# STUDIES ON THE PARASITIC NEMATODES ASSOCIATED WITH VEGETABLES IN KERALA



By

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THESIS

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## CERTIFICATE

This is to certify that the thesis herewith submitted contains the results of bona fide research work carried out by Shri. N. Ramakrishnan Nair, under my supervision. No part of the work embodied in this thesis has been submitted earlier for the award of any degree.

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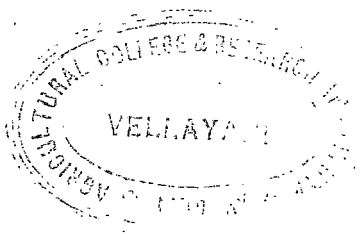
# INTRODUCTION



## INTRODUCTION

Nematodes are minute thread-like animals commonly called thread-worms, roundworms, eelworms or nemas. They may be plant parasites or animal parasites or may be free living in soil, fresh water or sea water. A plant parasitic nematode can generally be differentiated from the rest by the presence inµit of a needle-like feeding organ called the mouth-spear at the anterior end of the body. Eventhough the great majority of the members of this phylum are microscopic, according to Jones and Jones (1964) they rank next to insects as pests of cultivated crops. According to Thorne (1948) many research workers are unaware of the fact that the soils of the research stations contain numerous species of nematodes to such an extent that the results secured from them are of doubtful value, if not worthless.

It has been well established now that the plant parasitic nematodes play an important role in limiting agricultural production. The cultivated soils provide ideal media for the multiplication of the parasitic nematodes. Many of the pathological conditions of cultivated crops whose causative agents could not be found out have now been seen to be caused by plant nematodes. Investigations in this field in India were started only in recent years. Preliminary studies made in Kerala have shown that Kerala soils abound in various types of nematodes some of which have already been recognized as potential pests of the important crops. Thus for example the presence of such classical forms

like the burrowing nematode, Radopholus similis (Nair et al., 1966), the citrus nematode, Tylenchulus semipenetrans (Nair, 1965), the root-knot nematode, Meloidogyne incognita (Sathya Rajan et al., 1966) and the spiral nematode, Helicotylenchus carebensis has already been reported in this state. Apart from these, unidentified species of Helicotylenchus, Rotylenchus and Criconemoides have been observed to occur in association with banana. Much remains yet to be done to understand the various parasitic nematodes infesting the various crops of Kerala and to unravel the role they play in interfering with agricultural production.

In view of the above mentioned facts the work reported in the present thesis was taken up to further our knowledge on this important groups of agricultural pests in this state. An effort has been made to find out the different types of parasitic nematodes associated with the important vegetable crops of Kerala and the part they play in the welfare of the crops concerned. The variations in the population of the different nematodes affecting the vegetable crops in relation to the different soil types have also been determined.

The literature on the plant parasitic nematodes infesting vegetable crops have been reviewed.

# REVIEW OF LITERATURE

## REVIEW OF LITERATURE

There exists many records of nematodes associated with vegetables and those of Tomato, Bhindi, Brinjal and Gourds, the more commonly cultivated vegetables in Kerala have been reviewed here.

1 Tomato: (Lycopersicon esculentum)

In 1925 Waite et al. reported Caconema radicicola, Greff, 1872 making root galls in tomato.

Triffitt (1931) reported Heterodora schachtii, Schmidt on tomato from Britain, along with a critical note on its morphology and bionomics.

Young (1930) reported that root-knot nematodes greatly decreased the expression of resistance to Fusarium wilt in his tomato breeding lines.

Harrison and Young (1941) found that loss due to Fusarium sp. in Marglobe variety of tomato was much less when it followed root-knot resistant peanuts in a rotation than when it followed root-knot susceptible cowpeas.

Thorne (1942) noticed the root-knot nematode, Heterodera marioni, Cornue, Goodey on tomatoes in Britain. He mentioned that raising the crop on ridges and keeping the irrigation water level down below in the furrows reduced incidence of the parasite considerably.

Mc Farlane and Frazier (1946) successfully incorporated the root-knot resistance and the high vitamin 'C' content of the wild species of tomato, Lycopersicon peruvianum into a commercial variety of

L. esculentum, by crossing and selecting the superior plants. They also showed that the nematode resistance is a dominent character and L. peruvianum is heterozygous for nematode resistance and vitamin 'C' content.

Watts (1947) crossed the wild species of L. peruvianum with commercial variety, L. esculentum and found that the progeny showed a fair degree of resistance to the root-knot nematode. The factors controlling the resistance were found dominent.

Mc Farlane and Matsuura (1947) found that DD. applied at the rate of 200 lb per acre increased the yield and reduced the incidence of root-knot nematode in tomato.

Frank, Stark and Bert (1947) tried 13 soil fumigants against the root-knot disease of tomato and found that Ethylene-di-bromide was the best, followed by DD, Methyl bromide and chloropicrin.

Frazier and Donnet (1949), Hawaii, bred a homozygous line of tomato, resistant to the penetration of root-knot larvae.

Shubert and Dunlap (1950) found that tomato, variety 'Earliana' was more susceptible to the attack of Heterodora marioni, Cornue, Goodey. than the wild species, L. peruvianum, variety P.I. 128651.

Taylor and Chitwood (1951) reported that L. peruvianum was not infested by Meloidogyne incognita, obtained from several sources. But it was infested by M. arenaria, Neal.

Feldmesser (1952) noticed that Heterodera rostochiensis, Woll., produced cysts 17 or 18 days after invading the roots of 'Bonny best' variety of tomato.

Mai (1952) reported that among several species of Lycopersicon tested with the golden nematode, L. peruvianum, L. glandulosum, L. pimpinellifolium and L. hirsutum proved to be susceptible. However, two collections of L. peruvianum viz. 47-B-323 and 732, appeared to possess a high degree of resistance. Other species of these collections were more susceptible.

Sasser (1952) found that concentrations of 0.005, 0.01, 0.02, 0.03, 0.05, 0.1, 0.5 and 1.0 per cent 'systox', drenched in soil at the rate of 300 ml per 5 inch pot, greatly reduced the infestation of tomatoes by Meloidogyne sp.

Dropkin (1953) found that the infectivity of the root-knot nematode, Meloidogyne incognita var. acrita was less for the Marglobe variety of tomato seedlings than for cucumber.

Tarjan (1954) reported that aqueous emulsions of 3-p-chlorophenyl -5-methyl rhodanine applied at the rate of two gm per square foot in potted tomatoes infested with Meloidogyne incognita, (Kofoid and White, 1919) Chitwood, 1949 completely controlled the parasite.

Rohde and Jenkins (1956) noticed the susceptibility of the 'Chesapeake' variety of tomato to the attack of Trichodorus sp.

Bert and Raski (1956) found that nemagon when applied in field and in green house trials at the rate of 10 gal/ per acre did not penetrate the non rotted tomato or grape roots in amounts lethal to the root-knot nematodes. It proved lethal at a dose of 20 gal/ per acre.

Myuge (1957) reported that Indole-3-acetic acid, when applied to foliage of tomato plants reduced the number of root-galls.

Jenkins and Coursen (1957) found that wilting can be induced to 'Chesapeake' variety of tomato which is a wilt resistant one, by the presence of root-knot nematodes.

Arya (1957) reported that tomatoes of Jodhpur were attacked by the root-knot nematode, Heterodera marioni, Cornue, Goodey.

Sen (1958) reported the attack of Meloidogyne javanica (Treub, 1885) Chitwood, 1949 on tomatoes in Bihar.

Bird (1959) observed that the larvae of Meloidogyne javanica and M. hapla were attracted to the region of 'cell-elongation' within the roots of 'Pan American' variety of tomato.

Bloom and Couch (1959) found that the root-knot counts were significantly higher on roots of 'Pearson' and 'Rutgers' varieties of tomato grown at field capacity level to moisture and knots were absent or few at permanent wilting percentage level of moisture.

Lall and Das (1959) studied in detail the biology of the root-knot nematode, Meloidogyne incognita var. acrita, Chitwood using tomatoes. They reported that the nematodes could live in the soil for 3 months without the host plant. They also found that application of potash fertilizers reduce the nematode infection. Among the nematicidal trials D.D. fumigant gave best results.

Race and Hutchinson (1959) found that tomato was an excellent host for Pratylenchus penetrans.

Riggs and Winstead (1959) showed that the factors for resistance or susceptibility to the root-knot nematode Meloidogyne incognita and M.arenaria in tomatoes were located in both the tops and roots of plants.

Minton et al. (1960) reported that cultures of Meloidogyne incognita incognita and M. incognita acrita attacked tomato.

Robert and Novotny (1960) found that the enlargement of giant cells in tomato caused by the attack of root-knot nematode was due to the combination of turgor pressure and cell wall digestion.

Schuster and Sullivan (1960) studied the incidence of Meloidogyne hapla, M. incognita incognita and Necobbus batatiformis on 'Kokomo' variety of tomato. About 60 per cent of the larvae infested the roots. Epidermal cells turned square in shape and M. hapla induced root hair formationon on subsurface galls.

Chitwood and Young (1960) observed M. incognita in 'Marglobe' tomato from Taipei, Taiwan and New Delhi.

Ahmed and Khan (1960) showed that the excised roots of tomato displayed a neutral effect to the larvae of Meloidogyne incognita as far as larval penetration is concerned.

Bird (1960) reported that the parasitisation of tomato plants, deficient in nitrogen by Meloidogyne javanica resulted in the quicker growth than in plants which received full nutrients.

Lownsbery and Viglierchio (1960) observed that the larvae of Meloidogyne incognita acrita accumulated around germinating tomato seeds responding to a dialyzable agent or agents produced at the seedling surface.

Prasad (1960) reported the incidence of M.incognita v.acrita, M.javanica, M. arenaria and Pratylenchus pratensis on tomato.

Bird (1961) observed that growing larvae of M.javanica did not require a large amount of sodium during its development.

Powell and Moore (1961) described a technique of inoculating Meloidogyne incognita v.acrita egg masses taken from roots of 'Rutgers' tomato into the leaf midrib with a hypodermic syringe.

Lownsbery and Viglierchio (1961) reported that the accumulation of Meloidogyne hapla around germinating tomato seeds was governed by an agent secreted from the seeds and showed that it was a dailyzable diffusing agent which was effective upto a distance of 10 millimetres.

Swarup and Pillai (1963) reported that the susceptibility or non-susceptibility of tomato seedlings to Meloidogyne javanica was depend upon the initial reaction of its favouring the larvae to enter the roots and also to subsequent plant environment favouring further development of larvae in the root tissue.

Chambers and Reed (1963) found that dowfume, telone, dorlone, nemagon and D.D. in split application made in spring gave good control of Meloidogyne incognita v. acrita in tomato fields.

Libman et al. (1963) showed that both Meloidogyne hapla and Helicotylenchus nannus increased the incidence and severity of bacterial wilt of tomato.

Whitehead (1964) found that the association of larvae of Meloidogyne sp. with tomato seedlings was governed by the species and genotype of host.

Ahmed and Khan (1964) found that the root diffusate of tomato, taken from the 'zone of maturation' of young roots gave favourable responses to Meloidogyne incognita.

Hottzmann (1965) found that tomato varieties Anahu, Kalohi-6560 (6351), 3-2-P.8 and STEP-402 were relatively resistant to root-knot nematode at 20 and 25 degrees centigrade of soil temperature.

Singh and Sitaramiah (1966) reported that the application of oil cakes of margosa, castor and groundnut at the rate of 0.2 per cent

of the active ingredient, 3 weeks before planting, reduced the intensity of root-galling significantly in tomatoes infested by Meloidogyne - javanica. He recommended a field dosage of 1600 lb per acre.

Swamy and Govindu (1966) reported Meloidogyne incognita v.acrita and M. javanica on tomato from Mysore.

Dropkin and Webb (1967) reported the resistance of 'Axonic' tomato seedlings to Meloidogyne incognita v.acrita and to M. hapla.

Ling and Rohde (1967) found that the tomato variety 'Nemared' was resistant to the attack of Meloidogyne incognita v.acrita. 'Hawaii-7153' was moderately resistant while 'B-5' was susceptible. They noted more chlorogenic acid in the epidermis of resistant varieties.

Bhatt (1967) reported Longidorus elongatus on tomato as a harmful pathogen from Khatmandu.

Chandwani and Reddy (1967) reported Meloidogyne javanica on tomato from Andhra.

Singh and Sitaramiah (1968) found that addition of green leaves or sawdust at 200 mounds per acre or urea at 400 lb of nitrogen per acre reduced the incidence of root-knot in tomato.

Ditylenchus dipsaci (Williams, 1936), Dolichodorus - heterocephalus (Christie, 1952), Heterodera tabacum (Lownsbery and Lownsbery, 1954), H. schachtii (Morgan, 1925), Meloidogyne arenaria

(Tarjan, 1952), M. hapla (Chitwood, 1949), M. javanica (Tarjan, 1952), Pratylenchus pratensis (Godfrey, 1929), Rotylenchulus reniformis (Linford and Yap, 1940), Trichodorus sp. (Christie and Perry, 1951), Xiphinema diversicaudatum (Schindler, 1954), Belonolaimus gracilis (Heldeman and Graham, 1953), Helichotylenchus sp. (Martin and Birchfield, 1955), Meloidogyne acronea (Coetzee, 1956), Meloidogyne arenaria ssp. thamesi (Linde, 1956), Nacobbus batatiformis (Thorne and Schuster, 1956), Nacobbus sp. (Graham, 1958), Pratylenchus projectus (Coursen et al.,1958), Pratylenchus brachyurus (Martin and Birchfield, 1955), Pratylenchus minyus (Mountain and Fisher, 1954), Pratylenchus pratensis (Mountain and Fisher, 1954), Radopholus similis (Feder and Feldmesser, 1957), and Trichodorus christiei (Coursen et al.,1958) were also reported on tomato.

II Bhindi(Abelmoschus esculentus)

Sen (1958) reported the lance nematode, Hoplolaimus sp. on bhindi from Bihar.

Lall and Das (1958) studied the biology of root-knot nematode, Meloidogyne incognita v.acrita on bhindi and observed the longest duration of 40 days in bhindi.

In 1959 they have reported the susceptibility of bhindi to Aphelenchus avenae.

Prasad (1960) from I.A.R.I. reported that Meloidogyne incognita, M. incognita v. acrita and M. javanica caused root-knot formation in bhindi. He also observed Hoplolaimus sp.on this crop.

Ahmed and Khan (1961) found that the root diffusates of bhindi gave favourable responses to Meloidogyne incognita and the zone of maturation of young bhindi roots gave highly potent leachings.

Good (1961) found that 'panogen 161,' 162 and american cyanamide 18133 gave good control for Meloidogyne incognita incognita and Fusarium wilt of okra.

Birat (1964) noted that 'Long green smooth' variety possessed highest degree of resistance to Meloidogyne javanica than ' Summer special'and 'Lucknow Dwarf'.

Nadakal (1964) reported the root-knot nematode Meloidogyne - incognita on bhindi from Kerala.

Ahmed and Khan (1964) using bhindi as host plants, found that hatching of Meloidogyne incognita larvae was optimum at 25 degrees centigrade and at a hydrogen-ion-concentration of 7.

Rangaswami and Balasubramanian (1964) were able to find out tryptophan in the extracts of galled roots of bhindi and the root-knot index was found to be 2.3.

Singh and Sitaramiah (1966) showed that incorporation of oil cakes to soil at the rate of 1600 lb per acre reduced the population of Meloidogyne javanica considerably in bhindi.

Littrell (1966) observed that giant cell development in okra seedlings variety 'Clemson spineless' attacked by Meloidogyne incognita v.acrita continued by mitosis and coalesing multinucleated root cells and by the engulfing of adjacent parenchyma.

Birat (1966) observed a sharp decline in population of Meloidogyne sp. from March to June while host plants were absent in the field.

Thirugnanam and Rangaswami (1966) reported that differential behaviour of certain isolates of the same nematode M. javanica and M. incognita on different hosts might be due to the possible occurrence of physiological races within the nematode species.

Reports about Meloidogyne javanica (Swami and Govindu, 1966), (Chandwani and Reddy, 1967) and M.incognita (Krishnamoorthy and Elias, 1967) were also made on bhindi.

Addition of green leaves, saw dust or urea into soil reduced the root-knot infection on bhindi (Singh and Sitaramiah, 1968).

Rotylenchulus reniformis (Linford and Yap, 1940), Xiphinema diversicaudatum (Schindler, 1954), Pratylenchus projectus (Courson et al.1958), Radopholus similis (Feder and Feldmesser, 1957) and Trichodorus christiei (Courson et al., 1958) were also reported as serious pests of bhindi.

III Brinjal (Solanum melongena)

Meloidogyne incognita (Lall and Das, 1959; Prasad, 1960; Nadakal, 1964), Meloidogyne javanica (Prasad, 1960; Swarup and Pillai,1963; Nadakal, 1964 and Ahmed and Khan, 1964) were reported on brinjal.

Jotwani et al.,(1961) found in a field experiment that 'Pusa purple long' variety of brinjal was more susceptible to nematode attack than the 'Pusa purple round' variety.

Reports were also made on the occurrence of Meloidogyne incognita (Krishnamoorthy and Elias, 1967), M. javanica (Chandwani and Reddy, 1967), Heterodera rostochiensensis (Fassuliotis and Feldmesser, 1964), Meloidogyne javanica (Tarjan, 1963) Rotylenchulus reniformis (Linford and Yap, 1940), Nacobbus batatiformis (Thorne and Schuster, 1956) and Trichodorus christiei (Coursen et al., 1958) on brinjal.

IV Gourds

Ahmed and Khan (1960) reported that excised roots of different varieties of bitter gourd and bottle gourd showed profound attractiveness towards the larvae of Meloidogyne incognita and they also reported (1961) that root diffusates of bitter gourds gave similar responses.

Prasad (1960) found that bitter gourds and bottle gourds were susceptible to root-knot nematodes.

Meloidogyne incognita (Krishnamoorthy and Elias, 1967) was reported on bitter gourd.

Chandwani and Reddy (1967) reported M. javenica on bitter gourd and snake gourd.

Sen (1968) reported M. javenica on bitter gourd.

# MATERIALS AND METHODS

## MATERIALS AND METHODS

### Nematode sieves

Four sieves of meshes 20, 100, 200 and 325 square inch made by Daul Mfg. Co., Chicago were used for sieving out the nematodes from the soil.

### Baermann funnel

Glass funnels of 10 cm diameter with 9 inch long rubber tube and a pinch cock fitted at its tail end constituted the Baermann funnel. A dozen of such funnels were used for filtering the nematodes from the soil washings.

### Tissue paper

'Sateena' white facial tissue paper of size 21 cm x 16 cm was used for filtering the nematodes.

### Wire gauze

Wire gauzes of 20 mesh having a size of 15 cm x 15 cm were used as supports for the tissue paper in the Baermann's funnels. The gauze pieces were made into a dish like shape to fit into the funnels.

### Basins

Enamel basins eachof 32 cm diameter were used for washing the soil samples.

### Other equipment

They included funnel stands, wash bottles, beakers, specimen-

tubes, test-tubes, spirit lamp, cavity blocks, counting slide, counting dish, fine needles, glass slides, cover slips, glass wool, cavity slide, nematode picks made of bamboo, pipettes, homogeniser, reagent bottles, microscopes, talley counter, earthern pots, polythene bags, hot air oven and specimen tube stands.

Chemicals

Formaline 40% formaline solution diluted to 10% was used for preserving the specimens.

T.A.F. fixative T.A.F. fixative (courtney et al.,1955) was prepared as follows:

| | |
|---|---|
| Triethanol amine | 2 parts |
| Glycerine | 7 parts |
| Distilled water | 91 parts |

The ingredients were mixed well and kept in a bottle and was used for fixing the nematodes.

| Lactophenol | It contained |
|---|---|
| Phenol crystals | 20 gm |
| Lactic acid | 20 gm |
| Glycerine | 40 gm |
| Distilled water | 20 gm |

The chemicals were weighed out accurately and mixed in a bottle and used for removing the stains.

Stain

1% solution of methylene blue in lactophenol was used for staining the nematodes inside the root-tissue.

Sein horst solution I

| | |
|---|---|
| 96% ethanol | 20 parts |
| Glycerine | 1 part and |
| Distilled water | 79 parts were taken and |

mixed in a bottle.

Sein horst solution II

Glycerine - 5 parts and 96% ethanol 95 parts constituted the solution II. The solutions were used for processing the nematodes for making permanent slides.

## Methods

Collection of soil and root samples

Different localities were selected at random covering the different soil types and roots and soil from around the base of the healthy and diseased plants of tomato, brinjal, bhindi, snake gourd and bitter gourd were taken. The locality was thoroughly examined and plants showing a general yellowing and stunted growth were taken as diseased plants. Six diseased and six healthy plants each were chosen. From the base of each plant about 100 gm of soil was taken from a depth of 4 to 6 inch. The individual soil samples collected

of the each category were mixed up together and about 1000 cc of the mixed samples was taken as the sample for studies. The samples were kept in polythene bags to prevent drying.

A few roots were also collected from each plant and kept in polythene bags and properly secured to prevent their drying.

Washing the soil samples

The soil samples were processed by the method adopted by Christie and Perry (1951).

500 ml of the soil was measured out from the sample using a beaker, into a basin and it was mixed well with 3 times of water by volume. Coarse particles like stem pieces and roots were allowed to settle. Then it was passed through a series of sieves of 20, 100, 200 and 325 meshes per square inch. The fine silt and nematodes collected in 200 and 325 mesh sieves were washed down into a beaker with minium quantity of water by using a wash bottle.

Isolating the nematodes by the Baermann funnel.

The nematode suspension sieved out from soil samples was poured gently into a tissue paper tray kept in position in the Baermann funnel with the help of the flat bottomed wire gauze. The funnel was filled with water till the level just touched the tissue paper. It was kept undisturbed and at the end of 24 hours, about 30 cc of water was drawn out into a specimen tube by loosening the pinch cock. Then the water

level in the funnel was restored as before for the second drawing at the end of 48 hours.

Killing and preserving the nematodes

The nematodes collected from the Baermann funnel together with the water in which they were suspended were kept still for about 30 minutes allowing the nematodes to settle down and the volume was reduced to half by pipetting out the water from the top. The remaining suspension was shaken to mix up the nematodes in water. The tube was gently heated over a flame. At frequent intervals drops of the nematodes suspension were taken in a cavity slide and examined under a binocular microscope to ascertain whether the nematodes have died or not. When the nematodes were killed and relaxed to their characteristic shape, a few drops of the suspension were removed for making permanent mounts and to the rest an equal volume of 10% formaline, neutralized with a little $CaCO_3$ (Baker, 1945) added, thus getting the nematodes preserved in 5% formaline.

Counting the nematodes

The preserved suspension of nematodes was made upto 50 cc by adding water. It was stirred well and the counting slide was filled with 1 cc of this suspension using a pipette and the nematodes present in it were counted. From this, the nematodes present in 500 cc soil was calculated. The counts of Helicotylenchus, Hoplolaimus, Rotylenchus

Pratylenchus, Meloidogyne larvae and Rhabditids were recorded for each sample.

Preparation of permanent slides

The nematodes which were killed were transferred to T.A.F. fixative for 4 to 6 hours. Then they were transferred to the sein horst solution I taken in a syracuse dish. The dish was placed in a petridish containing 96% alcohol (about 10 times the volume of sein horst solution I) and it was partly closed with a watch glass and then kept in a hot air oven maintained at 35°C for 12 hours. Then the nematodes were transferred to the Sein horst solution II in another dish and kept at 40°C for 3 hours. After the complete evaporation of alcohol, the nematodes were taken out and mounted in pure glycerine with glass wool support. Then it was ringed with zart.

Processing the roots for assessing the population of nematodes

The root samples collected from healthy and diseased plants were washed and chopped into small bits and from each lot a sample of 100 gm was weighed out. This was put in a homogeniser along with 5 cc of water and the homogeniser worked for 60 seconds twice with an interval of 30 seconds. Then the contents were washed down into a beaker with minimum quantity of water and made up to 30 cc. This was transferred to a counting dish and the nematodes counted under a microscope. A few drops of formaline were added before counting.

Staining the roots for observing the position of endo parasitic nematodes

Small bits of the roots were immersed in boiling lactophenol with 1% methylene blue taken in a test-tube and the boiling was continued for 3 minutes. Then it was cooled excess stain was poured out and the roots were transferred to an excess of clear lactophenol. After 24 hours roots were teased under a microscope and the position of the endo parasitic nematodes ascertained.

# DETAILS OF STUDIES AND RESULTS

## DETAILS OF STUDIES AND RESULTS

A survey of nematodes associated with tomato, brinjal, bhindi, snakegourd and bittergourd has been made from different parts of Kerala covering various types of soil. The details of samples collected from various localities and the population of nematodes in each sample are given in the following pages:

### Locality.1 Vellayani, Trivandrum

**Details of collection**

| | |
|---|---|
| Place of collection. | Agricultural College, Vellayani. |
| Type of soil. | Red loam. |
| Date of collection. | 6—10—1967. |

Collection of root and soil samples, analysis of nematodes in soil and analysis of nematodes in roots were done as detailed in " Methods ".

**Results**

Results are furnished in Table I. It is observed that the total populations of nematodes in 500 cc soil of diseased tomato and brinjal plants are 4650 and 2850 respectively as against 2200 and 1650 for healthy plants. But the population in similar soil samples of diseased bhindi, snakegourd and bittergourd are 700, 500 and 150 as against 1450, 1350 and 1250 for healthy plants. The Rhabditids are more in the soil samples of

TABLE I

**Population of nematodes in the soil and roots of different vegetables at Vellayani.**

| Name of crop | Condition of crop | 500 cc of soil sample | | | | | | 100 gm of root sample | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Helico | Hoplo | Prat | Rot | Non-par | Total | Mel | Hoplo | Prat | Rot | Total |
| Tomato | Diseased | 2300 | 900 | 900 | .. | 550 | 4650 | 96 | 12 | .. | .. | 108 |
| | Healthy | 150 | 100 | .. | .. | 1950 | 2200 | .. | .. | 2 | .. | 2 |
| Brinjal | Diseased | 450 | 700 | 550 | 100 | 1050 | 2850 | 110 | 25 | .. | .. | 135 |
| | Healthy | 100 | 350 | 50 | 200 | 950 | 1650 | 4 | 1 | .. | .. | 5 |
| Bhindi | Diseased | 250 | .. | 300 | .. | 150 | 700 | 90 | .. | 2 | 4 | 96 |
| | Healthy | 150 | 50 | .. | .. | 1250 | 1450 | .. | 2 | .. | 2 | 4 |
| Snake gourd | Diseased | 100 | .. | 100 | .. | 300 | 500 | .. | .. | 5 | 8 | 13 |
| | Healthy | .. | .. | 150 | .. | 1200 | 1350 | .. | .. | 1 | 1 | 2 |
| Bitter gourd | Diseased | .. | 50 | .. | .. | 100 | 150 | .. | .. | 6 | 12 | 18 |
| | Healthy | .. | 150 | .. | .. | 1100 | 1250 | .. | .. | 2 | 1 | 3 |

healthy plants than in those of diseased ones. The populations of parasitic nematodes in the roots of diseased tomato, brinjal, bhindi, snakegourd and bittergourd are 108, 135, 96, 13 and 18 respectively as against 2, 5, 4, 2 and 3 in the case of healthy plants. The parasitic forms observed are Helicotylenchus, Hoplolaimus, Pratylenchus and Rotylenchus, the last one being associated with brinjal alone. Helicotylenchus is more in the root. Meloidogyne. sp. is observed in the roots of tomato and brinjal.

Locality. 2 Peroorkada, Trivandrum

Details of collection

| | |
|---|---|
| Place of collection. | Law Academy Compound, Peroorkada. |
| Type of soil | Lateritic. |
| Date of collection | 8—11—1967. |

Results

Results are furnished in the Table II. The total population of nematodes in 500 cc soil of diseased tomato and brinjal plants are found to be 3300 and 1200 as against 650 and 1400 for healthy plants. The nematode population in other soil samples of diseased bhindi, snakegourd and bittergourd are 1300, 400 and 250 as against 2350, 750 and 400 for healthy plants. Here also Rhabditids are more in number in healthy plants than in the diseased plants. The populations of parasitic nematodes in the roots of diseased tomato, brinjal, bhindi, snakegourd and bittergourd are 82,

TABLE II

Population of nematodes in the soil and roots of different vegetables at Peroorkada.

| Name of crop | Condition of crop | 500 cc of soil sample | | | | | | 100 gm of root sample | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Helico | Hoplo | Prat | Rot | Non-par | Total | Hel | Hoplo | Prat | Rot | Total |
| Tomato | Diseased | 2050 | .. | 450 | 100 | 700 | 3300 | 82 | .. | .. | .. | 82 |
| | Healthy | 450 | .. | .. | .. | 200 | 650 | 4 | .. | .. | .. | 4 |
| Brinjal | Diseased | .. | 550 | 250 | 250 | 150 | 1200 | 120 | .. | .. | .. | 120 |
| | Healthy | 100 | .. | 200 | 150 | 950 | 1400 | 6 | .. | .. | .. | 6 |
| Bhindi | Diseased | .. | .. | 50 | 850 | 400 | 1300 | 76 | .. | .. | .. | 76 |
| | Healthy | 50 | .. | 250 | .. | 2050 | 2350 | 18 | .. | .. | .. | 18 |
| Snake gourd | Diseased | 200 | .. | 50 | 150 | .. | 400 | .. | .. | 16 | .. | 16 |
| | Healthy | 50 | .. | .. | .. | 700 | 750 | .. | .. | 1 | 1 | 2 |
| Bitter gourd | Diseased | 50 | .. | 150 | 50 | .. | 250 | .. | .. | 11 | 7 | 18 |
| | Healthy | .. | .. | .. | .. | 400 | 400 | .. | .. | .. | .. | .. |

120, 76, 16 and 18 respectively as against 4, 6, 18, 2 and nil in the case of healthy plants. The parasitic forms observed are same as in Vellayani, Pratylenchus and Rotylenchus are, however, more common here. The nematodes are few inside the roots except Heloidogyne sp.

Locality.3 Vithura, Trivandrum

Details of collection

| | |
|---|---|
| Place of collection. | Chittar, Vithura. |
| Soil type | Lateritic. |
| Date of collection | 12—12—1967. |

Results

Results are furnished in Table III. The total population of nematodes in soil of diseased tomato, brinjal, bhindi, snakegourd and bittergourd are found to be 750, 850, 350, 300 and 150 per 500 cc of soil respectively as against 300, 100, 150, 550 and 250 per 500 cc of soil for healthy plants. Here significant difference can be observed in the total number of nematodes in healthy and diseased plants of tomato, brinjal and bhindi. But for the rest the number is more in the case of healthy plants due to the increased number of Rhabditids present. The population of parasitic nematodes in the roots of diseased tomato, brinjal, bhindi, snakegourd and bittergourd are 46, 4, 28, 14 and 4 respectively as against nil, 2, 8, 1 and 2 for healthy plants. The

TABLE III

Population of nematodes in the soil and roots of different vegetables at Vithura.

| Name of crop | Condition of crop | 500 cc of soil sample | | | | | | 100 gm of root sample | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Helico | Heplo | Prat | Rot | Non-par | Total | Hel | Heplo | Prat | Rot | Total |
| Tomato | Diseased | 400 | .. | 100 | .. | 250 | 750 | 46 | .. | .. | .. | 46 |
| | Healthy | 100 | .. | .. | .. | 200 | 300 | .. | .. | .. | .. | .. |
| Brinjal | Diseased | 100 | 150 | 150 | 50 | 300 | 850 | 4 | .. | .. | .. | 4 |
| | Healthy | .. | .. | 100 | .. | .. | 100 | 2 | .. | .. | .. | 2 |
| Bhindi | Diseased | 250 | .. | .. | .. | 100 | 350 | 28 | .. | .. | .. | 28 |
| | Healthy | 150 | .. | .. | .. | .. | 150 | 8 | .. | .. | .. | 8 |
| Snake gourd | Diseased | .. | .. | 300 | .. | .. | 300 | .. | .. | 14 | .. | 14 |
| | Healthy | .. | .. | 300 | .. | 250 | 550 | .. | .. | 1 | .. | 1 |
| Bitter gourd | Diseased | .. | .. | .. | .. | 150 | 150 | .. | .. | 1 | 3 | 4 |
| | Healthy | .. | .. | 150 | .. | 100 | 250 | .. | .. | 1 | 1 | 2 |

parasitic forms counted are the same as in the above Tables. In the root samples variations in the number of parasitic forms between diseased and healthy plants are quite pronounced.

Locality. 4 Chavara, Quilon

Details of collection

| | |
|---|---|
| Place of collection. | Sankaramangalam, Chavara. |
| Type of soil | Sandy |
| Date of collection | 3—1—1968 |

Results

Results are tabulated in Table IV. The total population of nematodes observed in 500 cc soil samples of tomato, brinjal, bhindi, snakegourd and bittergourd are 300, 1350, 550, 600 and 100 respectively as against 200, 300, 200, 50 and 250 for healthy plants. Here the number of parasitic forms are more in diseased plants except for bittergourd where the number of nematodes remains the same for both healthy and diseased plants. The total number in diseased root samples of tomato, brinjal, bhindi, snakegourd and bittergourd are 9, 13, nil, 25 and 2 as against nil, 5, 2, 5 and nil for healthy roots. Here also number of parasitic forms are more in diseased samples except for bhindi and bittergourd. Parasitic forms counted are the same as in the above samples.

TABLE IV

Population of nematodes in the soil and roots of different vegetables at Chavara.

| Name of crop | Condition of crop | 500 cc of soil sample | | | | | | 100 gm of root sample | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Helico | Hoplo | Prat | Rot | Non-par | Total | Mel | Hoplo | Prat | Rot | Total |
| Tomato | Diseased | 100 | 50 | .. | .. | 150 | 300 | 7 | 2 | .. | .. | 9 |
| | Healthy | 100 | .. | 50 | .. | 50 | 200 | .. | .. | .. | .. | .. |
| Brinjal | Diseased | .. | 150 | 350 | 850 | .. | 1350 | 12 | 1 | .. | .. | 13 |
| | Healthy | 150 | .. | .. | .. | 150 | 300 | 3 | 2 | .. | .. | 5 |
| Bhindi | Diseased | 150 | .. | .. | .. | 400 | 550 | .. | .. | .. | .. | .. |
| | Healthy | .. | .. | 50 | .. | 150 | 200 | .. | 2 | .. | .. | 2 |
| Snake gourd | Diseased | 100 | .. | 350 | 100 | 50 | 600 | .. | .. | 8 | 17 | 25 |
| | Healthy | .. | .. | .. | .. | 50 | 50 | .. | .. | 4 | 1 | 5 |
| Bitter gourd | Diseased | .. | .. | .. | .. | 100 | 100 | .. | .. | 1 | 1 | 2 |
| | Healthy | .. | .. | .. | .. | 250 | 250 | .. | .. | .. | .. | .. |

## Locality. 5 Mavelikara, Quilon

### Details of collection

| | |
|---|---|
| Place of collection. | District Agricultural Farm, Mavelikara. |
| Type of soil | Sandy. |
| Date of collection | 21—1—1968. |

### Results

The results are tabulated in Table V. The total number of nematodes observed in 500 cc soil samples of tomato, brinjal, bhindi, snakegourd and bittergourd are 450, 1400, 700, 600 and 250 as against 300, 150, 600, 200 and 50 for healthy plants. Here also presence of Rhabditids are more in healthy samples. But variation between the number of nematodes in the diseased plants and healthy plants are conspicuous in all cases. Helicotylenchus sp. is seen more in diseased plants of all vegetables under study. Hoplolaimus sp. is absent. Pratylenchus and Rotylenchus sp. are also present in fairly good numbers in diseased plants. In the root samples of diseased tomato, brinjal, bhindi, snakegourd, and bittergourd the populations of nematodes are found to be nil, 26, 54, 15 and 11 respectively as against 2, 1, 23, nil and nil in healthy plants. Meloidogyne sp. is abundantly present. Pratylenchus sp. and Rotylenchus sp. are found associated with snakegourd and bittergourd only. The parasitic forms observed are same as in the above samples.

TABLE V

Population of nematodes in the soil and roots of different vegetables at Mavelikara.

| Name of crop | Condition of crop | 500 cc of soil sample | | | | | | 100 gm of root sample | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Helico | Hoplo | Prat | Rot | Non-par | Total | Hel | Hoplo | Prat | Rot | Total |
| Tomato | Diseased | 100 | .. | 50 | 50 | 250 | 450 | .. | .. | .. | .. | .. |
| | Healthy | .. | .. | .. | 50 | 250 | 300 | 2 | .. | .. | .. | 2 |
| Brinjal | Diseased | 150 | .. | 400 | 850 | .. | 1400 | 15 | 11 | .. | .. | 26 |
| | Healthy | 100 | .. | 50 | .. | .. | 150 | 1 | .. | .. | .. | 1 |
| Dhindi | Diseased | 100 | .. | 250 | 100 | 250 | 700 | 54 | .. | .. | .. | 54 |
| | Healthy | .. | .. | .. | 100 | 500 | 600 | 23 | .. | .. | .. | 23 |
| Snake gourd | Diseased | 100 | .. | 350 | 100 | 50 | 600 | .. | .. | 6 | 9 | 15 |
| | Healthy | .. | .. | 200 | .. | .. | 200 | .. | .. | .. | .. | .. |
| Bitter gourd | Diseased | 50 | .. | 150 | 50 | .. | 250 | .. | .. | 10 | 1 | 11 |
| | Healthy | .. | .. | .. | .. | 50 | 50 | .. | .. | .. | .. | .. |

Locality. 6 Thiruvarpu, Kottayam

Details of collection

| | |
|---|---|
| Place of collection. | Vetticadu, Thiruvarpu. |
| Type of soil. | Clayey. |
| Date of collection | 15—3—1968. |

Results

The results are furnished in Table VI. It is observed that the total population of nematodes in 500 cc soil of diseased tomato, brinjal, bhindi, snakegourd and bittergourd are 400, 350, 100, 450 and 100 respectively as against 50, 350, 200 100 and 50 for healthy plants. The difference is great in the case of tomato and gourds. For brinjal and bhindi there is not so much variation. Rhabditids are more in the healthy samples of brinjal and bhindi. The populations in the root samples for tomato, brinjal, bhindi, snakegourd and bittergourd are 18, 24, 17 21 and 19 while those of healthy are 2, nil, 4, 4 and 3 respectively. Meloidogyne sp. is restricted to tomato, brinjal and bhindi; Pratylenchus sp. and Rotylenchus sp. are associated with snakegourd and bittergourd only. The parasitic forms noted are similar to those in the above samples.

Locality. 7 Alwaye, Ernakulam

Details of collection

| | |
|---|---|
| Place of collection. | Vegetable Farm, Alwaye. |
| Soil type | Clayey |
| Date of collection | 27—3—1968. |

TABLE VI

**Population of nematodes in the soil and roots of different vegetables at Thiruvarur.**

| Name of crop | Condition of crop | 500 cc of soil sample | | | | | | 100 gm of root sample | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Helico | Hoplo | Prat | Rot | Non-par | Total | Hel | Hoplo | Prat | Rot | Total |
| Tomato | Diseased | 200 | 50 | .. | 100 | 50 | 400 | 18 | .. | .. | .. | 18 |
| | Healthy | .. | .. | 50 | .. | .. | 50 | 2 | .. | .. | .. | 2 |
| Brinjal | Diseased | .. | 200 | .. | .. | 150 | 350 | 22 | 2 | .. | .. | 24 |
| | Healthy | 200 | .. | .. | .. | 150 | 350 | .. | .. | .. | .. | .. |
| Bhindi | Diseased | 100 | .. | .. | .. | .. | 100 | 17 | .. | .. | .. | 17 |
| | Healthy | 50 | .. | 100 | .. | 50 | 200 | 3 | .. | 1 | .. | 4 |
| Snake gourd | Diseased | .. | .. | .. | 100 | 350 | 450 | .. | .. | 21 | .. | 21 |
| | Healthy | .. | .. | .. | .. | 100 | 100 | .. | .. | 4 | .. | 4 |
| Bitter gourd | Diseased | .. | .. | 100 | .. | .. | 100 | .. | .. | 13 | 6 | 19 |
| | Healthy | .. | .. | .. | 50 | .. | 50 | .. | .. | .. | 3 | 3 |

TABLE VII

Population of nematodes in the soil roots of different vegetables at Alwaye.

| Name of crop | Condition of crop | 500 cc of soil sample | | | | | | 100 gm of root sample | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Helico | Haplo | Prat | Rot | Non-par | Total | Hel | Haplo | Prat | Rot | Total |
| Tomato | Diseased | 1100 | .. | 100 | .. | 150 | 1350 | 31 | 2 | .. | 1 | 34 |
| | Healthy | 750 | .. | 50 | .. | 300 | 1100 | 4 | .. | .. | .. | 4 |
| Brinjal | Diseased | 200 | .. | 50 | .. | 150 | 400 | 15 | .. | .. | .. | 15 |
| | Healthy | 150 | .. | 50 | .. | .. | 200 | 8 | .. | .. | .. | 8 |
| Bhindi | Diseased | .. | .. | 150 | 250 | 150 | 550 | 21 | .. | .. | .. | 21 |
| | Healthy | .. | .. | .. | .. | 50 | 50 | 2 | .. | .. | .. | 2 |
| Snake gourd | Diseased | .. | .. | 150 | 100 | 50 | 100 | .. | .. | 1 | 10 | 11 |
| | Healthy | .. | .. | 50 | 50 | 100 | 200 | .. | .. | .. | 3 | 3 |
| Bitter gourd | Diseased | .. | .. | 100 | 100 | 350 | 550 | .. | .. | 4 | 6 | 10 |
| | Healthy | .. | .. | .. | 50 | .. | 50 | .. | .. | 1 | 1 | 2 |

Results

The results are tabulated in Table VII. The population of nematodes in 500 cc soil of diseased and healthy plants of brinjal and bhindi are 400, 200 and 550, 50 respectively. But the population in similar soil samples of diseased tomato, snakegourd and bittergourd are 1350, 100 and 550 as against 1100, 200 and 50 for healthy plants. Rhabditids are more in both these lots than the previous locality. Pratylenchus sp. is more abundant than the other genera. The populations of parasitic nematodes in the roots of diseased tomato, brinjal, bhindi, snakegourd and bittergourd are 34, 15, 21, 11 and 10 as against 4, 8, 2 3 and 2 for healthy plants. The parasites observed are similar to those in the previous locality.

Locality. 8 Pattambi, Palghat

Details of collection.

| | |
|---|---|
| Place of collection | Central Rice Research Station, Pattambi. |
| Soil type. | Loamy. |
| Date of collection. | 16—2—1968. |

Results

The results tabulated in Table VIII show that there is significant difference in the total population of nematodes of diseased and healthy plants. This is due to the increased number of Rhabditids present. The total populations are found to be 550, 200, 200, 150 and 100 for healthy tomato, brinjal, bhindi, snakegourd and bittergourd respectively while

TABLE VIII

Population of nematodes in the soil and roots of different vegetables at Pattambi.

| Name of crop | Condition of crop | 500 cc of soil sample | | | | | | 100 gm of root sample | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Helico | Heplo | Prat | Rot | Non-par | Total | Mel | Heplo | Prat | Rot | Total |
| Tomato | Diseased | 50 | 300 | 50 | .. | 150 | 550 | 10 | 20 | .. | .. | 30 |
| | Healthy | .. | .. | 50 | .. | 50 | 100 | .. | .. | 2 | .. | 2 |
| Brinjal | Diseased | 100 | .. | 50 | .. | 50 | 200 | 20 | .. | .. | .. | 20 |
| | Healthy | 100 | .. | .. | .. | .. | 100 | .. | .. | .. | .. | .. |
| Bhindi | Diseased | 50 | .. | .. | 100 | 50 | 200 | 47 | 2 | .. | .. | 49 |
| | Healthy | .. | .. | .. | 150 | 350 | 500 | 2 | .. | .. | .. | 2 |
| Snake gourd | Diseased | 50 | .. | 100 | .. | .. | 150 | .. | .. | 40 | .. | 40 |
| | Healthy | .. | .. | 50 | 100 | 100 | 250 | .. | .. | 2 | .. | 2 |
| Bitter gourd | Diseased | .. | .. | 50 | .. | 50 | 100 | .. | .. | .. | .. | .. |
| | Healthy | .. | .. | .. | 50 | 400 | 450 | .. | .. | .. | 1 | 1 |

that of healthy plants are 100, 100, 500, 250 and 450 respectively. The more abundant parasitic genera noticed are Helicotylenchus, Pratylenchus and Rotylenchus. The population in root samples of diseased tomato, brinjal, bhindi, snakegourd and bittergourd are 30, 20, 49, 40 and nil as against 2, nil 2, 2 and 1 for healthy plants. The parasitic forms observed are as under the above samples.

### Locality. 9 Madupatty, Kottayam

Details of collection

| | |
|---|---|
| Place of collection. | Indo-Swiss Project, Madupatty. |
| Type of soil. | Black soil. |
| Date of collection. | 13—2—1968. |

Results

Results are furnished in Table IX. The total populations of diseased tomato and bhindi are found to be 200 and 150 as against 50 and 100 for healthy plants. Parasitic forms observed are Hoplolaimus in tomato and Pratylenchus in bhindi. In the root samples of diseased tomato and bhindi plants showed a population of 37 and 4 as against 4 and 3 in the case of healthy plants. Meloidogyne sp. is well distributed.

### Locality. 10 Vandanmedu, Kottayam

Details of collection

| | |
|---|---|
| Place of collection | State Vegetable Farm, Vandanmedu. |
| Type of soil | Black soil. |
| Date of collection. | 12—2—1968. |

TABLE IX

Population of nematodes in the soil and roots of different vegetables at Maduratty.

| Name of crop | Condition of crop | 500 cc of soil sample | | | | | | 100 gm of root sample | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Helico | Hoplo | Prat | Rot | Non-par | Total | Mel | Hoplo | Prat | Rot | Total |
| Tomato | Diseased | .. | 150 | .. | .. | 50 | 200 | 17 | 20 | .. | .. | 37 |
| | Healthy | .. | 50 | .. | .. | .. | 50 | 2 | 2 | .. | .. | 4 |
| Bhindi | Diseased | .. | .. | 50 | .. | 100 | 150 | 4 | .. | .. | .. | 4 |
| | Healthy | .. | .. | .. | 50 | 50 | 100 | 1 | .. | .. | 2 | 3 |

TABLE X

Population of nematodes in the soil and roots of different vegetables at Vandanmedu.

| Name of crop | Condition of crop | 500 cc of soil sample | | | | | | 100 gm of root sample | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Helico | Hoplo | Prat | Rot | Non-par | Total | Mel | Hoplo | Prat | Rot | Total |
| Tomato | Diseased | 200 | .. | 50 | .. | 50 | 300 | 16 | .. | 2 | .. | 18 |
| | Healthy | 50 | .. | 50 | .. | 100 | 200 | 7 | 1 | .. | .. | 8 |
| Brinjal | Diseased | .. | 50 | .. | .. | 100 | 150 | 10 | 8 | .. | .. | 18 |
| | Healthy | .. | .. | 50 | .. | 150 | 200 | 3 | .. | 2 | .. | 5 |
| Bhindi | Diseased | 50 | .. | .. | .. | .. | 50 | 7 | .. | .. | .. | 7 |
| | Healthy | .. | .. | .. | .. | 50 | 50 | 4 | .. | .. | .. | 4 |

Results

Results are tabulated in Table X. Population of parasitic forms is more in the case of diseased samples of tomato. It is in the order of 300 for diseased and 200 for healthy plants. For brinjal total population is 150 for diseased and 200 for healthy. This may be due to the presence of more number of Rhabditids in the healthy plants. For bhindi equal number (50) is observed for both healthy and diseased plants. Rhabditids are well distributed. The population of parasitic nematodes in root samples of tomato, brinjal and bhindi are 18, 15 and 7 as against 8, 5 and 4.

# DISCUSSION

## DISCUSSION

Results of the analysis of soil and root samples of vegetables for nematode population show that in general there is a high population of parasitic and non-parasitic nematodes associated with vegetables in Kerala. Since vegetables are irrigated crops the nematode population is always kept up without suffering any set back caused by dry conditions. The generous manuring with organic materials which is usually practiced in raising vegetable crops appears to have encouraged the sustenance of a very high population of the saprophytic, predacious and non-parasitic forms also in the soil.

The different genera of parasitic nematodes found in association with vegetable crops are Helicotylenchus, Hoplolaimus, Pratylenchus, Rotylenchus and Meloidogyne. Tomato, brinjal and bhindi are infested by all these five genera of nematodes. The gourds, namely, bittergourd and snakegourd are infested only by Helicotylenchus, Pratylenchus and Rotylenchus and not by Hoplolaimus and Meloidogyne. As regards the distribution of the different nematodes in the localities under study, that is from Vellayani in the south to Pattambi in the north, it is observed that all the different types of nematodes are present in all the localities examined.

Table XI gives the average population of the different nematodes observed in the different types of soils from which samples have been collected. In the loamy soil Helicotylenchus has the maximum population

TABLE XI

**Consolidated table giving the average population of nematodes in the different types of soil**

| Soil type | Condition of the plant | Parasitic forms | | | | | Total | Non-parasitic forms |
|---|---|---|---|---|---|---|---|---|
| | | Helico | Hoplo | Praty | Roty | Mel | | |
| Loamy | Diseased | 83.75 | 50.23 | 53.83 | 5.60 | 9.33 | 202.74 | 183.75 |
| | Healthy | 12.50 | 10.33 | 7.73 | 12.60 | 0.15 | 49.31 | 61.25 |
| | Total | 96.25 | 60.56 | 61.56 | 18.20 | 9.48 | 6.85 | 245.00 |
| Sandy | Diseased | 21.25 | 5.35 | 48.13 | 53.20 | 2.20 | 130.13 | 36.25 |
| | Healthy | 8.75 | 0.10 | 8.85 | 3.78 | 0.73 | 22.21 | 30.00 |
| | Total | 30.00 | 5.45 | 56.98 | 56.98 | 2.93 | 152.34 | 66.25 |
| Lateritic | Diseased | 76.25 | 17.50 | 38.80 | 36.50 | 8.90 | 177.95 | 76.25 |
| | Healthy | 22.50 | .. | 25.08 | 3.80 | 0.95 | 52.33 | 51.25 |
| | Total | 98.70 | 17.50 | 63.88 | 40.30 | 9.85 | 230.23 | 127.50 |
| Clayey | Diseased | 40.00 | 6.35 | 17.23 | 16.83 | 2.85 | 43.26 | 18.75 |
| | Healthy | 28.75 | .. | 7.65 | 3.93 | 0.48 | 40.81 | 35.00 |
| | Total | 68.75 | 6.35 | 24.88 | 20.76 | 3.33 | 124.07 | 53.75 |
| Black | Diseased | 6.25 | 5.70 | 2.55 | .. | 1.45 | 15.95 | 6.75 |
| | Healthy | 1.25 | 1.33 | 2.55 | 1.30 | 0.45 | 6.88 | 7.50 |
| | Total | 7.50 | 7.03 | 5.10 | 1.30 | 1.90 | 22.83 | 16.25 |

followed closely by Hoplolaimus and Pratylenchus. The population of Rotylenchus is considerably less than that of the other genera. In the sandy soil on the other hand, the maximum population is shown by Pratylenchus and Rotylenchus and the least by Hoplolaimus. In the laterite soil the maximum population is attained by Helicotylenchus closely followed by Pratylenchus; Hoplolaimus has the lowest population. Clayey soil also is more favourable for Helicotylenchus and least favourable for Hoplolaimus. In the case of black soil the population of Helicotylenchus and Hoplolaimus are more than the rest.

Helicotylenchus is seen to thrive well in all the different types of soils. For Hoplolaimus however loamy soil is considerably more favourable than the rest of the soil types. Pratylenchus like Helicotylenchus is seen to thrive equally well in all the soil types. Sandy and lateritic soils are far more favourable to Rotylenchus than the other soils.

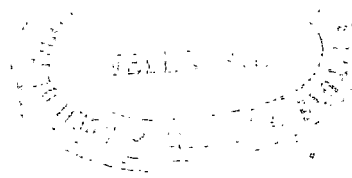
As regards the root-knot nematode Meloidogyne, whose population in roots has been studied, it is observed that the roots of plants growing in the lateritic and loamy soils are far more highly infested by these nematodes than the roots of plants growing in the other types of soils. Considering the total population of parasitic forms, it is seen that the loamy soil harbours the maximum population followed closely by lateritic and sandy soils. Clayey soil has considerably less population of the parasitic forms than the other soil types excepting the black soil which has a very low population of the parasitic fauna. The

population of the non-parasitic forms also with reference to the soil types presents the same picture as that of the total parasitic forms. In the case of all the parasitic and non-parasitic forms the black soil is invariably seen to maintain a very low population. The black soil regions from where the samples were collected ie. Madupatty and Vandanmedu are situated on the High Ranges at altitudes of 4000 to 5000 ft. above M.S.L. These are forest areas, the soils of which are rich in organic matter. As such it is only logical to expect that the population of the non-parasitic (saprophytic and predacious) forms will be high in these soils. The population of these nematodes in the forest soils thus appears to be restricted and inhibited by factors other than the organic contents. An explanation for the low nematode population in these soils may have to be found in the texture of the soil and also in the climatic factors existing in the High Ranges.

While collecting samples of soil and roots for nematode population studies, an effort was made to distinguish healthy plants and plants showing apparent symptoms caused by nematode infestation. These symptoms included discolouration of the leaves and stunted growth of the plants. It was finally, ascertained that these symptoms observed were not caused by any other known causes such as fungal, baterial or virus disease or

by soil insects. Table XI gives a comparison of the populations of the various nematodes found in association with the different vegetables which are healthy and which show the disease symptoms. In general it is observed that the population of the parasitic nematodes associated with the diseased plant is considerably higher than that associated with healthy plants. A similar correlation exists in the case of non - parasitic forms also though not to a significant level. The association shown between the manifestation of disease symptoms and the occurrence of the higher population of parasitic forms is a logical proof to conclude that these symptoms are caused by the parasitic nematodes.

# SUMMARY



## SUMMARY AND CONCLUSIONS

A survey of the various types of parasitic and non-parasitic nematodes associated with the important vegetable crops of Kerala has been made. A total of 100 samples of soil and 100 samples of roots have been analysed.

The parasitic forms found infesting the various vegetable crops in Kerala are Helicotylenchus, Hoplolaimus, Pratylenchus, Rotylenchus and Meloidogyne. Of these Hoplolaimus and Meloidogyne do not infest the gourds namely, bittergourd and snakegourd.

There exists variation in the population of the different types of nematodes in relation to the different types of soils. In general the total parasitic population as well as the population of the non-parasitic forms is highest in loamy soils followed closely by lateritic soil. This again is followed in the descending order by the sandy soil, clayey soil and the black soil. The black soil in spite of its high humus and organic matter contents shows the lowest nematode population.

Considerably more number of parasitic nematodes are found associated with the vegetable plants showing fading and stunting symptoms indicating that the parasitic nematodes are responsible for causing them.

# REFERENCES

## REFERENCES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