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## INFLUENCE OF PLANT AGE ON ROOT-KNOT NEMATODE DEVELOPMENT IN CARDAMOM

by  
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**Summary.** Two, 12 and 24 months old seedlings and mature vegetative suckers of cardamom (*Elettaria cardamomum* Maton) plants when inoculated with 500 second stage juveniles of *Meloidogyne incognita* showed varying responses. The highest multiplication rate, gall and egg mass indices were observed in 24 months old seedlings while the per gram root population was highest in 12 months old seedlings. The galls on the root system of mature plants were comparatively small and supported fewer nematodes. In general, young cardamom seedlings were more susceptible to root knot nematodes than mature plants.

Root knot nematodes (*Meloidogyne* spp.) are important pathogens of small cardamom, *Elettaria cardamomum* Maton (D'souza *et al.*, 1970; Kumar *et al.*, 1971; Koshy *et al.*, 1976; Sundararaju *et al.*, 1979) and widespread in cardamom nurseries and plantations in Kerala, Karnataka and Tamil Nadu (Ali, 1984, 1986; Ali and Koshy, 1982). The common aerial symptoms of nematode infestation are stunting, poor tillering, yellowing and drying of leaf tips and margins; below ground roots are galled with abnormal branching. On older seedlings and mature plants in the field, instead of typical galling, excessive branching (witches-broom type) of roots near the root tips with milky white rootlets devoid of hairs has been reported (Ali, 1984, 1987).

The present study was undertaken to understand the influence of plant age on root-knot nematode development and the effect of nematode infestation on the growth and morphology of roots of cardamom plants.

### Materials and methods

Cardamom plants of four age groups viz., two, 12 and 24 months old seedlings and mature vegetative suckers were raised in nematode-free soil in a screenhouse. From these, plants of uniform size from each age category were transplanted into plastic pots (22 cm diameter) containing sterilised soil. Once established, a nematode suspension of 500 active second stage juveniles of *Meloidogyne incognita* (Kofoid *et al.* White) Chitw. was poured on to the root zone in five pots of each age group of plants; the inoculum was collected from root-knot nematode cultures maintained on

cardamom. A few pots without nematodes were retained to see the root branching pattern in them. After three months, the plants were uprooted and the root systems were removed, washed thoroughly and their fresh weights were recorded. The entire root system was carefully observed under a microscope and rated for galling and egg masses based on Taylor and Sasser's (1978) scale. Egg masses were stained with Phloxine-B for easy detection (Daykin and Hussey, 1985). Comparison was made with uninoculated plants to identify any change in root morphology due to nematode infestation. Root-knot nematode galls, root-knot and root diameters of ten randomly selected galls from each plant were measured at the point of greatest girth along a line parallel to the root and root diameter at a point one cm above the gall. To assess the total nematode populations, roots were cut into small pieces and stained with acid fuchsin (Byrd *et al.*, 1983). These roots were macerated in an electric mixer and three 1 ml aliquots per sample were removed from the suspension for counting. The average of the counts was used to calculate the total nematodes per plant and per gram of root.

### Results and discussion

Plants of all age groups were susceptible to nematode attack as is evident from the final nematode population (Table D). However, the highest root-knot index (RKI), egg mass index (EMI) and final nematode population were observed in 24 months old seedlings. Plants of other ages had similar RKI and EMI but supported greatly different nematode populations. The lowest multiplication rate in two

Table I - Mean gall, egg mass indices and number of nematodes in the roots of cardamom plants of different ages inoculated with *Meloidogyne incognita* (mean of five replications).

Plant age	Root knot index	Egg mass index	Final population (PF)	Per 'g' root population
2 - months	2.8 a*	2.6 a	811.33 a**	467.7 a**
12 - months	2.8 a	2.8 a	2860.22 b	849.2 a
24 - months	4.2 b	4.0 b	4543.60 b	307.6 ab
Suckers	3.5 ab	3.5 ab	1828.10 ab	93.5 b

\* Means with different letters are significantly different, P = 0.05 according to Duncan's multiple range test; \*\* nematode counts were log transformed prior to statistical analysis and the weighted means were used for comparison.

month old seedlings probably was due to the small root mass available for nematode colonisation. The high nematode population in roots (per g) of two months old seedlings which is on par with that of 12 months and 24 months old seedlings also supports this. Suckers had a mean RKI and EMI of 3.5 each, even at a low nematode level in the roots. In suckers, adult females were embedded in the outer periphery of roots with their egg masses exposed, hence the high EMI in suckers. Also, there were more galls but of smaller size than in seedling plants.

Gall size was compared in different age groups of plants by measuring the difference in gall diameter with the corresponding root diameter as the root diameters varied considerably in various age groups of plants. Significantly bigger galls were observed in two months old seedlings (Table II). Gall size is reported to be related to the number of nematodes in the tissue (Dropkin, 1954). It is also observed that small galls are induced by juveniles continuously feeding at the root surface without actually entering the roots (Lowenberg *et al.*, 1960).

The low number of nematodes in suckers may be due

to low penetration or because of the low multiplication rate of nematodes. Tissue maturation and tissue senescence are two important factors influencing the susceptibility of a plant to pathogens (Bruehl, 1987). Weiser (1955) reported that actively elongating roots were more attractive to nematode juveniles than roots in which extension had slowed.

In contradiction to the earlier reports (Ali, 1984, 1987), no consistent pattern of root branching caused by nematode invasion was associated with any of the age categories of plant. In the present study young cardamom seedlings were more susceptible to root-knot nematodes than older seedlings or mature plants. The inverse relationship between increasing plant age and decreased root galling and population development has been observed in alfalfa (Griffin and Hunt, 1972), in tea (Sivapalan, 1972) and in sugar beets (Olthof, 1983).

The study shows that more emphasis has to be given for early protection of cardamom seedlings as the age of the seedling at the time of exposure to the pathogen is critical.

Table II - Comparison of root and root-knot diameters of cardamom plants of various ages exposed to *M. incognita* (mean of five replications).

Plant age	Mean root diameter (mm)	Mean gall diameter (mm)	Gall diameter as % of root diameter
2 - months	0.52 a*	1.04 a	269.2 a
12 - months	1.06 b	1.36 b	129.3 b
24 - months	0.95 b	1.21 ab	129.1 b
Suckers	0.71 ab	0.95 a	135.1 b

\* Means with different letters are significantly different, P = 0.05 according to Duncan's multiple range test.

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