CHAPTER - 4

RESULTS
The present work "Studies on plant parasitic nematodes of some vegetables and medicinal plants of Kashmir valley with reference to damage and management" was carried out from January, 2004 to March, 2008. This study was centered on two major aspects of survey and management of plant parasitic nematodes. So, the results obtained in this endeavour are being separately given under three major headings: Survey of plant parasitic nematodes, Description and Management of plant parasitic nematodes.

4.1. Survey of Plant Parasitic Nematodes

4.1.1. Plant Parasitic Nematodes of Onion in Six Districts of Kashmir Valley

Survey and studies were conducted for nematodes of onion in Kashmir valley. The nematodes encountered from onion sample of Pulwama were *Helicotylenchus vulgaris*, *Merlinius brevidens*, *Aphelenchus avenae*, *Tylenchus exigus*. The total number of nematodes was 860 /200 ml of soil. The nematodes recovered from soil sample of Ganderbal site were *Helicotylenchus vulgaris*, *Helicotylenchus pseudorobustus*, *Merlinius brevidens*, *Tylenchus exigus*. The
total number of nematodes was 880/200 ml of sample. The nematodes found in the sample of Anantnag were *Helicotylenchus vulgaris*, *Helicotylenchus pseudorobustus*, *Merlinius brevidens*, *Aphelenchus avenae*. The total number of nematodes was 454 nematode/200 ml of soil. The nematodes extracted from soil sample of Channapora were *Helicotylenchus vulgaris*, *H. martini*, *H. pseudorobustus*, *Aphelenchus avenae*, and *Tylenchus exigus*. The total number of nematodes was 537.6/200 ml of soil sample. The nematodes found in onion sample from Kreeri Baramulla were *Helicotylenchus vulgaris*, *Aphelenchus avenae*, *Pratylenchus thornei*, *Tylenchus exigus*. The total number of nematode was 1420/200 ml of soil sample. The nematodes found in soil sample of Chadoora Budgam were *Helicotylenchus digonicus*, *Psilenchus hilarulus*, *Aphelenchus avenae*, *Pratylenchus thornei*, the nematodes of order *Dorylaimida* and *Rhabditida* were found in all the samples. The total number of nematodes recorded in sample of Chadoora Budgam was 3046.4/200 ml soil. Highest number of nematodes in onion was found in Chadoora Budgam followed by that in district Baramulla.

Table 1. Plant parasitic nematodes of onion in Kashmir valley

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Sites</th>
<th>No. of Nematodes /200ml soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Letapora Pulwama</td>
<td>860</td>
</tr>
<tr>
<td>2</td>
<td>Ganderbal</td>
<td>880</td>
</tr>
<tr>
<td>3</td>
<td>Anantnag</td>
<td>454</td>
</tr>
<tr>
<td>4</td>
<td>Channapora</td>
<td>537.6</td>
</tr>
<tr>
<td>5</td>
<td>Kreeri Baramulla</td>
<td>1420</td>
</tr>
<tr>
<td>6</td>
<td>Chadoora Budgam</td>
<td>3046.4</td>
</tr>
</tbody>
</table>
Fig. 1. Plant parasitic nematodes of onion in Kashmir valley

Table 2. Showing prevalence of plant parasitic nematodes infesting onion in Kashmir valley

<table>
<thead>
<tr>
<th>Nematodes</th>
<th>Letapora</th>
<th>Ganderbal</th>
<th>Anantnag</th>
<th>Chanapora</th>
<th>Kreeri</th>
<th>Baramulla</th>
<th>Chadoora</th>
<th>Budgam</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Helicotylenchus vulgaris</em></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><em>H. psuedorobustus</em></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><em>H. digonicus</em></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><em>H. martinii</em></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><em>Merlinius brevidens</em></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><em>Aphelenchus elongatus</em></td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td><em>Tylenchus exigus</em></td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><em>Pratylenchus thornei</em></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><em>Psilenchus hilarulus</em></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
</tbody>
</table>
4.1.2. Plant Parasitic Nematodes of Tomato Crop

Survey and studies were conducted for nematodes of tomato in August 2004 in five sites of Kashmir valley. The nematodes extracted from tomato sample of Hajibal were *Helicotylenchus vulgaris*, *Helicotylenchus pseudorobustus*, *Merlinius brevidens*, *Aphelenchus avenae*, *Tylenchus exigus*. The total nematode population recovered from sample was 2508 nematodes per 200ml of soil. The nematodes encountered in soil sample of Char-e-Sharief were *Helicotylenchus vulgaris*, *Helicotylenchus pseudorobustus*, *Aphelenchoides* spp. The total nematode population recorded was 430.4 nematodes per 200 ml soil. The nematodes found in soil sample of Letapora were *Tylenchus exigus*, *Aphelenchus avenae*, *Helicotylenchus vulgaris*, *Helicotylenchus pseudorobustus*. The total nematode population recorded was 1584 nematodes per 200ml of soil. The nematodes found in soil sample of Pattan were *Pratylenchus thornei*, *Helicotylenchus vulgaris*, *Tylenchus exigus*, *Aphelenchus avenae*, *Rotylenchus* spp. Total nematode population recorded was 1065 nematodes per 200ml of soil. The nematodes encountered in soil samples of Chadoora were *Helicotylenchus vulgaris*, *Helicotylenchus digonicus*, *Helicotylenchus pseudorobustus*, *Merlinius brevidens*, *Tylenchus exigus*. The total nematode population was 435.2 nematodes per 200 ml of soil. The highest nematode population was recorded in Hajibal followed by Letapora.
Table 3. Plant parasitic nematodes of tomato crop in Kashmir valley

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Sites</th>
<th>Nematode population / 200ml of soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hajibal (Kakapora)</td>
<td>2508</td>
</tr>
<tr>
<td>2</td>
<td>Charar-e-Sharief</td>
<td>430.4</td>
</tr>
<tr>
<td>3</td>
<td>Letapora</td>
<td>1584</td>
</tr>
<tr>
<td>4</td>
<td>Pattan</td>
<td>1065</td>
</tr>
<tr>
<td>5</td>
<td>Chadoora</td>
<td>435.2</td>
</tr>
</tbody>
</table>

Table 4. Showing prevalence of nematodes of tomato

<table>
<thead>
<tr>
<th>Nematodes</th>
<th>Hajibal</th>
<th>Charar-e-Sharief</th>
<th>Letapora</th>
<th>Pattan</th>
<th>Chadoora</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Helicotylenchus</em></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><em>vulgaris</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>H. psuedorobustus</em></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td><em>H. digonicus</em></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td><em>Merlinius brevidens</em></td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td><em>Aphelenchus avenae</em></td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td><em>Tylenchus exigus</em></td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><em>Pratylenchus thornei</em></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td><em>Rotylenchus spp.</em></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td><em>Aphelenchoides spp.</em></td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
4.1.3. Plant Parasitic Nematodes of Mint

The study was carried out on plant parasitic nematodes associated with mint. The nematodes extracted from soil sample of mint were Helicotylenchus vulgaris, Helicotylenchus pseudorobustus, Aphelenchus avenae, Pratylenchus thornei, Tylenchus exigus, Merlinius brevidens, Aphelenchoides spp. The total number of nematodes recorded was 826/200 ml of soil. The most prevalent among plant parasitic nematodes was Helicotylenchus vulgaris, followed by Tylenchus exigus H. pseudorobustus, Aphelenchus avenae, Pratylenchus thornei, Aphelenchoides spp., Merlinius brevidens respectively.
Table 5. Showing prevalence of nematodes of mint

<table>
<thead>
<tr>
<th>Nematodes</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Helicotylenchus vulgaris</em></td>
<td>31%</td>
</tr>
<tr>
<td>Tylenchus exigus</td>
<td>20%</td>
</tr>
<tr>
<td><em>H. pseudorobustus</em></td>
<td>15%</td>
</tr>
<tr>
<td>Aphelenchus avenae</td>
<td>12%</td>
</tr>
<tr>
<td>Pratylenchus thornei</td>
<td>9%</td>
</tr>
<tr>
<td>Aphelenchoides spp.</td>
<td>7%</td>
</tr>
<tr>
<td>Merlinius brevidens</td>
<td>6%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Fig. 3. Showing percentage of different nematodes species of mint.

The monthly sampling from the site was started from 7th January 2004. The nematodes encountered during study were Helicotylenchus vulgaris, H. pseudorobustus, H. digonicus, Tylenchus hematus, Merlinius brevidens, Aphelenchus avenae, Pratylenchus thornei, Tylenchus exigus, Doryliamid and Rhabditis were also present. In year 2004 lowest number of nematodes were recorded in the month of October and highest number of nematodes were recorded in July. In year 2005 lowest number of nematodes were recorded in the month of November and highest in July, in both the years the peak season recorded was the month of July. The results given in the Table (6) indicate that the number of nematodes were lower in cold months and higher in hot months. The mean number of nematodes/month in 2004 was 886.5/ 200 ml of soil and mean of number of nematodes/month in 2005 was 1530.33/ 200 ml of soil. The number of nematodes increased was 72.62% in year 2005.
Table 6. Nematode population build up in saffron crop of site Letapora from January 2004- December 2005

<table>
<thead>
<tr>
<th>Months</th>
<th>Number of Nematodes/200ml of soil in year 2004</th>
<th>Number of Nematodes/200ml of soil in year 2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>242</td>
<td>155</td>
</tr>
<tr>
<td>February</td>
<td>1040</td>
<td>697</td>
</tr>
<tr>
<td>March</td>
<td>1040</td>
<td>144</td>
</tr>
<tr>
<td>April</td>
<td>877</td>
<td>782</td>
</tr>
<tr>
<td>May</td>
<td>1630</td>
<td>2484</td>
</tr>
<tr>
<td>June</td>
<td>866</td>
<td>3792</td>
</tr>
<tr>
<td>July</td>
<td>2317</td>
<td>4544</td>
</tr>
<tr>
<td>August</td>
<td>1384</td>
<td>2986</td>
</tr>
<tr>
<td>September</td>
<td>768</td>
<td>2510</td>
</tr>
<tr>
<td>October</td>
<td>120</td>
<td>85</td>
</tr>
<tr>
<td>November</td>
<td>160</td>
<td>68</td>
</tr>
<tr>
<td>December</td>
<td>144</td>
<td>117</td>
</tr>
<tr>
<td>Mean±SD</td>
<td>886.5±673.53</td>
<td>1530.33±1637.02</td>
</tr>
</tbody>
</table>
4.1.5. Relation between number of nematodes and age of saffron 
(Crocus sativus) crop

The experiment was conducted from January 2004- December 2005 to study relation between age of saffron (Crocus sativus) crop and nematode population. The nematode population recorded was 2720, 2832 and 4556/200 ml of soil respectively. The age of control plot was one year and nematodes recorded were 634. The Pearson correlation of nematode population and age of saffron crop was (+ 0.994)
Table 7. Relation between number of nematodes and age of saffron crop

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Name of sites</th>
<th>No. of nematodes / 200ml soil</th>
<th>Age in years</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Control crop Letapora</td>
<td>634</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Gundbal</td>
<td>2720</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>Ladhoo</td>
<td>2832</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>Chandhara</td>
<td>4547</td>
<td>10</td>
</tr>
</tbody>
</table>

Fig. 5. Relation between number of nematodes and age of saffron crop

The above figure reveals the positive correlation between number of nematodes and age of saffron crop.
4.2. Description of various Nematodes Recovered during the Present Study

4.2.1 Pratylenchus thornei Sher and Allen, 1953

Systematic position

Order ............................................................Tylenchida
Suborder .......................................................Tylenchina
Subfamily .....................................................Tylenchoidea
Family ..........................................................Pratylenchidae
Sub family ....................................................Pratylenchinae
Genus ............................................................Pratylenchus
Species .........................................................thornei

Dimensions: Male not found

Female: L ...................................................620 μm
a..................................................26 μm
b.............................................8 μm
c.............................................21 μm
c............................................1.9 μm
V .............................................78 μm
Spear........................................14 μm

Description: Body slender and large, assuming open C shape when killed by gentle heat. Cuticle with transverse striations, lip region with 3 annules, not set off from the body. Spear (14 μm) long with rounded basal knobs. Ovary not extending up to esophagus. Tail terminus bluntly rounded. (Plate 1, Pmg. 1)
Plate 1: *Pratylenchus thornei* Sher and Allen, 1953

A. Anterior part showing stylet

B. Continuous lip region

C. Middle portion

D. Anal opening and bluntly rounded tail terminus
Pmg. 1. *Pratylenchus thornei* Sher and Allen, 1953

A. Anterior part showing stylet
B. Continuous lip region
C. Middle portion
D. Anal opening and bluntly rounded tail terminus
Habitat: Rhizosphere of saffron.

Locality: Karewa of Letapora Pampore

Remarks: *Pratylenchus thornei* is for the first time reported from saffron in Kashmir. The dimensions closely agree with most of the measurements and morphological characters reported in original description of *Pratylenchus thornei* with variation in spear (14 μm vs 17-19 μm). The variation is due to different geographical location.

4.2.2 *Tylenchus exigus* de man, 1876

Systematic position

Order................................................................Tylenchida
Suborder........................................................Tylenchina
Subfamily.....................................................Tylenchoidea
Family........................................................Tylenchidae
Sub family................................................Tylenchinae
Genus........................................................*Tylenchus*
Species......................................................*exigus*

Dimensions:

Female:  
L ....................................................680 μm  
a....................................................37 μm  
b.....................................................6.8 μm  
c....................................................5.7 μm  
c'....................................................5.9 μm  
V...................................................69μm  
Spear..................................................9μm
Plate 2: *Tylenchus exigus* de man, 1876

A. Anterior part showing stylet

B. Spicule in male

C. Continuous lip region

D. Transverse vulva

E. Filiform tail
Pmg. 2. *Tylenchus exigus* de man, 1876

A, C. Anterior parts
B. Spicule in male
D. Transverse vulva
E. Filiform tail
Results

Description: (Female) Tails of both sexes filiform lip region slightly set off, minutely striated. Spear (9 µm) strongly knobbed, ovary outstretched, posterior uterine branch half as long as body width. Body tapering uniformly from vulva to terminus, the vulva anus distance being about equal to half tail length. Male similar to female with typical Tylenchoid spicule. (Plate 2, Pmg. 2)

Habitat: Rhizosphere of onion

Locality: Ganderbal Kashmir

Remarks: Tylenchus exigus is for the first time reported from onion in Kashmir. The morphological characters and measurements are in agreement with original description of Tylenchus exigus de Man, 1876

4.2.3. Psilenchus hilarulus de man, 1921

Systematic position

Order............................................................Tylenchida
Suborder.........................................................Tylenchina
Subfamily.....................................................Tylenchoidea
Family..........................................................Psilenchidae
Sub family....................................................Psilenchinae
Genus............................................................Psilenchus
Species..........................................................hilarulus

Dimensions:

Female: L ...................................................1200 µm
a ....................................................37.5 µm
b ....................................................8 µm
c ....................................................7.05 µm
c' ....................................................4.85 µm
V ....................................................47.5 µm
Spear ....................................................10 µm
Plate 3: *Psilenchus hilarulus* de man, 1921

A. Anterior part

B. Amphidelphic ovary

C, D. Elongate tail with clavate tail terminus
Pmg. 3. *Psilenchus hilarulus* de man, 1921

A. Anterior part
B. Amphidelphic ovary
C.D. Elongate tail with clavate tail terminus
Description: Male not found

(Female) Cuticle marked with striations about 1μ near head slightly less on body proper and on tail. Spear is small (10μm) and devoid of basal knobs. Vulva transverse slit ovaries paired, outstretched. The tail tapering but the tail terminus is clavate. (Plate 3, Pmg. 3)

Habitat: Rhizosphere of onion

Locality: Chadoora Budgam

Remarks: Psilenchus hilarulus is for the first time reported from onion in Kashmir. Most measurements and morphological characters are in conformity with original descriptions and measurements of Psilenchus hilarulus with little morphometric variation in value of and b (8 vs 6-6.8)

4.2.4. Rotylenchus Filipjev, 1936

Systematic position

Order..............................................................Tylenchida
Suborder........................................................Tylenchina
Subfamily......................................................Tylenchoidea
Family...........................................................Rotylenchidae
Sub family......................................................Rotylenchinae
Genus............................................................Rotylenchus
Plate 4: *Rotylenchus* Filipjev, 1936

A. Anterior part showing stylet

B. Short pointed tail

C. Reniform body
Pmg. 4. *Rotylenchus* Filipjev, 1936

A. Anterior part showing stylet
B. Short pointed tail
C. Reniform body
**Dimensions:** Male not found

Female:  
L .....................................................350 μm  
a .....................................................20 μm  
b .....................................................7 μm  
c .....................................................9 μm  
c' ....................................................2.7 μm  
V ....................................................68 μm  
Spear .............................................18 μm

**Description:** (Female) Body small sized (350 μm). Mature female kidney-shaped after relaxation, Cuticle annulated, Cephalic region high continuous, Spear strong (18 μm). Ovaries paired. Short pointed tail. (Plate 4, Pmg. 4)

**Habitat:** Soil around roots of tomato

**Locality:** Pattan Baramulla

**Remarks:** *Rotylenchus* is for the first time reported from tomato in Kashmir. Most measurements and morphological characters closely agree with original descriptions and measurements of *Rotylenchus* Filipjev, 1936, for the generic identification. However, it could not be assigned to any species due to less number of specimens available.

### 4.2.5. *Helicotylenchus vulgaris* Yuen, 1964

**Systematic position**

Order..............................................................Tylenchida  
Suborder..........................................................Hoplolaimina  
Super family......................................................Hoplolaimidea  
Family............................................................Hoplolaimidae  
Sub family........................................................Hoplolaiminae  
Genus.............................................................*Helicotylenchus*  
Species..........................................................*vulgaris*
**Dimensions:** Male not found

**Female:**
- **L** .............................................870µm
- **a** .............................................34 µm
- **b** .............................................7.8 µm
- **c** .............................................63 µm
- **c’** .............................................0.91 µm
- **V** .............................................59µm
- **Spear** .............................................30µm

**Description:** Body attains loose spiral-shape after fixation. Lip region truncate having 5 annules. Spear strong, spear knobs slightly intended anteriorly. Tail more curved dorsally, terminus irregularly hemispherical, tail having 12 annules, distal annules narrower than other annules. (Plate 5, Pmg. 5)

**Habitat:** Rhizosphere of knob khol

**Locality:** Letapora Pampore

**Remarks:** *Helicotylenchus vulgaris* is for the first time reported from onion in Kashmir. Most measurements and morphological characters are in conformity with original descriptions and measurements of *Helicotylenchus vulgaris* with little morphometric variation in values of a and b. Values of both a and b are greater than original values due to different geographical location.
Plate 5: *Helicotylenchus vulgaris* Yuen, 1964

A. Anterior part with prominent stylet

B. Anterior part showing offset neck region

C.D. Hemispherical tail
Pmg. 5. *Helicotylenchus vulgaris* Yuen, 1964

A. Anterior part with prominent stylet
B. Anterior part showing offset neck region
C.D. Hemispherical tail
4.2.6. *Helicotylenchus digonicus* Darling and Thorne, 1959

**Systematic position**

Order ...............................................................Tylenchida  
Suborder .........................................................Hoplolaimina  
Super family ...................................................Hoplolaimidea  
Family ..............................................................Hoplolaimidae  
Sub family .....................................................Hoplolaiminae  
Genus ...............................................................*Helicotylenchus*  
Species ............................................................*digonicus*

**Dimensions:** Male not found

Female:  
L ....................................................650μm  
a ....................................................26 μm  
b ....................................................5.6 μm  
c ....................................................50 μm  
c' .....................................................0.9 μm  
V ....................................................61μm  
Spear ..................................................29μm

**Description:** Body attains loose spiral- shape after fixation. Lip region offset having 4 annules. Spear strong (29 μm) spear knobs, slightly intended anteriorly. Tail more curved dorsally, with slight ventral projection, tail with 6 annules. (Plate 6, Pmg. 6)

**Habitat:** Rhizosphere of Saffron

**Locality:** Letapora Pampore

**Remarks:** *Helicotylenchus digonicus* is for the first time reported from Saffron in Kashmir. All the measurements and morphological characters are in conformity with original descriptions and measurements of *Helicotylenchus digonicus.*
Plate 6: *Helicotylenchus digonicus* Darling and Thorne, 1959

A.B. Annulated body and prominent stylet

C. Amphidelphic ovary

D. Tail with slight ventral projection
Pmg. 6. *Helicotylenchus digonicus* Darling and Thorne, 1959

A.B. Annulated body and prominent stylet
C. Amphidelphic ovary
D. Tail with slight ventral projection
4.2.7. *Helicotylenchus pseudorobustus* Steiner, 1914

Systematic position

Order.............................................................Tylenchida
Suborder.......................................................Hoplolaimina
Super family................................................Hoplolaimidea
Family...........................................................Hoplolaimidae
Sub family....................................................Hoplolaiminae
Genus............................................................*Helicotylenchus*
Species............................................................*pseudorobustus*

**Dimensions:** Male not found

Female:  
L ..................................................620μm  
a....................................................31 μm  
b....................................................6 μm  
c.....................................................32 μm  
c'...................................................1.4 μm  
V ..................................................71μm  
Spear..................................................30μm

**Description:** Body attains loose spiral- shape after relaxation. Lip region hemispherical having 5 small annules. spear knobs flattened. Tail with pronounced ventral projection. Hemispherical terminally, tail having 8 annules. (Plate 7, Pmg. 7)

**Habitat:** Soil around roots of capsicum

**Locality:** Letapora Pampore

**Remarks:** Capsicum is the new record of *Helicotylenchus pseudorobustus*. Most measurements and morphological characters correspond with data
Plate 7: *Helicotylenchus pseudorobustus* Steiner, 1914

A. Anterior part with prominent stylet
B. Tail with prominent ventral projection
C. Spiral body
Pmg. 7. *Helicotylenchus pseudorobustus* Steiner, 1914

A. Anterior part with prominent stylet.
B. Tail with prominent ventral projection.
C. Spiral body.
given by Steiner 1914. However, the value of V is greater due to different geographical location.


**Systematic position**

Order..............................................................Tylenchida  
Suborder........................................................Hoplolaimina  
Super family.................................................Hoplolaimidea  
Family............................................................Hoplolaimidae  
Sub family.....................................................Hoplolaiminae  
Genus............................................................*Helicotylenchus*  
Species...........................................................*martini*

**Dimensions:** Male not found

Female:  
L ..................................................580μm  
a .................................................256 μm  
b .....................................................5 μm  
c .....................................................21 μm  
c' ...................................................2.5 μm  
V ....................................................65μm  
Spear ...................................................27μm

**Description:** Body attains loose spiral-shape after relaxation. Lip region high, truncate, without annulations. Spear strong, spear knobs rounded, excretory pore just interior to level of esophago-intestinal valve. Tail more curved dorsally terminus hemispherical, tail having 10 annulations. (Plate 8, Pmg. 8)

**Habitat:** Soil around roots of onion
Plate 8: *Helicotylenchus martini* Sher, 1966

A.B. Prominent stylet and spear knobs
C. Posterior part
D. Loose spiral body
Pmg. 8. *Helicotylenchus martini* Sher, 1966

A.B. Prominent stylet and spear knobs  
C. Posterior part  
D. Loose spiral body
Localities: Anantnag Kashmir

Remarks: Helicotylenchus martrini is for the first time reported from onion in Kashmir. Most measurements and morphological characters are in conformity with original descriptions and measurements of Helicotylenchus martrini with little morphometric variation in value of V and spear length. Value of V is greater and spear length larger due to different geographical location and environmental factors.


Systematic position
Order....................................................Tylenchida
Suborder............................................Tylenchina
Super family........................................Tylenchoidea
Family..................................................Dolichodoridae
Sub family............................................Merlininae
Genus.....................................................Merlinius
Species..................................................brevidens

Dimensions: Male not found
Female: L ..............................................570μm
    a..............................................23 μm
    b..............................................6 μm
    c..............................................11 μm
    c'..........................................2.4 μm
    V.............................................65μm
    Spear..............................14μm

Description: Body attains slight ventrally arcuate shape on relaxation, with annules about 1μm wide near middle of body. Lateral fields with 6 small incusers lip region broadly rounded exhibiting 5 annules. Spear moderately

A.B. Rounded and continuous lip region

C.D. Sub cylindrical tail with rounded terminus
Merlinius brevidens (Allen, 1955) Siddiqi, 1970

A.B. Rounded and continuous lip region
C.D. Sub cylindrical tail with rounded terminus
developed, basal knobs rounded, backwardly sloping. Median esophageal bulb well developed, oval with distinctive vulvular apparatus in centre. Vulva transverse slit about one third of body width. Tail sub cylindrical, finely annulated, rounded terminus. (Plate 9, Pmg. 9)

**Habitat:** Soil around roots of Tomato

**Locality:** Chadoora Budgam

**Remarks:** *Merlinius brevidens* is for the first time reported from tomato in Kashmir. Most measurements and morphological characters are in conformity with original descriptions and measurements with little morphometric variation in value of b and V, values of b and v are greater due to different geographical location.

### 4.2.10. *Aphelenchus avenae* Bastian, 1865

**Systematic position**

Order..............................................................Tylenchida
Suborder..........................................................Tylenchina
Super family........................................................Aphelenchoidea
Family............................................................Aphelenchidae
Sub family........................................................Aphlenchinae
Genus.............................................................*Aphelenchus*
Species.............................................................*avenae*
**Results**

**Dimensions:** Male not found

Female:  
L .................................................. 620µm  
a...................................................... 28 µm  
b.................................................... 5 µm  
c.................................................... 28 µm  
c'................................................... 5.5 nm  
V.................................................... 78 µm  
Spear............................................ 11 µm

**Description:** Body cylindrical usually with slight ventral curvature when killed by heat. Body wide at middle and tapering towards head and tail. Head bluntly rounded. Vulva transverse slit like, Stylet shorter and not knobbed. Median bulb well developed widening abruptly from procorpus. Ovary single, anterior, outstretched. Tail bluntly rounded. (Plate 10, Pmg. 10)

**Habitat:** Soil around roots of Saffron

**Locality:** Letapora Pampore

**Remarks:** *Aphelenchus avenae* is for the first time reported from saffron in Kashmir. Most measurements and morphological characters correspond with Bastian 1865 for the generic identification with difference in spear length (11 µm vs 14 µm). The variation in spear length is due to different geographical location and environmental factors. However, it could not be assigned to any species due to less number of specimens available.
Plate 10: *Aphelenchus avenae* Bastian, 1865

A. Prominent median bulb
B. Stylet without knobs
C. Transverse vulva
D. Blunt tail
Pmg. 10. *Aphelenchus avenae* Bastian, 1865

A. Prominent median bulb
B. Stylet with out knobs
C. Transverse vulva
D. Blunt tail
4.2.11. *Aphelenchoides* Fischer 1894

**Systematic position**

Order ................................................................. Tylenchida  
Suborder ........................................................... Tylenchina  
Super family ..................................................... Aphelenchoidea  
Family .............................................................. Aphelenchoidae  
Sub family ....................................................... Aphlenchoinae  
Genus ............................................................... *Aphelenchoides*

**Dimensions:** Male not found

Female:  
L ..................................................... 560 µm  
 a ....................................................... 19 µm  
 b ....................................................... 8 µm  
 c ....................................................... 13 µm  
 c' ...................................................... 3.4 µm  
 V ...................................................... 68 µm  
 Spear ..................................................... 18 µm

**Description:** Body slightly curved ventrally. Cuticle with fine annulations. Head rounded, set off from the body. Stylet with small basal swellings. Median bulb strong. Ovary outstretched. Tail elongate conoid, ventrally arcuate. (Plate 11, Pmg. 11)

**Habitat:** Soil around roots of tomato

**Locality:** Chrar- e- Sharief

**Remarks:** *Aphelenchoides* spp., is for the first time reported from saffron in Kashmir. Most measurements and morphological characters correspond with Fischer, 1894, for the generic identification. However, it could not be assigned to any species due to less number of specimens available.
Plate 11: *Aphelenchoides* Fischer 1894

A. Prominent median bulb
B. Off set lip region
C. Elongate conoid tail
D. Outstretched vagina
Pmg. 11. *Aphelenchoides* Fischer 1894

A. Prominent median bulb  
B. Offset lip region  
C. Elongate conoid tail  
D. Outstretched vagina
4.2.12. *Aporcelaimus* Thorne and Swanger, 1936

**Systematic position**

Order.................................................... Dorylaimida  
Suborder.................................................. Dorylaimina  
Super family............................................. Dorylaimoidea  
Family..................................................... Aporcelaimidae  
Sub family.................................................. Aporcelaiminae  
Genus...................................................... *Aporcelaimus*

**Dimensions:** Male not found  
Female:  
L .................................................. 4080μm (4.08 mm)  
a .................................................. 24 μm  
b .................................................. 765 μm  
c .................................................. 107 μm  
c' .................................................. 0.97 μm  
V .................................................. 54 μm  
Odontostyle .......................... 19 μm  
Odontophore ......................... 20 μm

**Description:** (Female) Large sized body, length 4.08 mm. Lip region offset by deep constriction, odontostyle dorylaimoid with lumen with wide lumen, aperture about one-half of length. Female reproductive system amphidelphic, vulva large transverse slit. Tail short, conoid to bluntly rounded. (Plate 12, Pmg. 12)

**Habitat:** Soil around roots of Saffron  
**Locality:** Gundbal Pampore

**Remarks:** *Aporcelaimus* spp. is for the first time reported from soil around the roots of saffron from Kashmir. The measurements and morphological
Plate 12: *Aporcelaimellus* Thorne and Swanger, 1936

A. Offset lip region and strong odotostyle
B. Prominent anal opening and bluntly rounded tail
C. Transverse vulva
D. Ventrally arcuate body
Pmg. 12. *Aporcelaimellus* Thorne and Swanger, 1936
A. Offset lip region and strong odotostyle
B. Prominent anal opening and bluntly rounded tail
C. Transverse vulva
D. Ventrally arcuate body
characters correspond with data given by Thorne and Swanger, 1936, for the
generic identification. However, it could not be assigned to any species due
to less number of specimens available.

4.2.13. *Mesodorylaimus mesonyctius* Andrassy, 1959

**Systematic position**

- **Order**: Dorylaimida
- **Suborder**: Dorylaimina
- **SuperFamily**: Dorylaimoidea
- **Family**: Dorylaimidae
- **Sub family**: Dorylaiminae
- **Genus**: Mesodorylaimus
- **Species**: mesonyctius

**Dimensions:** Male not found

**Female:**

- **L**: 1200µm (1.2 mm)
- **Body width**: 50 µm
- **Body width at anus**: 65µm
- **Oesophagus**: 275µm
- **B**: 4.36µm
- **Tail**: 120µm
- **Body width at anus**: 30µm
- **C’**: 4µm
- **V**: .65µm
Plate 13: *Mesodorylaimus mesonyctius* Andrassy, 1959

A. Long odontostyle
B. Lip region offset
C. Transverse vulva, uterus containing eggs
D. Filiform tail
Plate 13
Pmg. 13. *Mesodorylaimus mesonyctius* Andrassy, 1959

A. Long odontostyle
B. Lip region offset
C. Transverse vulva, uterus containing eggs
D. Filiform tail
Description: (Female) Body length 1.2mm. Lip region offset by depression. Odontostyle slightly longer than one lip width, its aperture occupying about one-third of its length. Odontophore rod-like. Esophagus muscular. Female reproductive system amphidelphic, vulva transverse slit, vulval lips strongly cuticularised. Tail elongate-conoid. (Plate 13, Pmg. 13)

Habitat: Soil around roots of Saffron

Locality: Gundbal Pampore

Remarks: *Mesodorylaimus mesonyctius* is for the first time reported from soil around the roots of saffron from Kashmir. The measurements and morphological characters correspond with data given by Andrassy, 1959.


Systematic position

Order.......................................................... Dorylaimida.

Suborder....................................................Dorylaimina.

SuperFamily................................................Dorylaimoidea.

Family.......................................................Qudsianematidae.

Sub family...............................................Qudsianematinae.

Genus........................................................*Ecuminicus*
**Dimensions:** Male not found

Female:  
- **L** .................................................. 1540μm (1.54 mm)
- **Body width** .................................... 35 μm
- **a** .................................................. 44μm
- **Esophagus** ..................................... 300μm
- **b** ................................................. 5.13μm
- **Tail** ............................................. 48μm
- **c** .................................................. 32μm
- **Body width at anus** ....................... 30μm
- **Odontostyle** ................................. 8 μm
- **Odontophore** ................................. 13 μm
- **c'** ............................................... 1.92μm
- **V** .............................................. 55.19μm

**Description (Female):** Body length 1.54 mm, narrowing gradually above the base of esophagus, cuticle finely striated. Lip region offset by depression, lips distinct. Odontostyle dorylaimoid, aperture about one third of its length. Vulva transverse slit. Tail conoid, digitate. (Plate 14, Pmg. 14)

**Habitat:** Soil around roots of onion

**Locality:** Chadoora Budgam

**Remarks:** *Ecuminicu*s is for the first time reported from soil around the roots of onion from Kashmir. The measurements and morphological characters correspond with data given by Thorne1974, for the generic identification with variation in length (1.54 vs 1.40) due to different geographical variation. However, it could not be assigned to any species due to less number of specimens available.
Plate 14: *Ecuminicus* Thorne, 1974

A. Lip region offset by depression

B. Prominent odotostyle

C. Slightly ventrally arcuate body

D. Conoid tail with sub-digitate tip

E. Transverse vulva

A. Lip region offset by depression
B. Prominent odotostyle
C. Slightly ventrally arcuate body
D. Conoid tail with sub-digitate tip
E. Transverse vulva
4.2.15. Pelodera Schneider, 1860

**Dimensions:** Male not found

Female: 
- $L$ ..................................................... $1820\mu m$ (1.82 mm)
- Body width .......................... $21\mu m$
  a......................................................$6\mu m$
- Esophagus ............................. $153\mu m$
  b.......................................................... $4.62\mu m$
- Tail ............................................. $10.5\mu m$
  c....................................................... $67.42\mu m$
- Body width at anus ............... $7\mu m$
  c'..................................................... $1.5\mu m$
- V ................................. $52.17\mu m$

**Description (Female):** The body is longer in relation to width, annulated body, lips distinct, precarpsus elongate, isthmus medium sized, median bulb strongly developed. Vulva slit like and median, Ovary paired and reflexed. Tail conical. (Plate 15, Pmg. 15)

**Habitat:** Soil around roots of Saffron

**Locality:** Chandhara Pampore

**Remarks:** Pelodera spp., is for the first time reported from soil around the roots of saffron from Kashmir. The measurements and morphological characters agree with data given by Schneider 1866, for the generic identification. However, it could not be assigned to any species due to less number of specimens available.
Plate 15: *Pelodera* Schneider, 1860

A. Elongate precarpus

B. Amphidelphic reflexed ovaries

C. Conoid tail

D. Slightly ventrally arcuate body
Pmg. 15. Pelodera Schneider, 1860

A. Elongate precarpus
B. Amphidelphic reflexed ovaries
C. Conoid tail
D. Slightly ventrally arcuate body
4.2.16. *Penagrolaimus* Fuchs, 1930

**Dimensions:** Male not found

Female:  
- L .................................................. 620μm  
- Body width ............................. 27μm  
- a ..................................................... 22.96μm  
- Esophagus ......................... 100μm  
- b ..................................................... 6.2μm  
- Tail .............................................. 32μm  
- c ..................................................... 19.37μm  
- Body width at anus .............. 14μm  
- c' ..................................................... 2.28μm  
- V ..................................................... 63μm

**Description:** Male not found

Female: Body medium sized and annulated, head with three lips, stoma short and wide, denticles present. Esophagus penagrolaimoid, anterior part cylindrical, isthumus shorter than anterior part. Gonad prodelphic. (Plate 16, Pmg. 16)

**Habitat:** Soil around roots of knol khol

**Locality:** Letapora Pampore

**Remarks:** The *Penagrolaimus* is for the first time reported from soil around the roots of knol khol. The measurements and descriptions correspond with original description of *Penagrolaimus* Fuchs, 1930, for the generic identification. However, it could not be assigned to any species due to less number of specimens available.
Plate 16: *Penagrolaimus* Fuchs, 1930

A. Continuous lip region

B. Anterior part of body with Median bulb

C,D. Pen shaped tail
Pmg. 16. *Penagrolaimus* Fuchs, 1930

A. Continuous lip region  
B. Anterior part of body with Median bulb  
C.D. Pen shaped tail
4.2.17. \textit{Acrobloides} (Cobb, 1924) Thorne, 1937

\textbf{Dimensions}: Male not found

\textbf{Female}:  
L ............................................583\textmu m  
Body width............................25 \textmu m  
a..........................................23.32,\textmu m  
esophagus...............................160\textmu m  
b..........................................3.64\textmu m  
Tail.......................................37.60\textmu m  
c..........................................15.50\textmu m  
Body width at anus...............16\textmu m  
c'.........................................2.35\textmu m  
V...........................................62.5\textmu m

\textbf{Description}

\textbf{Female}: Labial probolae low conical, not furcated, corpus of esophagus with elongate spindle like swelling, medium bulb well developed. Tail convex conoid. (Plate 17, Pmg. 17)

\textbf{Habitat}: Soil around roots of knol khol

\textbf{Locality}: Letapora Pampore

\textbf{Remarks}: \textit{Acrobloides} is for the first time reported from the soil around the roots of knol khol. The measurements and descriptions agree with original descriptions by Thorne, 1937, for the generic identification. However, it could not be assigned to any species due to less number of specimens available.
Plate 17: *Acrobloides* (Cobb, 1924) Thorne, 1937

A. Prominent median bulb
B. Labial probolae pointed
C. Outstretched vulva
D. Bluntly rounded tail
Pmg. 17. *Acrobloides* (Cobb, 1924) Thorne, 1937

A. Prominent median bulb
B. Labial probolae pointed
C. Outstretched vulva
D. Bluntly rounded tail
4.2.18. *Chiloplacus* Thorne, 1937

**Dimensions:** Male not found

Female: L .......................................... 499\(\mu\)m

Body width........................................... 23 \(\mu\)m

a.................................................. 21.69\(\mu\)m

oesophagus........................................ 110\(\mu\)m

b.................................................... 4.53\(\mu\)m

Tail.................................................. 32\(\mu\)m

c................................................... 15.59\(\mu\)m

Body width at anus......................... 28\(\mu\)m

c'.................................................. 1.14\(\mu\)m

V..................................................... 61.20\(\mu\)m

**Description**

Female: Lip region tapers less than half mid-body with labial probolae plate-like, cephalic probolae furcate forwardly pointed processes. Cephalic axils edentate. Anterior part of oesophagus slender, almost cylindrical except in its tapering posterior end, set off from isthmus only by a break in the musculature. Tail cylindrical, terminus bluntly rounded with 17 annules. (Plate 18, Phg. 18)

**Habitat:** Soil around roots of saffron

**Locality:** Letapora pampore

**Remarks:** *Chiloplacus* is first time reported from the soil around the roots of saffron. The measurements descriptions and morphological characters correspond with original descriptions by Thorne, 1937, for the generic identification. However, it could not be assigned to any species due to less number of specimens available.
Plate 18: *Chiloplacus* Thorne, 1937

A. Annulated cuticle  
B. Anterior end with furcate lips  
C. Posterior part showing anal opening  
D. Blunt tail
Pmg. 18. *Chiloplacus* Thorne, 1937

A. Annulated cuticle
B. Anterior end with furcate lips
C. Posterior part showing anal opening
D. Blunt tail
4.3. Management of Plant Parasitic Nematodes

4.3.1. Effect of Mustard Oil Cakes on Plant Parasitic Nematodes Infesting Capsicum

The data presented in Table 8 depicts the total number of nematodes in control and treated plots. The nematodes encountered were *Tylenchus exigus*, *Pratylenchus thornei*, *Helicotylenchus vulgaris*, *Helicotylenchus pseudorobustus*, *Aphelenchus avenae*, *Merlinius brevidens* small number of *Rhabidita* spp., and some *Dorylaimid* spp. were also present.

The average number of nematodes in control plots was 1334.5 ± 376.978 and average number of nematodes in treated plot was 704.66 ± 140.736 nematodes. The number of nematodes in control plots was 26.41% higher than treated plots. The average yield was 2.25 ± 0.37 kg. in control plots and average yield was 3.55 ± 0.53 kg. in treated plots, the yield of chilies was 57.77 % higher in treated plots.

Statistical analysis of data depicted that the number of nematodes was significantly lower in oil cake treated plots (P < 0.00064) than the control. Capsicum yield was also significantly higher in oil cake treated plots, (P < 0.0005)
Table 8. Effect of mustard oil cakes on nematode infesting capsicum yield.

<table>
<thead>
<tr>
<th>Replications</th>
<th>No. of Nematodes/200ml soil</th>
<th>Yield in Kgs/plot(1x2)mts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
<td>Treated</td>
</tr>
<tr>
<td>R1</td>
<td>1213</td>
<td>719</td>
</tr>
<tr>
<td>R2</td>
<td>1761</td>
<td>813</td>
</tr>
<tr>
<td>R3</td>
<td>706</td>
<td>556</td>
</tr>
<tr>
<td>R4</td>
<td>1227</td>
<td>545</td>
</tr>
<tr>
<td>R5</td>
<td>1465</td>
<td>692</td>
</tr>
<tr>
<td>R6</td>
<td>1635</td>
<td>903</td>
</tr>
<tr>
<td>Mean±SD</td>
<td>1334.5±376.97</td>
<td>704.66±140.73</td>
</tr>
</tbody>
</table>

R1-R6* are replications
Fig. 6. Effect of mustard oil cakes on plant parasitic nematodes infesting capsicum

Fig. 7. Effect of mustard oil cakes on yield of capsicum infested by plant parasitic nematodes.

R1-R6* are replications
4.3.2. Effect of Walnut (*Juglans regia*) Leaf Soil Amendment on Plant Parasitic Nematode Infesting Chillies (*Capsicum annum*)

The data presented in Table 9 and Fig. 8 depicts the total number of nematodes in control and treated plots. The nematodes encountered were *Helicotylenchus vulgaris*, *Helicotylenchus pseudorobustus*, *Merlinius brevidens* *Tylenchus exigus*, *Pratylenchus thornei*, *Aphelenchus avenae* and small number of *Dorylaimid* spp., and *Chiloplacus* spp., were also present.

The mean number of nematodes in control plots was 2347.33±378.34 and that in treated plot was 1525.16±166.08. The number of nematodes in control plots was 35.02% higher than treated plots.

The mean yield was 3.03±0.37 kg., in control plots and that in treated plots was 4.33±0.51 kg / plot, the yield of chillies was 42.90% higher in treated plots, (Fig. 8)

Hence the number of nematodes was significantly controlled by walnut leaves which was checked statistically P<0.0006, the yield of chillies was also significantly increased in treated plots P< 0.0005, implying that plant parasitic nematodes damage the chilly plants and decline the yield, organic amendment with walnut leaves was found useful in reducing nematodes and increasing yield.
Table 9. Effect of walnut (*Juglans regia*) leaves on plant nematode infesting chillies (*Capsicum annum*)

<table>
<thead>
<tr>
<th>Replications</th>
<th>No. of Nematodes/200ml soil</th>
<th>Yield of chillies / Kg/plot(2x2) mt</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
<td>Treated</td>
</tr>
<tr>
<td>R1</td>
<td>2767</td>
<td>1816</td>
</tr>
<tr>
<td>R2</td>
<td>2105</td>
<td>1491</td>
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<tr>
<td>R3</td>
<td>1981</td>
<td>1561</td>
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<tr>
<td>R4</td>
<td>2015</td>
<td>1309</td>
</tr>
<tr>
<td>R5</td>
<td>2384</td>
<td>1462</td>
</tr>
<tr>
<td>R6</td>
<td>2832</td>
<td>1512</td>
</tr>
<tr>
<td>Mean±SD</td>
<td>2347.33±378.34</td>
<td>1525.16±166.08</td>
</tr>
</tbody>
</table>
Fig. 8. Effect of walnut (*Juglans regia*) leaves on number of plant nematodes infesting chillies (*Capsicum annum*)

Fig. 9. Effect of walnut (*Juglans regia*) leaves on yield of chillies infested by plant parasitic nematodes
4.3.3. Effect of Walnut (*Juglans regia*) Leaf Soil Amendment on Nematodes Infesting Knol Khol Seed Crop and its Yield

The nematodes encountered in soil samples from knol khol crop were *Aphelenchus avenae, Tylenchus exigus, Merlinius brevidens, Psilenchus hilarulus, Helicotylenchus vulgaris, Helicotylenchus pseudorobustus*, small number of *Rhabdita* spp., and *Dorylaimid* spp., were also present, Table 10 and Fig.10 exhibits the total number of nematodes/200 ml of soil. The mean number of nematodes calculated from control plots was 1303.57 ± 238.44 and mean calculated from treated plots was 630.57 ± 115.10 nematodes. 51.62% of nematodes were controlled in treated plots.

**Table 10. Effect of walnut leaf soil amendment on plant parasitic nematodes infesting knol khol seed crop**

<table>
<thead>
<tr>
<th>Replications</th>
<th>Number of nematodes/200 ml soil.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control plot (2x2 mt.)</td>
</tr>
<tr>
<td>R1</td>
<td>1175</td>
</tr>
<tr>
<td>R2</td>
<td>1165</td>
</tr>
<tr>
<td>R3</td>
<td>1587</td>
</tr>
<tr>
<td>R4</td>
<td>1320</td>
</tr>
<tr>
<td>R5</td>
<td>957</td>
</tr>
<tr>
<td>R6</td>
<td>1627</td>
</tr>
<tr>
<td>R7</td>
<td>1294</td>
</tr>
<tr>
<td>Mean±SD</td>
<td>1303.57±238.44</td>
</tr>
</tbody>
</table>
Fig. 10. Effect of walnut leaf soil amendment on plant parasitic nematodes infesting knol khol

The mean yield of knol khol seed crop in control plots was 345.7 ± 60.23 g. and that in treated plot was 614.28 ± 123.40 gm. The yield of seeds was 77.97% higher in treated plots. Statistical analysis of data depicted that the yield of seed crop was significantly higher in walnut treated plots.
Table 11. Effect of walnut leaf soil amendment, on the seed crop of knol khol infested with nematodes

<table>
<thead>
<tr>
<th>Replications</th>
<th>Weight of seeds in grams/plot (2x2)mts.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
</tr>
<tr>
<td>R1</td>
<td>350</td>
</tr>
<tr>
<td>R2</td>
<td>380</td>
</tr>
<tr>
<td>R3</td>
<td>290</td>
</tr>
<tr>
<td>R4</td>
<td>410</td>
</tr>
<tr>
<td>R5</td>
<td>390</td>
</tr>
<tr>
<td>R6</td>
<td>240</td>
</tr>
<tr>
<td>R7</td>
<td>360</td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>345.7±60.23</td>
</tr>
</tbody>
</table>

*Fig. 11. Effect of walnut leaf soil amendment, on the seed crop of knol khol infested with nematodes*
4.3.4. Effect of *Allium sativum* on Nematodes Infesting Knol Khol Crop

The data presented in Table 12 depicts the total number of nematodes/200 ml of soil in control and treated plots. The nematodes encountered were *Tylenchus exigus*, *Tylenchorhynchus clarus*, *Merlinius brevidens*, *Aphelenchus avenae* small number of *Rhabdita* spp. and *Dorylaimida* spp. were also present.

The average number of nematodes in control plots was 3057.85 ± 483.05 and average number of nematodes in treated plot was 980.14 ± 220.43 nematodes. The number of nematodes in control plots 67.94 % higher than treated plots. The average yield was 2.60± 0.50 kg in control plot and was 4.75 ± 0.709kg in treated plots, the yield of knol khol was 82.69% higher in treated plots.

**Table 12. Effect of *Allium sativum* on plant parasitic nematodes infesting knol khol crop and its yield**

<table>
<thead>
<tr>
<th>Replications</th>
<th>No. of Nematodes/200ml soil</th>
<th>Yield of knol khol (Kgs/plot1x2mt.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
<td>Treated</td>
</tr>
<tr>
<td>R1</td>
<td>3210</td>
<td>994</td>
</tr>
<tr>
<td>R2</td>
<td>2596</td>
<td>971</td>
</tr>
<tr>
<td>R3</td>
<td>3002</td>
<td>1005</td>
</tr>
<tr>
<td>R4</td>
<td>2567</td>
<td>615</td>
</tr>
<tr>
<td>R5</td>
<td>3405</td>
<td>1203</td>
</tr>
<tr>
<td>R6</td>
<td>2734</td>
<td>812</td>
</tr>
<tr>
<td>R7</td>
<td>3891</td>
<td>1261</td>
</tr>
<tr>
<td>Mean±SD</td>
<td>3057.85±483.05</td>
<td>980.14±220.24</td>
</tr>
</tbody>
</table>
Fig. 12. Effect of *Allium sativum* on plant parasitic nematodes infesting knol khol crop

Fig. 13. Effect of *Allium sativum* on yield of knol khol crop infesting by plant parasitic nematodes
4.3.5. Cultural Control of Plant Parasitic Nematodes Infesting Saffron (Crocus sativus) and its Floral Yield

The nematodes encountered in soil samples from saffron crop were Pratylenchus thornei, Helicotylenchus digonicus, Aphelenchus avenae, Tylenchus exigus, Merlinius brevidens, Psilenchus hilarulus, Helicotylenchus vulgaris, Helicotylenchus pseudorobustus, small number of Rhabdita spp., and Dorylaimid spp., were also present. The Table 13 exhibits the total number of nematodes/200 ml of soil. The mean number of nematodes calculated from control plots was 2012.28 ± 570.71 and mean number of nematodes calculated from treated plots was 1192.57 ± 175.18 nematodes. 40.73% of nematodes were controlled in treated plots. The nematodes were significantly controlled by hoeing (P<0.0034)

The mean floral yield of saffron crop in control plots was 2.05±0.252 kg and that in treated plot was 2.98 ±0.40 kg/plot. The floral yield of saffron was 45.36% higher in treated plots. The floral yield of Saffron was significantly increased by hoeing at (P<0.0002)
Table 13. Effect of hoeing on number of plant parasitic nematodes and floral yield of saffron

<table>
<thead>
<tr>
<th>Replications</th>
<th>No. of Nematodes/200ml soil</th>
<th>Floral yield of saffron in kgs/plot (1 kanal)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
<td>Treated</td>
</tr>
<tr>
<td>R1</td>
<td>2938</td>
<td>1392</td>
</tr>
<tr>
<td>R2</td>
<td>2661</td>
<td>1361</td>
</tr>
<tr>
<td>R3</td>
<td>1920</td>
<td>1350</td>
</tr>
<tr>
<td>R4</td>
<td>1449</td>
<td>989</td>
</tr>
<tr>
<td>R5</td>
<td>1874</td>
<td>1041</td>
</tr>
<tr>
<td>R6</td>
<td>1738</td>
<td>1186</td>
</tr>
<tr>
<td>R7</td>
<td>1506</td>
<td>1029</td>
</tr>
<tr>
<td>Mean±SD</td>
<td>2012.28±570.71</td>
<td>1192.57±175.18</td>
</tr>
</tbody>
</table>

Fig. 14. Effect of hoeing on number of plant parasitic nematodes and floral yield of saffron
4.3.6. Effect of Hoeing and 5% Garlic (*Allium sativum*) Water on Nematodes Infesting *Brassica oleracea* Crop

The data presented in Table 14 depicts the total number of nematodes in control plots, hoed plots and treated plots. The nematodes encountered were *Helicotylenchus vulgaris*, *Helicotylenchus pseudorobustus*, *Psilenchus hilarulus*, *Tylenchus exigus*, *Aphelenchus avenae* small number of *Rhabditis* spp. and *Dorylaimid* spp., were also present. The mean number of nematodes calculated from control plots was 872.16 ±192.87, and that from hoed plots was 567 ±150.78 nematodes and mean calculated from treated plots was 249 ± 46.74. 34.99% of nematodes were controlled in pulverized plots (*P*<0.0121) and 71.45% of nematodes were controlled in treated plots (*P*<1.6592).
Table 14. Effect of hoeing and 5% garlic water on nematodes infesting *Brassica oleracea*

<table>
<thead>
<tr>
<th>Replications</th>
<th>No. of nematodes/200ml of soil.</th>
<th>Control</th>
<th>Pulverized</th>
<th>Treated with 5% garlic water</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>866</td>
<td>382</td>
<td>174</td>
<td></td>
</tr>
<tr>
<td>R2</td>
<td>630</td>
<td>457</td>
<td>282</td>
<td></td>
</tr>
<tr>
<td>R3</td>
<td>1214</td>
<td>755</td>
<td>233</td>
<td></td>
</tr>
<tr>
<td>R4</td>
<td>903</td>
<td>730</td>
<td>229</td>
<td></td>
</tr>
<tr>
<td>R5</td>
<td>840</td>
<td>583</td>
<td>272</td>
<td></td>
</tr>
<tr>
<td>R6</td>
<td>780</td>
<td>495</td>
<td>304</td>
<td></td>
</tr>
<tr>
<td>Mean±SD</td>
<td>872.16±192.87</td>
<td>567±150.78</td>
<td>249±46.74</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 16. Effect of hoeing and 5% garlic water on number of plant parasitic nematodes infesting *Brassica*
4.3.7. Field Evaluation of Orange (*Citrus reticulata*) Peeling against Plant Parasitic Nematodes Infesting Tomato Crop and its Yield

The data presented in Table 15 depicts the total number of nematodes/200 ml of soil in control and treated plots. The nematodes found were *Tylenchorynchus clarus, Merlinius brevidens, Aphelenchus avenae, Basiria* spp. *Helicotylenchus vulgaris, Helicotylenchus pseudorobustus* a small number of *Rhabdita* spp. and *Dorylaimid* spp. were also present.

The pooled mean of nematodes in control plots was $1565.78 \pm 249.07$ and pooled mean of nematodes in treated plots was $406.7 \pm 118.66$, in treated plots 74.07% of nematodes were controlled ($P<1.1224$)

Table 15. Field evaluation of orange peeling against nematodes infesting tomato crop

<table>
<thead>
<tr>
<th>Replications</th>
<th>No. of Nematodes/200ml soil</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Control</strong></td>
<td><strong>Mean</strong></td>
<td><strong>Treated</strong></td>
<td><strong>Mean</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>2005</strong></td>
<td><strong>2006</strong></td>
<td><strong>2005</strong></td>
<td><strong>2006</strong></td>
<td></td>
</tr>
<tr>
<td>R1</td>
<td>1957</td>
<td>1796</td>
<td>1876.5</td>
<td>382</td>
<td>537</td>
</tr>
<tr>
<td>R2</td>
<td>1269</td>
<td>1471</td>
<td>1370</td>
<td>323</td>
<td>321</td>
</tr>
<tr>
<td>R3</td>
<td>1837</td>
<td>1041</td>
<td>1439</td>
<td>204</td>
<td>282</td>
</tr>
<tr>
<td>R4</td>
<td>1192</td>
<td>1230</td>
<td>1211</td>
<td>287</td>
<td>312</td>
</tr>
<tr>
<td>R5</td>
<td>1674</td>
<td>1462</td>
<td>1568</td>
<td>492</td>
<td>636</td>
</tr>
<tr>
<td>R6</td>
<td>1829</td>
<td>1907</td>
<td>1868</td>
<td>316</td>
<td>583</td>
</tr>
<tr>
<td>R7</td>
<td>1684</td>
<td>1572</td>
<td>1628</td>
<td>532</td>
<td>478</td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>1634.57</td>
<td>1497</td>
<td>1565.78</td>
<td>362.28</td>
<td>449.85</td>
</tr>
<tr>
<td></td>
<td>±293.32</td>
<td>±301.17</td>
<td>±249.07</td>
<td>±115.77</td>
<td>±144.07</td>
</tr>
</tbody>
</table>
Fig. 17. Effect of orange peeling against nematodes infesting tomato crop

The mean yield of tomatoes in control plot was 4.62±0.336 kg. and that in treated plots was 7.94 ± 1.154 kgs, the yield of tomatoes was 71.86% higher in treated plots (P<9.3828)
Table 16. Effect of orange peeling on yield of tomato crop infested by plant parasitic nematodes

<table>
<thead>
<tr>
<th>Replications</th>
<th>2005</th>
<th>2006</th>
<th>Mean</th>
<th>2005</th>
<th>2006</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>5.25</td>
<td>4.85</td>
<td>5.05</td>
<td>8.70</td>
<td>9.30</td>
<td>9.00</td>
</tr>
<tr>
<td>R2</td>
<td>4.50</td>
<td>3.90</td>
<td>4.20</td>
<td>6.85</td>
<td>7.60</td>
<td>7.22</td>
</tr>
<tr>
<td>R3</td>
<td>3.90</td>
<td>4.50</td>
<td>4.20</td>
<td>5.90</td>
<td>5.50</td>
<td>5.70</td>
</tr>
<tr>
<td>R4</td>
<td>5.10</td>
<td>4.85</td>
<td>4.97</td>
<td>9.50</td>
<td>7.00</td>
<td>8.25</td>
</tr>
<tr>
<td>R5</td>
<td>4.10</td>
<td>5.10</td>
<td>4.60</td>
<td>8.60</td>
<td>8.40</td>
<td>8.50</td>
</tr>
<tr>
<td>R6</td>
<td>4.65</td>
<td>4.50</td>
<td>4.57</td>
<td>7.85</td>
<td>8.20</td>
<td>8.02</td>
</tr>
<tr>
<td>R7</td>
<td>4.30</td>
<td>5.20</td>
<td>4.75</td>
<td>9.10</td>
<td>8.70</td>
<td>8.90</td>
</tr>
</tbody>
</table>

Mean±SD 4.54±0.49 4.7±0.44 4.62±0.33 8.07±1.29 7.81±1.261 7.94±1.15

Fig. 18. Effect of orange peeling on yield of tomato crop infested by plant parasitic nematodes
4.3.8. Loss Assessment due to Plant Parasitic Nematodes Infesting Saffron (Crocus sativus) Floral Yield

The table (17) depicts the number of flowers in control and (folidol) treated plots during year 2005 and 2006. The pooled mean of number of flowers in control plots was 93.8±22.69 and number of flowers in treated plots was 122.85±40.27.

Though the difference in floral yield was not statistically significant (P<0.0623) still the floral yield of saffron was 30.97% higher in treated plots.

Table 17. Loss assessment due to plant parasitic nematodes infesting saffron-floral yield

<table>
<thead>
<tr>
<th>Replications</th>
<th>Total No. of Flowers/plot (1.5x3mts.)</th>
<th>Mean</th>
<th>Total No. of Flowers/plot (1.5x3mts.)</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
<td></td>
<td>Treated</td>
<td></td>
</tr>
<tr>
<td>R1</td>
<td>59</td>
<td>92</td>
<td>75.5</td>
<td>86</td>
</tr>
<tr>
<td>R2</td>
<td>76</td>
<td>125</td>
<td>100.5</td>
<td>98</td>
</tr>
<tr>
<td>R3</td>
<td>47</td>
<td>99</td>
<td>73</td>
<td>108</td>
</tr>
<tr>
<td>R4</td>
<td>83</td>
<td>120</td>
<td>101.5</td>
<td>116</td>
</tr>
<tr>
<td>R5</td>
<td>93</td>
<td>145</td>
<td>119</td>
<td>78</td>
</tr>
<tr>
<td>R6</td>
<td>51</td>
<td>185</td>
<td>68</td>
<td>108</td>
</tr>
<tr>
<td>R7</td>
<td>61</td>
<td>99</td>
<td>80</td>
<td>47</td>
</tr>
<tr>
<td>R8</td>
<td>98</td>
<td>159</td>
<td>128.5</td>
<td>86</td>
</tr>
<tr>
<td>R9</td>
<td>56</td>
<td>182</td>
<td>119</td>
<td>97</td>
</tr>
<tr>
<td>R10</td>
<td>55</td>
<td>91</td>
<td>73</td>
<td>200</td>
</tr>
<tr>
<td>Mean±SD</td>
<td>67.9±18.21</td>
<td>119.7±36.21</td>
<td>93.8±22.69</td>
<td>102.4±39.47</td>
</tr>
</tbody>
</table>
Fig. 19. Loss assessment due to plant parasitic nematodes infesting saffron-floral yield