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# Incidence and Population Density of Plant Parasitic Nematodes Infecting Vegetable Crops and Associated Yield Losses in Eastern Uttar Pradesh

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**ABSTRACT: Plant parasitic nematodes population densities were determined in 196 root and soil samples collected from vegetables growing areas in Varanasi, Mirzapur, Kushinagar and Deoria districts of eastern U.P. Yield losses linked with nematode incidence were calculated in 19 vegetable crops including two pulse vegetable. The most abundant plant parasitic nematodes detected, in order of decreasing frequency of infestation, were *Meloidogyne incognita, Rotylenchulus reniformis, Hoplolaimus indicus, Tylenchorynchus indicus, T. brassicae, Pratylrnchus spp., Helicotylenchus spp., Xiphenema spp*. and *Longidorous* spp. Kushinagar and Deoria districts were explored first time to determine distribution of nematodes and yield losses caused by them. It is observed that yield losses ranged from 4% to 30.2% depending upon the host and nematode. The main reasons responsible for these losses were unawareness among growers/ farmers about these tiny hidden enemies of crops, lack of resistant varieties, non-availability of effective management tactics including nematicides, farm practices and monoculture crop farming on the same field. This study suggests the need for development of nematode management modules to avoid losses due to nematodes.**

**Key words:** Plant parasitic Nematode, population density, vegetable crops, yield Loss.

Plant parasitic nematodes cause estimated annual crop losses of $ 78 billion worldwide (Barker *et al*., 1998). The estimated overall annual yield loss of world's major crops due to damage by phyto-parasitic nematodes has been reported to the extent of 12.3% (Sasser & Freckman, 1987). In USA, damage caused by these tiny organisms on 24 crops was estimated to be 11 % (Feldmesser *et al*., 1971). Specific estimates of vegetable crop yield losses caused by two important *Meloidogyne* spp. (*M. incognita* and *M. javanica*) ranged from 17 to 20% for eggplant, 18-33% for melon, 24 -38% for tomato and 25% for potato (Kathy, 2000. Jain *et al*., (2007) reported the damage to different crops due to plant parasitic nematodes in term of monetary loss is approximately 21068.73 million rupees. The presence of root-knot nematode, *Meloidogyne* spp. and other ecto-parasitic nematodes together not only increase the damage caused but also predisposes the host plants to attack by fungal and bacterial diseases. Sharma *et al*., (2002) reported that *M. incognita* is most studied nematode species in India and they ranked it first among plant parasitic nematodes recorded from India in terms of damaging economically important agricultural crops. An interaction between *M. incognita* and *Rotylenchulus reniformis* was studied by Singh *et al*., (2007). They reported that the population density of both the nematodes was mostly competitive in nature, one establishes at the cost of other on tomato. Singh *et al*. 2011 also concluded that *M incognita* is the predominant species of nematode, infesting all vegetable crops grown at Varanasi region.

The area of study was unexplored as per plant parasitic nematodes and losses caused by them is concerned. Nevertheless, the information on the losses caused by the nematodes on vegetable crops in eastern UP is not available in the literature. The objective of this study was to to determine the identity, frequency, prominence value and population density of nematodes associated with vegetable crops and to assess the losses in yield caused by them in eastern part of UP.

## MATERIALS AND METHODS

Random soil samples were drawn from root-zones of plants with the help of a shovel at the depth range of 20-25 cm. each sample was mixed thoroughly to make soil uniform in all aspects and placed in an individual plastic bag. A sub sample of 200 cc soil was processed using Cobb's sieving and decanting method followed by Baerman's funnel technique (Southey, 1986) for the extraction of soil nematodes. Aliquot of each processed sample was collected after 48 hrs and nematode were counted by taking 1 ml of this nematode suspension with the help of counting dish under binocular microscope. An average of three counting was considered and multiplied with total volume of the nematode suspension. A total of 196 samples were collected and processed for extraction of plan parasitic nematodes and expressed as the number of individuals per 200 cc of soil. The nematodes were identified on the basis of morphological characteristics of juveniles and adult male and female. *M. incognita* was identified by the perineal pattern of the mature female (Eisenback 1985).

Presence of nematodes in soil was determined at the time of sowing and / or transplanting (initial population). For final population presence of nematodes in vegetable roots and soil was determined at the time of harvest. Root were separated from soil carefully, washed and dried with help of face tissue. Nematodes were extracted from a fresh root composite sub sample of 25 g (McKenry & Roberts, 1985).

The criteria used to assess yield included: Growers interview, visual assessment based on foliage growth (necrotic, chlorotic, stunted and wilted plant); Root symptoms and educated guess to expert opinion; plant mortality, condition of the plant and duration of the crop and most importantly quality and quantity loss in yield based on local market considerations (obtained from nematode affected plants). The yield loss percentage was determined from the relationship between the average highest yield of 10 plant (T) with nil or less nematode infestation (below economic injury level) and the average lowest yield of 10 plants having maximum nematode infestation (t) with above economic injury level. To calculate percent loss, (t) is divided by (T), multiplied by 100. [Yield loss (%) = t/T*100]

The frequency (F) of the nematode genus was determined from the relationship between the numbers of samples in which the nematode was observed (A) divided by the total number of samples (B) taken from that area or crop, multiplied by 100 to express as a percentage (Sawadogo *et al.*, 2009). (F=A/B*100). Relative density of the nematode was determined by the total number of nematode from particular area/crop divided by the total number of plant parasitic nematodes, multiplied by 100 to express as percentage.

## RESULTS AND DISCUSSION

The present investigation was carried out in four districts (Varanasi, Mirzapur, Kushinagar and Deoria) of eastern UP. Ten plant parasitic nematodes were isolated and identified from the rhizosphere soil and root samples. Among them, the endoparasite/migratory endoparasite *M. incognita* and *R. reniformis* were most abundant frequently encountered nematode species. The frequency of plant parasitic nematodes was recorded in the range of 12.8 to 91.2. The maximum frequency (91.2) was recorded with root-knot nematode, *M. incognita* followed by 81.3 with reniform nematode, *R. reniformis* as evidenced by Table 1. Data showed that root-knot nematode, *M. incognita*, reniform nematode, *R. reniformis* and lesion nematode, *Pratylenchus* sp. were recorded to be infested almost all crops (Table 2). Maximum frequency (91.2%), prominence value (1676.4) and disease incidence was recorded with root-knot nematode, *M. incognita*. This study is in conformity with the previous studies related to vegetable crops in Varanasi region (Singh *et al*., 2011).

The results of the present investigation provide not only the information of major destructive nematode i.e. root–knot nematode, *M. incognita*, which was ranked first in causing disease and yield losses (Sharma *et al*., 2002) associated with vegetable crops grown in eastern UP but also indication of their occurrence, geographical distribution, and possible potential for yield and monetary losses. The yield losses caused by nematodes concomitantly with *M. incognita* is presented in Table-2. Nearly nineteen vegetable crop including pulse vegetables (cowpea and pea) of economic importance were taken into account. The yield loss from 4% to 30.2% was recorded with an average of 14.5%. The

**Table 1. Frequency and population densities of plant parasitic nematodes in soil and roots of vegetable crops in eastern Uttar Pradesh.**

| Nematode species* | Frequency** | Prominence value | Nematode population densities (Max.) | |
|---|---|---|---|---|
| | | | 200 cc soil | Per g of root |
| *Longidorous* spp. | 12.8 | 127.8 | 118 | (-) |
| *Xiphinema* spp. | 18.2 | 132.3 | 98 | (-) |
| *Dorylaimus* spp. | 28.6 | 96.8 | 218 | (-) |
| *Pratylenchus* spp. | 30.4 | 266.4 | 42 | 17 |
| *Hoplolaimus indicus* | 37.6 | 387.6 | 390 | (-) |
| *Tylenchorynchus brassicae* | 40.0 | 144.5 | 64 | (-) |
| *Tylenchorynchus vulgaris* | 42.2 | 265.3 | 212 | (-) |
| *Helicotylenchus spp.* | 52.0 | 325.4 | 114 | (-) |
| *Rotylenchulus reniformis* | 81.3 | 1132.2 | 316 | 62 |
| *Meloidogyne incognita* | 91.2 | 1672.4 | 432 | 92 |
| Saprophytes *** | 100.0 | - | 3328 | (-) |

*Nematode species are listed in increasing frequency; ** Frequency (%) of nematode infested samples; ***Non stylet bearing nematode; (-) absence of nematode

ecto-parasites and/or migratory ecto-parasites including sting nematode *Balanolaimus* spp., spiral nematode, *Helicotylenchus* spp., lance nematode, *Hoplolaimus* spp. needle nematode, *longidorous* spp., stubby root nematode, *Paratrichodorus* spp., stunt nematode, *Tylenchorynchus* spp. and dagger nematode, *Xiphenema* spp. have been recorded to be damaging nematode pests of many vegetable crops as they cause destruction of epidermis during feeding (Cooke, 1989, McKenry *et al*. 2001). However, in India, no such studies were conducted which indicate the losses caused by ecto-parasitic and/or migratory ecto-parasitic alone and/or concomitantly with endo-parasitic and migratory endo-parasitic nematode infesting vegetable crops under naturally infested field.

The data presented in Table 2 showed yield losses due to concomitantly association of endo-parasites as well as ecto-prasites present in the same rhizosphere of the same plant under field condition. Ecto-parasitic nematode species damage root tips resulted in growth arrest and reduces the ability to absorb nutrients and water (Anwar & Vangundy, 1989, Carneiro *et al*., 2002,). Damage due to endo-parasite or migratory endo-parasites are well documented the literature and given preferences by researchers to work on them (Sharma *et al*., 2002). However, under natural infestation on fields, the interaction may be present due to two or more nematode species. Various nematode spp. association seems to be causing synergistic increase in yield loss (Singh *et al*., (2007). Vegetable production is not possible in the tropics and subtropics without considering the nematodes pests (Sikora & Fernandez, 2005) is true in the context of developing countries including India. The methods used to determine some of the information on yield loss relationships in the past suffers from the criticism that nematicides have a range of side effects.

The present study has the benefit of producing information on the relationships between initial population, final population and yield. It provides important information to extension specialists, which can be utilize to create awareness among farmers and a massage to plant protectionists to consider nematodes as major damaging pests of vegetable crops. Further investigations are needed and requires experimental errors to be minimized.

**Table 2. Nematode associated with vegetable crops and related yield losses in eastern Uttar Pradesh.**

| Name of vegetable | | Yield loss (%) | Associated nematode based on feeding habit | | |
|---|---|---|---|---|---|
| **Common** | **Scientific Name** | | **Ectoparasite (epidermal invader)** | **Semi-endoparasite (cortical feeder)** | **Endoparasite (vascular feeder)** |
| **Solanaceous vegetables** | | | | | |
| Chilli | *Capsicum annum* | 10.8 | 1,3,5,6,8* | 4,9 | 10 |
| Egg plant | *Solanum melongena* | 17.0 | 1,2,3,5,6,7,8 | 4,9 | 10 |
| Tomato | *Lycopersicon esculentum* | 28.0 | 1,2,3,5,6,7,8 | 4,9 | 10 |
| **Cucurbataceous vegetables** | | | | | |
| Bitter gourd | *Momordica charantia* | 22.0 | 1,3,5,6,8 | 4,9 | 10 |
| Bottle gourd | *Lagenaria siceraria* | 16.0 | 1,2,3,6,7,8 | 4,9 | 10 |
| Cucumber | *Cucumis sativus* | 16.2 | 2,3,5,6,7, | 4,9 | 10 |
| Pointed gourd | *Trichosanthes dioica* | 26.0 | 1,2,5,7,8 | 4,9 | 10 |
| Pumpkin | *Cucurbita maxima* | 12.8 | 1,3,5,6,8 | 4,9 | 10 |
| Ridge gourd | *Luffa acutangula* | 11.0 | 1,5,6,8 | 4,9 | 10 |
| Sponge gourd | *Luffa cylindrica* | 9.6 | 2,3,7,8 | 4,9 | 10 |
| **Legume vegetables** | | | | | |
| Cowpea | *Vigna unguiculata* | 30.2 | 1,2,7,8 | 4,9 | 10 |
| Pea | *Pisum sativum* | 14.0 | 1,6,7,8 | 4,9 | 10 |
| **Cole vegetables** | | | | | |
| Brocolli | *Brassica oleracea* | 4.0 | 1,2 | 4,9 | 10 |
| Cabbage | *Brassica oleracea var. capitata* | 6.0 | 1,2,6,7,8 | 4,9 | 10 |
| Cauliflower | *Brassica oleracea var. botrytis* | 8.0 | 1,2,3,7 | 4,9 | 10 |
| **Root vegetables** | | | | | |
| Carrot | *Daucus carota* | 4.5 | 1,8 | 4,9 | 10 |
| **Leafy vegetables** | | | | | |
| Spinach (Palak) | *Spinacia oleracea* | 6.1 | 1,2,5,6,7,8 | 4,9 | 10 |
| **Malvaceous vegetables** | | | | | |
| Okra | *Ablemoschus esculentus* | 18.6 | 1,2,3,5,6,7,8 | 4,9 | 10 |

Note - *1. *Longidorous* spp., 2. *Xiphinema* spp., 3. *Dorylaimus* spp., 4. *Pratylenchus* spp., 5. *Hoplolaimus indicus*, 6. *Tylenchorynchus brassicae*, 7.*Tylenchorynchus vulgaris*, 8. *Helicotylenchus* spp., 9. *Rotylenchulus reniformis*, 10. *Meloidogyne incognita*.

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