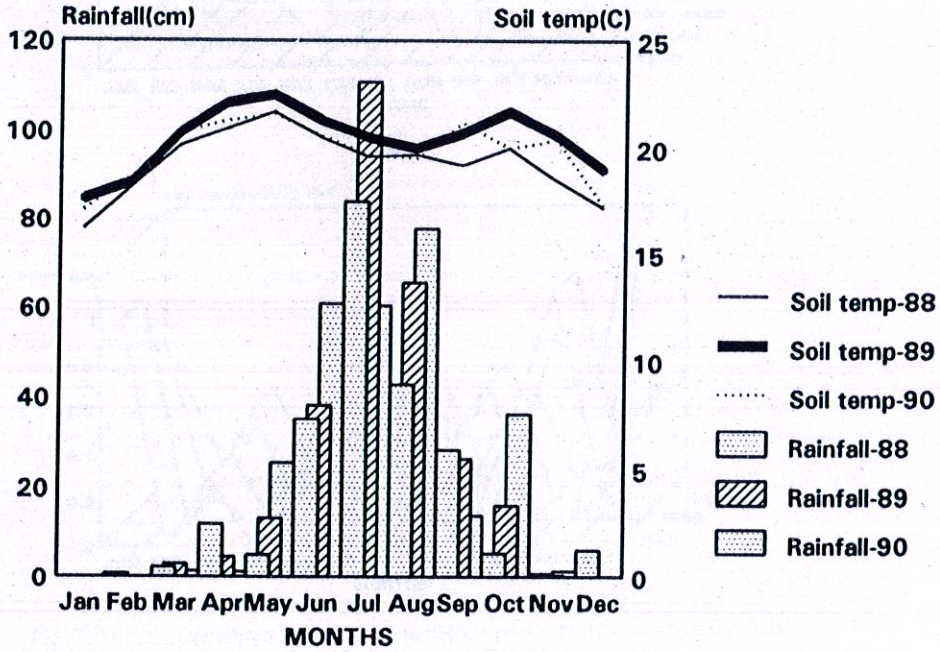

Fig. 2. Monthly rainfall and mean soil temperature of top 30cm of soil in a cardamom plantation.

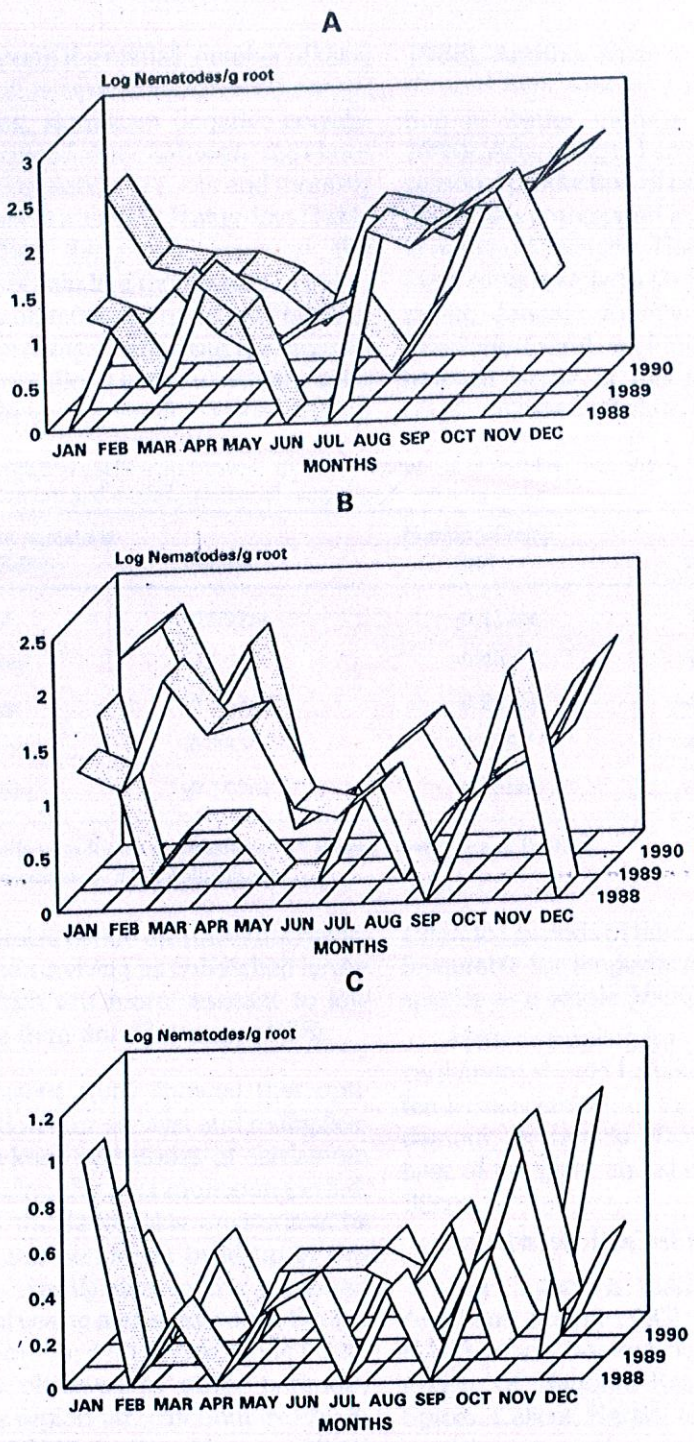

Fig. 3. Seasonal variations in root-knot nematode populations in cardamom roots : A) Eggs, B) Larvae and C) Adults.

Eventhough the rainfall, number of rainy days and soil temperature followed consistent patterns, significant negative correlation was noticed only between root-knot nematode population in roots and monthly rainfall as well as number of rainy days (Table 2). More than the rainfall intensity, the distribution of rain in a month was found to be adversely affecting the nematode build up in cardamom roots. Continuous rain leads to anaerobic conditions in soil which are quite unfavourable for nematode survival. During this unfavourable period the root-knot nematodes may be surviving as unhatched larvae in eggs, which are more resistant to low temperature than are J2 (Vrain, 1978).

TABLE 2. Correlation coefficients between monthly populations of root-knot nematodes in soil and roots of cardamom and rainfall, number of rainy days & soil temperature.

Root-knot nematode population	Rainfall	Number of rainy days	Soil temperature
In soil	-0.097ns	-0.117ns	-0.241ns
In roots	-0.386*	-0.435**	-0.254ns
a) Eggs	-0.268ns	-0.262ns	-0.143ns
b) Larvae	-0.335*	-0.485**	-0.294ns
c) Adults	-0.143ns	-0.155ns	-0.367*

Correlation coefficients for 36 observations. *,** denote significance at $P<0.05$ and $P<0.01$, respectively. ns=not significant.

The present study showed that optimum conditions for survival and multiplication of root-knot nematodes of cardamom prevailed during the post monsoon period. Apart from the favourable environmental conditions, the nematode build up in this season was mainly due to the increased availability of young and active roots. Similar post monsoon build up of nematode populations was observed in other perennial crops of the region viz., coconut (Koshy & Sosamma, 1978), coffee (Kumar, 1991) and black pepper (Mohandas & Ramana, 1988). Another study in kiwifruit orchards showed high root-knot nematode population in winter months (Pinochet *et al.*, 1990). According to Ferris & Noling (1986), seasonal production of new root biomass in perennials correspond to seasonal changes in nematode density. The non availability of fresh roots coupled with the moisture stress during January to May lead to reduced infestation and multiplication of newly hatched larvae of this season. Optimum conditions are unlikely to occur in nature for extended periods of time and are not always favourable for longevity and survival of the species as a whole (VanGuindy, 1982).

Hence sampling for nematode assay in cardamom should be taken up during September-December, in the root zone of cardamom, preferably 30cm away from the base of the plant and at a soil depth of 16-30cm.

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