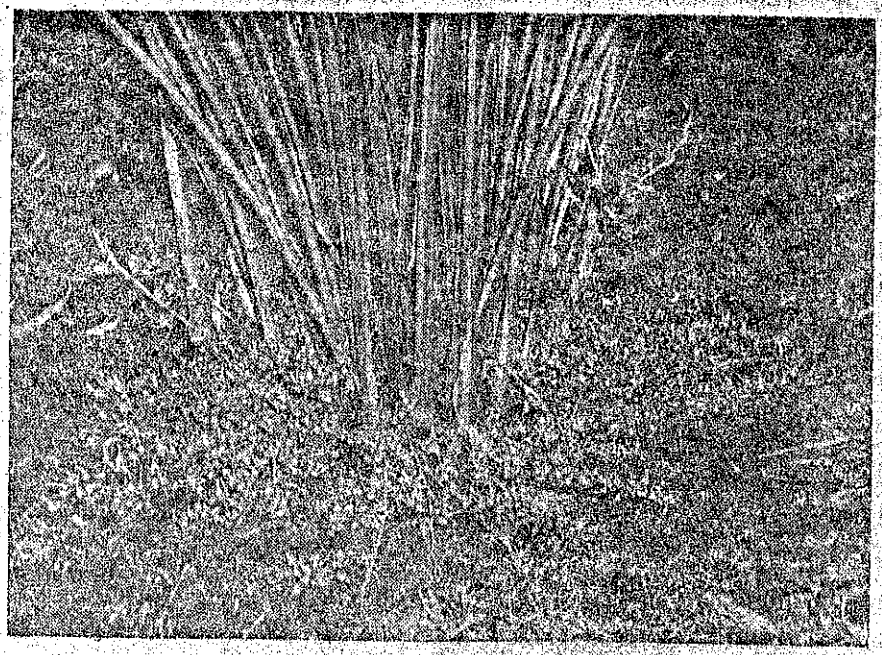

NEMATODE PESTS OF SMALL CARDAMOM: PRESENT STATUS AND FUTURE PROSPECTS

SANTHOSH J. EAPEN
National Research Centre for Spices,
Cardamom Research Centre, Appangala, Madikeri-571201, Karnataka.

The productivity of small cardamom (*Elettaria cardamomum*) is very low in India compared to other cardamom growing countries. Plant parasitic nematodes are universally recognised as potentially serious constraints to productivity. But unfortunately the nature and magnitude of the problem and their economic importance are overlooked or go unnoticed due to the dearth of any specific external symptom. However, there were some reports in the last decade on the occurrence of nematodes in cardamom plantations. But intensive research work was initiated only after the establishment of a Nematology laboratory at Cardamom Research Centre, Appangala, during 1982, the then research centre of CPCRI.

NEMATODES ASSOCIATED WITH CARDAMOM

About 20 genera of plant parasitic nematodes are reported to be associated with cardamom (Table-1). Among them, the most important and more widely distributed are the root-knot nematodes, *Meloidogyne sp.* Other common nematodes are *Helicotylenchus sp.* and *Rotylenchulus sp. Pratylenchus sp. Radopholus similis* are present in mixed plantations (Eapen, 1987).

ROOT-KNOT NEMATODES, *Meloidogyne sp.*

The first report of the association of root-knot nematodes with cardamom was in 1970 (D'souza *et al.* 1970). Later Kumar *et.al.* (1971), Kasiviswanathan *et al.* (1974), Koshy *et al.* (1976) and Sundararaju et al. (1979) also reported their occurrence in cardamom plantations and nurseries. But a clear picture on their distribution and damage potential was available only after an extensive survey conducted during 1979-82 covering the entire cardamom growing belt of the country (Ali, 1984 a; 1986 a;

Table 1: PLANT PARASITIC NEMATODES ASSOCIATED WITH CARDAMOM

Nematode Species	*References*
a) ECTOPARASITES	
Aphelenchoides sp.	Sundararaju *et al.*, 1979.
Helicotylenchus sp.	,, ,,
Helicotylenchus dihystera	Kasi Viswanathan *et al.*, 1974.
Helicotylenchus multicinctus	,, ,,
Hemicriconemoides gaddi	,, ,,
Hemicycliophora argiensis	Khan & Nanjappa, 1972.
Hoplolaimus sp.	Sundararaju *et al.*, 1979.
Nothocriconema cardamomi	Khan & Nanjappa, 1972.
Nothocriconema coorgi	,, ,,
Crossonema taylatum	Khan *et al.*, 1976.
Rotylenchus sp.	Kasi Viswanathan *et al.*, 1974
Trichodorus minor	,, ,,
Tylenchorhynchus sp.	,, ,,
Xiphinema sp.	,, ,,
b) ENDOPARASITES	
Meloidogyne sp.	D'souza *et al.*, 1970
Meloidogyne arenaria	Ali, 1984 a.
Meloidogyne incognita	Kumar *et all.*, 1971 a, Kasi Viswanathan *et al.*, 1974 Koshy *et al.*, 1976; Sundararaju *et el.*, 1979; Ali & Koshy, 1982a; Ali, 1984a; Ali, 1986a.
Meloidogyne javanica	Kumar *et al.*, 1971a; Ali & Koshy, 1982 a.
Pratylenchus sp.	Kasi Viswanathan *et al.*, 1974, Sundararaju *et al.*, 1979.
Pratylenchus coffeae	D'souza *et al.*, 1970; Kumar *et al.*, 1971 a; Kasi Viswanathan *et al.*, 1974; Kumar & Kasi Viswanathan, 1972.
Radopholus similis	D'souza *et al.*, 1970; Kumar *et al.*, 1971 b; Kasi Viswanathan, *et al.*, 1974.
Rotylenchulus reniformis	Kumar *et al.*, 1971 a

Ali&Kosoy, 1982 a). A summary of results of this survey is given in Table II.

NATURE OF DAMAGE:

Root-knot nematodes are a 'limiting factor' that is constraining the effective utilisation of inputs by the plants. The time lag between initial infestation and visible plant injury is quite long. Kumaresan *et al.* (1988) have compiled the symptoms of nematode infestation on cardamom in detail. Below ground symptoms include the characteristic galling, which is more pronounced in seedlings, suppression of secondary roots and abnormal branching (Ali, 1986).

As in many other crops, the above ground symptoms in cardamom caused by damage to the root system are very general and non-specific. They are stunting, poor tillering, narrowing and yellowing of leaves, drying of leaf tips and margins, poor germination of seeds, poor establishment on transplanting, decline in capsule production and loss in yield (Anonymous, 1972; Anonymous, 1989 a) The level of plant response depends on the nematode species and their density, susceptibility of the plants and other growing conditions. Eventhough Ali (1987) reported 32 to 40 per cent yield loss in untreated plants, precise data on yield losses are not yet available. An ongoing microplot study at NRCS, Appangala has shown significant reduction in tillering, six months after inoculation, even at the inoculum level of 100 nematodes/plant (Anonymous, 1989b). Subsequently, there was about 38.6 to 54.5 per cent reduction in the first year yield of these plants.

The age of the plant at the time of infection is quite important. If the infestation takes place in the seedling stage itself, the damage will be more pronounced. Plants of different age groups were compared for their relative susceptibility and symptom expression. The galling and retardation of root growth are considerably greater in young seedlings than in adult suckers.

Table II: NUMBER OF SAMPLES AND AVERAGE ROOT-KNOT NEMATODE LEVEL IN CARDAMOM GROWING STATES OF SOUTH INDIA

State & District	NURSERIES				MAIN FIELDS		TOTAL samples collected	
	Primary		Secondary					
	Root	Soil	Root	Soil	Root	Soil	Root	Soil
KARNATAKA								
Chikmagalur	273*	278**	606	479	216	185	32	32
Hassan	340	274	453	376	316	260	101	101
Kodagu	345	285	442	341	393	297	166	166
Uttara Kannada	450	379	549	461	308	269	32	32
KERALA								
Idukki	1030	178	309	165	326	473	184	138
Palghat	—	—	—	—	556	428	8	6
Pathnamthitta	180	4	975	134	255	2	9	6
Wynadu	—	—	344	2	445	126	17	9
TAMIL NADU								
Anna	—	—	205	79	174	86	16	16
Kamarajar	530	28	576	60	343	105	33	33
Nellai Kattaboman	150	47	183	49	144	35	23	23

* Nematodes per g root. ** Nematodes per 250 g soil.

NEMATODE INTERACTIONS:

It is common that nematode infestations lead to secondary infections by other soil-borne pathogens, resulting in disease complexes. Studies have shown that *Meloidogyne incognita* predisposes cardamom planis to *Rhizoctonia solani* infections, leading to rhizome rot and damping off diseases prevalent in the nurseries (Anonymous, 1985). More studies have to be conducted for better understanding of their interaction with other nematodes as well as other soil-borne pathogens.

NEMATODE MANAGEMENT:

Realizing that nematodes cannot be eliminated, the overall goal is to bring down the nematode population to below economic threshold or non injurious level. This requires the carefully integrated combinations of several practices. This integrated approach has significant elements of prevention as well as curing (Table III).

Table III

RECOMMENDATIONS TO CONTROL ROOT-KNOT NEMATODES OF CARDAMOM

PREVENTIVE :

1. Use only healthy, nematode-free seedlings.
2. Change the location of nursery sites periodically.
3. Rake the soil of nursery sites and expose to sunlight.
4. Fumigate nursery beds with Methyl Bromide (500g/10sq m) Ethylene di bromide (20l/ha) or Durofume (30l/ha) or drench the beds with 2 per cent formalin polythene cover.
5. Proper sanitation like weed control, eradication of nematode-susceptible shade trees, crop residue destruction, etc., should be followed
6. Prune, the roots of seedlings before transplanting.

CURATIVE:

Treat nursery plants or infested patches in the mainfield with nematicides like carbofuran, phorate, etc.

Apply neem cake as an organic amendment.

USE OF NEMATODE-FREE PLANTING MATERIAL.

This is the most effective means limiting nematode damage and ir spread. Indiscriminate distri-tion and use of nematode-infe-d seedlings are reported to be reasons for the extensive dis-ution of root-knot nematodes the cardamom growing tracts li, 1986). At present, *fumiga-n of nursery beds is the best ilable way for mass production nematode-free seedlings.* Seed-gs raised in fumigated soil and nsplanted to an infested field ve a better chance of establi-ng, surviving and yielding gher than the plants raised in infested bed. *There should be od sanitation in fumigated rseries to avoid reinfestations.*

PHYSICAL CONTROL

Use of solar heat: Solar heat n be effectively used in carda-om nurseries for minimising matode problem. Nematode veniles and eggs die quickly ien exposed to sunlight and ying. Nursery sites may be eply ploughed several times ring summer. Soil solarization a technique of increasing soil mperatures to lethal levels by reading transparent polythene eet on the surface of moist soil r a period of at least two weeks ring hot, sunny weather. Studies ve been initiated to explore the asibility of this technique in rdamom nurseries.

Traditionally the nursery beds e retained at one site for conve-ence, resulting in high incidence nematodes. Keeping such sites e of all vegetation for varying riods by frequenttilling of soil or by application of herbicides results in starvation and death of nematodes present in the soil. Therefore, it is recommended to shift the nursery sites periodically.

c) BIOLOGICAL CONTROL:

Organic matter in cardamom fields is usually quite high and naturally more endemic biological control can be suspected in such fields. Preserving or enhancing the field conditions that favour the activity of natural control agents is more ideal in a perennial crop like Cardamom. *A recent survey has shown that about 80 per cent of cardamom growers in India use neem cake for nematode control* (Ahmed & Koppel, 1987). Incorporation of such organic cakes can promote the activity of biocontrol agents in the rhizosphere. Understanding the instrinsic control factors that operate in the field is important for identifying suitable agents to be used in induced biological control programmes. Unfortunately, no information is available on any such organisms associated with cardamom. However, Thomas *et. al* (1989) have screened six VA mycorrhizal fungi and reported *Gigaspora margarita* and *Glomus fasciculatum* to bo effective in reducing the root-knot nematode colonisation and in improving the plant growth. More studies are required to confirm their efficacy under field conditions. Mass realease of such bio-control agents can be effective in cardamom nurseries.

d) RESISTANT CULTIVARS:

The use of resistant or tolerant cultivars is economically attractive and is a long term approach for perennial) crops. Research is in progress to locate resistance/ toleraece in the available germplasm collections to the target nematodes. These cultivars have to be tested against different races, in order to get a comprehensive picture on their host status.

e) CHEMICAL CONTROL:

Nematicides are the most effective means for rapid kills. Various chemicals have been tested for their efficacy to control or to eradicate root-knot nematodes of cardamom (Table-IV). Soil fumigants are advocated as pre sowing treatment to raise nematode free seedlings. They have additional advantages like control of weeds and other soil-borne pests. Non volatile nematicides are recomended for control of nematodes in heavily infested nurseries and 'sick' patchs in the main fields. Repeated applications at high dosages are necessary. especially in mainfields because of perennial nature of the crop.

Maximum benefits can be gained from nematicide treatments only when they are chosen intelligently and used properly in areas where they are economically justified. For example, nematode distribution in cardamom fields are generally aggregated or clumped and blanket application of nematicides may not be of any use. This helps to improve their effectiveness, to reduce the cost and to minimise the potential environmental hazards in soil, groundwater and crop produce. Considerable attention should be given to the dosage to be used, mode and time of application of nematicides.

Table IV: CHEMICAL CONTROL OF ROOT-KNOT NEMATODES IN CARDAMOM

Name of Chemical	Dosages Tried	References
Volatile or Fumigants		
Methyl Bromide	500 g/10 sq. m.	Ali & Koshy, 1982 b.
Ethylene-di-Bromide	20 l/ha	Anonymous, 1986 & 1989.
Durofume (MBR: EDB - 50 : 50)	30 l/ha	
Formaledhyde Solution	2 per cent	
Non Volatile or Granular		
a) *In Nurseries:*		
Aldicarb; Carbofuran; Fensulforthion	3,4 & 5 kg a. i. / ha	Koshy *et al.*, 1979.
Aldicarb; Carbofuran; Phorate	5, 10 & 15 kg a. i. / ha	Ali, 1984 b.
Aldicarb; Carbofuran; Thiodemeton	2, 2 5 & 3; 0.6, 0.75 & 0.9; 4.5 g a. i. / m^2 resp.	Jacob & Chandrasekharan, 1984.
Fenamiphos	5, 10 & 15 kg a. i. / ha	Ali, 1986 b.
b) *In Mainfield:*		
Aldicarb: Carbofuran; Phorate	5 & 10 g a. i. / plant	Ali, 1987.
Aldicarb; Phorate	10 & 15 kg a. i. / ha	Jacob & Chandrasekharan, 1982
Carbofuran	3 & 10 kg a. i. / ha	
Carbofuran	0.6, 0.9 & 1.2 g a. i. / plant	Venkitesan *et al.*, 1989.

In view of the environmental risks with nematicides, there is an urgent need to lower the recommended dosages. Low dosage rates applied repeatedly may work as an alternative to bring down the nematode population below the damaging threshold level. In cardamom, side dressing and row treatments are recomended in mainfields and nurseries respectively (Anonymous, 1989 a). In all cases they should be thoroughly incorporated into the top few centimeters of soil. Adequate moisture should be ensured in the soil at the time of application. Soiltype, moisture and temperature can influence the movement of fumigants in the soil. Soil has to be properly tilled for best results with these volatile nematicides. The application has to be done when soils are warmer and biologically more active. Preliminary studies have shown that root-knot nematode population level in cardamom fields becomes quite high after the monsoon (Anonymous 1989 b). Therefore, *post monsoon application of nematicides will allow for a better control and for a greater root mass to absorb the chemical.*

CONCLUSION

The retrospection of the past decade's reseach clearly reveals the inadequate resources devoted to this field, resulting in a very limited number of publications and growers still consider it as a simple interest disease. Many lacunae exist in cardamom root – knot nematode research which may defeat the integrated management programmes. Basic informations on the biology, race status, more of survival, etc., are still lacking. Such informations are inevitable for developing new and effective control options. Intensive research has to be undertaken for evolving efficient and environmentally safer methods of control. Solarization, use of VA mycorrhiza or any other biological agents to combat nematodes are some promising areas of research. We may have to depend on chemicals in the coming years also. Instead of the soil application, which is not that effective always, the feasibility of other methods like root dip treatment, incorporation through irrigation water, etc., have to be studied. Concerted inter disciplinary efforts should be made to

rmine the accurate economic shold, nature and extent of loss due to various nema- s infecting cardamom under ing conditions. However, the cess depends on the research rt and support of various ncies involved in spices earch.

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FRUIT ROT OF NUTMEG IN SHEVROYS

Nutmeg (*Myristica fragrans*) is the one of the important tree spices grown in the coffee plantations of Shevroys. The recent survey on the plantations revealed that the nutmeg fruits are susceptible to fruit rot which leads to heavy loss of the crop. It is observed that the infection starts from the pedicel as water soaked lesion, which later beeomes black and spreads to fruit. In the fruit, brown discolouration and rotting of the rind is seen in the advanced stages of infection. The immature fruit splits prematurely and the infection spreads to interior portions leading to rotting and shedding fruit. The mace also shows infection leading to rotting black discolouration.

The observations of the fruit samples collected yielded the fungs *Diplodia* sp. The fruit rot caused by *Diplodia natalensis* has already been reported in the nutmeg growing areas of Kerala. It was reported that immature fruit split, fruit rot and fruit drop are highly prevalent in majority of nutmeg gardens in Kerala. In addition to this fungus, *Phytophthora* has also been reported. In addition to infection on

fruits, it is also known to cause dieback symptoms in the branches. In order to arrest the spread of the disease, the rotten and fallen fruits should be removad and destroyed. In addition, the half matured fruits should be sprayed with 0.25 per cent Copper oxychloride (2.5 g / litre) or one per cent Bordeaux mixture at monthly intervals. Based upon the severity, two to three sprays should be given. In the heavily shaded areas, shade regulation should be done.

V. PRAKASAM, N. KUMAR,
L. PUGALENDHI, S. THAMBURAJ
Horticultural Research Station,
Yercaud-636 602