Bangladesh J. Bot. **45**(5): 1015-1025, 2016 (December)

# PLANT AND SOIL NEMATODES ASSOCIATED WITH TUBEROSE IN WEST BENGAL, INDIA

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*Key words:* Survey, Diversity, Plant parasitic nematodes, Tuberose, Nematode infestation

**Abstract**

Analysis of plant and soil samples revealed association of major plant parasitic nematodes in tuberose; they were identified as *Aphelenchoides besseyi*, *Rotylenchulus reniformis*, *Helicotylenchus* spp., *Meloidogyne incognita, M. javanica, Tylenchorhynchus mashhoodi* and *Hoplolaimus indicus*. Among them, foliar nematode (*A. besseyi*) and root knot nematodes (*M. incognita* and *M. javanica*) were found as major problems in tuberose. The field infestation (PDI- per cent disease index-PDI; PI- per cent infestation) of foliar nematode was maximal in Nadia (PDI ~37-63; PI~63-90), followed by West Midnapore (PDI~23-57; PI~42-92) and North 24-Parganas (PDI~21-54; PI~50-83) districts. Similarly, number of foliar nematode per flower stalk was more in Nadia (4442) followed by West Midnapore (766) and North 24-Parganas (910) districts. Relative abundance of nematodes inhabiting tuberose rhizosphere was estimated from the samples areas. The total soil nematode population was maximal (567-1293 per 200 $cm^3$ soil) in Nadia district compared to other two districts. Among soil inhabiting plant parasitic nematodes, *R. reniformis* was encountered in high densities in some locations while *Helicotylenchus* spp., *T. mashhoodi* and *H. indicus* were estimated in low densities from tuberose rhizosphere.

## Introduction

Tuberose (*Polianthes tuberosa* L.) is one of the most important bulbous ornamental crops, popularly known as *Rajanigandha*. In India, tuberose cultivation is mainly confined to West Bengal, Karnataka, Tamil Nadu, Maharashtra, Orissa, Assam and U.P. It is mainly cultivated in Panskura, Kolaghat of Midnapore (West), Ranaghat and Haringhata areas of Nadia, and Bhalluka of 24-Parganas (North) districts of West Bengal. Tuberose is relatively hardy plant and suffers from less pest problems during its cultivation. Many plant parasitic nematodes are encountered around the crop rhizosphere. Among them root knot (*Meloidogyne* spp.) and reniform nematode (*Rotylenchulus reniformis*) proved as pathogen to tuberose (Babu and Vadivelu 1988, Mohanty and Das 1995, 1996, Kumar 2000, Kumar *et al*. 2001). In the above ground part of tuberose, the foliar nematode (*Aphelenchoides besseyi*) is one of the major concerns in West Bengal (Khan *et al*. 1999) and Orissa (Das *et al*. 2011) of India. The area under tuberose is declining due to foliar nematode infestation and the nematode could easily disseminate through infested bulb, the planting material of the crop. The nematode was first time reported from the Hawaii Islands (Holtzmann 1968) from the leaves of tuberose; subsequently it was recorded from Ranaghat areas of Nadia district in West Bengal (Chakraborti and Ghosh 1993, Khan 2001, Khan and Pal 2001). Similar problems have been reported from Mekong Delta of Vietnam (Cuc and Pilon 2007) on tuberose. Currently, the foliar nematode poses potential threat for profitable cultivation of tuberose in all the growing areas of West Bengal and Orissa. Considering the significance of the nematode pest and pest risks, the present investigation was carried out to record

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plant parasitic nematodes associated with tuberose, their density and diversity, and severity of foliar nematode infestation on tuberose in West Bengal, India.

**Materials and Methods**

The survey on the occurrence of plant parasitic nematodes associated with tuberose (cultivars Calcutta Single and Calcutta double) was carried out in Nadia, Midnapore (West) and North 24-Parganas of West Bengal during 2010-11. Twenty eight localities from 4 blocks of Nadia, 9 localities at Rajarhat block of North 24-Pargonas and 10 localities at Radhamohanpur block of West Midnapore district were included during 2010-11. During 2011-12, 18 localities of two blocks (Ranaghat and Krishnanagar) of Nadia, 8 localities of one block (Debra) of West Midnapore and 6 localities of one block (Bongaon block) from North 24-Parganas were surveyed. This was undertaken during pre-*kharif* and *kharif* season for both the years. Soil (200 $cm^3$) along with plant samples (flower stalk) were collected from the tuberose rhizosphere. Sampling was done randomly from the nematode infested fields at a distance of 5 - 10 km. A composite soil sample based on 5 cores from each field was collected with the help of *khurpi* (sampling tool) and ordinary spade. Nematode infested flower stalk was examined in the field itself; the level of infestation was recorded and infested flower stalks were collected from the fields in each location for further examination in the laboratory. All the samples collected in a day were stored in a cold place at room temperature or refrigerator for longer duration in laboratory. Nematode infested flower stalks collected from farmers' field were examined for determining per cent disease index (PDI) and per cent infestation (PI). The incidence of nematode disease in tuberose was recorded on a 0 - 4 scale (0 = no malady symptom on flowers stalk, 1 = distortions at basal part of flower stalk exhibit flower bloom, 2 = entire flower stalk exhibit distortions but few flowers bloom at the tip, 3 = entire flower stalk distorted but no flower bloom, 4 = complete sterility of flower stalk or blind head (Khan 2004). The PDI was calculated as below:

$$\text{PDI} = \frac{(1 \times \text{No. of flower stalk in class - 1}) + (2 \times \text{No. of flower stalk in class - 2}) + \ldots\ldots + (4 \times \text{No. of flower stalk in class - 4})}{\text{Total no. of flower stalks observed} \times 4} \times 100$$

For the detection and estimation of foliar nematodes (*A. besseyi*) in the infected flower, deformed flower stalks were selected randomly from each field, wrapped in paper, labeled properly and brought to the laboratory for extraction of nematodes. The samples were further processed; individual stalks were chopped into small pieces with help of a sharp knife, chopped flowers were placed on a wire-gauge assembly fitted over the Petri plate containing clean water in such a way that the bottom of the wire-gauge just touches to water. The assembly was covered by another Petri plate to prevent water loss from above surface and kept undisturbed for 12 hrs. During this incubation period, the nematode wriggled out from plant materials and migrated freely to the water below of the Petri plate. The nematode suspension was then passed through 20 mesh (840 µm) followed by 400 mesh (38µm) sieves for cleaning and removing toxic substances released from infected flower stalk. Finally, the nematode suspension was collected in a glass beaker (250 ml). The population of *A. besseyi* was counted with the help of multi-chambered counting disk under stereo binocular microscope (Zeiss, Stemi-2000C) and number of nematode of flower stalk was estimated. The soil samples (200 $cm^3$) collected from different locations were processed by Cobb's decanting and sieving method (Cobb 1918) followed by modified Baermann technique (Whitehead and Hemming 1965). The nematode specimens were killed by 'hot-water bath' method and preserved in 3% formaldehyde. Number of nematodes estimated based on multiple counts from each sample under stereoscopic binocular microscope. The nematode

specimens were processed by Seinhorst glycerol-ethanol method (Seinhorst 1959), mounted permanently in anhydrous glycerine on a glass slide and identified at species level under OLYMPUS BX-51 compound research microscope.

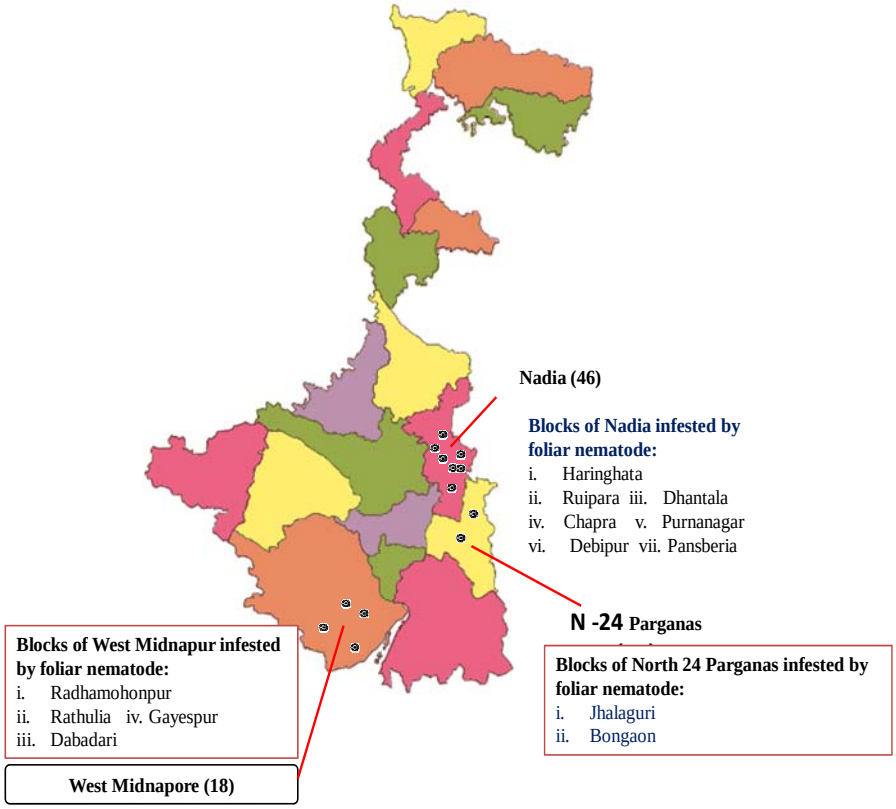


Fig. 1. Sampling sites for nematode infestation in West Bengal.

## Results and Discussion

The major plant parasitic nematodes identified from tuberose stalk and rhizosphere soil were *Aphelenchoides besseyi*, *Rotylenchulus reniformis*, *Meloidogyne incognita*, *M. javanica*, *Helicotylenchus* spp., *Tylenchorhynchus mashhoodi* and *Hoplolaimus indicus*. The foliar nematode, *Aphelenchoides besseyi* was recovered from the infested flowers as well as stalk (Fig. 2) from all the study areas and both tuberose cultivars Calcutta single and Calcutta double. Among the districts investigated, the highest foliar nematode infestation (PDI~15 - 63) was found in Nadia followed by West Midnapore (PDI~23 - 57) and North 24-Parganas (PDI~27 - 52) (Table 1a). Similarly, the highest percent of nematode infestation (PI~63-90) in tuberose was recorded in Nadia followed by West Midnapore (PI~40 - 90) and North 24-Parganas (PI~63 - 83). The population of *A. besseyi* (per stalk) was also found higher (4442) in Nadia district followed by North 24-Parganas (910) and West Midnapore (766). The rhizosphere of tuberose also supported plant parasitic nematodes (per 200 $cm^3$ soil) as *M. incognita* (41 - 58), *R. reniformis* (97 - 233), *H. indicus* (26 - 47), *Helicotylenchus* spp., (27 - 64), and *T. mashhoodi* (33 - 132).

**Table 1. Plant and soil nematodes from tuberose cv. Calcutta single growing areas of West Bengal during 2010-2011.**

| District/ block | Locality | Sample | PI ± Sd (Range) | PDI ± Sd (Range) | Stalk length (cm) (± Sd) | Foliar nematode population per stalk (*Aphelenchoides besseyi*) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Male | Female | Juvenile | Total |
| **Nadia (28)*** | | | | | | | | | |
| Fatepur | Haringhata | 6 | 76.98 ± 7.97 (63.63 - 90.00) | 42.32 ± 9.11 (31.81 - 55.00) | 41.96 ± 11.13 | 108.40 | 1059.87 | 273.47 | 1441.73 |
| Haringhata | Haringhata | 8 | 45.36 ± 7.02 (30.00 - 60.00) | 24.84 ± 9.09 (15.00 - 35.00) | 47.08 ± 11.72 | 34.34 | 282.43 | 50.71 | 350.60 |
| Krishnanagar | Ruipara | 8 | 73.8 ± 8.65 (61.53 - 88.88) | 49.41± 9.73 (36.53 - 62.50) | 46.14 ± 12.83 | 63.13 | 529.60 | 102.05 | 664.78 |
| Ranaghat | Dhantala | 6 | 69.39 ± 7.49 (61.50 - 80.00) | 46.62 ± 6.71 (35.41 - 55.00) | 43.95 ± 11.08 | 412.44 | 3628.31 | 401.13 | 4441.88 |
| **North 24-Parganas (9)** | | | | | | | | | |
| Rajarhat | Jhalaguri | 9 | 76.92 ± 8.14 (63.63 - 83.33) | 43.53 ± 7.10 (27.27 - 52.27) | 41.00 ± 12.54 | 53.73 | 662.77 | 49.73 | 766.23 |
| **West Midnapore (10)** | | | | | | | | | |
| Radhamohanpur | Radha-mohanpur | 10 | 69.34 ± 10.11 (40.00 - 90.90) | 38.06 ± 17.20 (22.91 - 56.81) | 45.96 ± 15.08 | 79.75 | 776.36 | 63.27 | 910.51 |

*Figures in parentheses are number of localities surveyed in each block.

**Table 2. Plant and soil nematodes from tuberose cv. Calcutta single growing areas of West Bengal during 2010-2011.**

| District/block | Locality | Sample | Soil nematode population/200 $cm^3$ soil | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Hel | Mel | Hop | Rot | Tylen | Other | Total |
| **Nadia (28)*** | | | | | | | | | |
| Fatepur | Haringhata | 6 | 30.32 (10.40 - 39.00) | 58.37 (24.00 - 83.20) | 26.60 (11.20 - 31.20) | 97.17 (65.00 - 154.00) | 32.53 (22.00 - 52.00) | 322.37 (165.00 - 600.00) | 567.36 |
| Haringhata | Haringhata | 8 | 63.95 (24.00 - 109.80) | 41.90 (15.60 - 75.60) | 32.86 (12.00-58.40) | 196.25 (48.00 - 451.40) | 36.40 (12.20 - 78.00) | 613.95 (420.00 - 826.80) | 985.31 |
| Krishnanagar | Ruipara | 8 | 35.89 (11.00 - 67.00) | 45.78 (12.00 - 80.40) | 47.43 (24.80 - 84.00) | 154.38 (55.00 - 294.00) | 66.03 (42.00 - 174.00) | 525.55 (330.00 - 728.00) | 875.06 |
| Ranaghat | Dhantala | 6 | 27.47 (12.00 - 52.00) | 40.96 (25.20 - 53.60) | 25.80 (11.60 - 40.20) | 232.57 (130.00 - 554.40) | 131.83 (78.00 - 254.60) | 405.10 (266.80 - 541.80) | 863.73 |
| **North 24-Parganas (9)** | | | | | | | | | |
| Rajarhat | Jhalaguri | 9 | 24.13 (12.60 - 41.40) | 48.55 (27.60 - 85.00) | 32.47 (14.00 - 55.20) | 73.53 (28.00 - 118.80) | 28.60 (12.60 - 45.00) | 503.08 (280.00 - 763.20) | 710.36 |
| **West Midnapore (10)** | | | | | | | | | |
| Radha-mohanpur | Radha-mohanpur | 10 | 28.80 (13.00 - 39.60) | 28.29 (11.20 - 51.20) | 21.40 (11.20 - 35.40) | 100.56 (48.00 - 140.80) | 31.49 (11.20 - 56.00) | 636.27 (494.00 - 817.60) | 846.81 |

*Figures in parentheses are number of localities surveyed in each block, Rot = *Rotylenchulus reniformis,* Hel = *Helicotylenchus* spp., Mel = *Meloidogyne* spp., Hop = *Hoplolaimus indicus*, Tylen = *Tylenchorhynchus mashhoodi*, Other = Saprozoic nematodes.

in Nadia district (Table 2). In West Midnapore, population of plant parasitic nematodes recovered from crops rhizosphere were *Meloidogyne* spp. (29), *R. reniformis* (101), *H. indicus* (21), *Helicotylenchus* spp. (29), and *Tylenchorhynchus* spp. (31) (Table 3). From North 24-Parganas, plant parasitic nematodes recorded were *Meloidogyne* spp. (49), *R. reniformis* (74), *Helicotylenchus* spp. (24), *Hoplolaimus indicus* (32), and *T. mashhoodi* (29). Soils in Nadia district showed higher load of soil nematodes (985) followed by West Midnapore (847) and North 24-Parganas (401). The survey on plant parasitic nematodes infecting tuberose was further investigated during 2011-2012 (Tables 3,4). The major plant parasitic nematodes identified from


Fig. 2. Foliar nematode (*Aphelenchoides besseyi*) infestation: A. Calcutta single. B. Calcutta double. C. Field of Calcutta double and D. Field of Calcutta single.

different localities were *A. besseyi*, *Meloidogyne incognita*, *M. javanica*, *R. reniformis*, *Helicotylenchus* spp., *Hoplolaimus indicus* and other saprozoic nematodes. Foliar nematode infestation in tuberose was also recorded highest (PDI~43-61) in Nadia (Table 3) which was

followed by West Midnapore (PDI~35 - 55) and North 24-Pargonas (PDI~21 - 54). The PI ranges was also higher (83 - 89) in Nadia followed by West Midnapore (67 - 92) and North 24-Parganas (50 - 83). The population of *A. besseyi* (per stalk) was also recorded higher (266) in Nadia district followed by North 24-Pargonas (906) and West Midnapore (683). The tuberose rhizosphere inhabited plant parasitic nematodes populations (per 200 $cm^3$ soil) were *Meloidogyne* spp. (68 - 130), *R. reniformis* (58-413), *H. indicus* (17-31) and *Helicotylenchus* spp. (41 - 178) in Nadia district (Table 2b). In North 24-Pargonas, tuberose crop supported low densities of *Meloidogyne* spp. (74), *H. indicus* (29), and *Helicotylenchus* spp. (32) and relatively higher densities of *R. reniformis* (744). In West Midnapore, tuberose crop rhizosphere was inhabited by *Meloidogyne* spp. (30 - 61), *R. reniformis* (25 - 52), *H. indicus* (14), and *Helicotylenchus* spp. (16 - 29). The total soil nematode populations in the rhizosphere of tuberose was higher in Nadia (1293/200 $cm^3$) followed by North 24-Parganas (1196) and West Midnapore (444).

Among the plant parasitic nematode infesting tuberose, root knot and foliar nematodes are major concerns and both the nematode species damaging crops in different ecological conditions. Root knot nematodes attacks root system of tuberose and often severely destroy the roots in association with other soil-borne fungi. Foliar nematode (*A. besseyi*) is well known nematode pest of rice induce a typical symptom of white tip disease. It is widespread in rice growing districts of West Bengal (Das and Khan 2007) and established on tuberose in rice-tuberose cultivation system (Khan 2001) and producing characteristic floral malady problem. Chakraborti and Ghosh (1993) reported floral malady on tuberose from Ranaghat region of Nadia district in India. Later Khan (2001) confirmed *A. besseyi* as a causal pathogen of floral malady of tuberose and demonstrated tuberose population capable of inducing typical 'white tip disease' in rice. Khan and Pal (2001) also reported occurrence of plant parasitic nematodes *viz*., *A. besseyi*, *M. incognita*, *R. reniformis*, *Hoplolaimus* spp. and *Helicotylenchus* spp. from the rhizosphere of tuberose in West Bengal; *M. incognita* and *R. reniformis* are recorded in very high densities from Ranaghat, Haringhata of Nadia, Kolaghat-Panskura of Midnapore and Bhalluka of North 24-Paragnas. Bala (2007) investigated floral malady due to *A. besseyi* in tuberose from five blocks *viz*. Ranaghat-I, Ranaghat -II and Haringhata of Nadia district, Rajarhat of North- 24 Pargonas and Bhangar of south 24-Parganas district and considered those areas as hot-spots for the infestation of foliar nematode. The present study generates information on the diversity of plant parasitic nematodes from the tuberose rhizosphere as well as from foliar part. The foliar nematode (*A. besseyi*) inducing *floral malady* in tuberose is still a major threat in Nadia followed by West Midnapore and North -24 Pargonas. The soil inhabiting plant parasitic nematodes were in general found relatively at low densities in the tuberose rhizosphere. However, reniform nematode from North 24-Parganas is found in large densities. This is in conformity with the observation of Khan and Pal (2001) on high densities of *R. reniformis* and *M. incognita* in the tuberose. The population densities of *M. incognita* in the soil along with root samples are found relatively low in the most of the surveyed areas. The infestation of root knots nematode is widespread on many crops as some previous works reported root knot nematode as a serious problem and one of the important constraints for commercial cultivation of tuberose in India (Babu and Vadivelu 1988). Root knot nematode infects tissues of bulb and root (Chawla *et al*. 2006) is reported to cause 10% reduction of yield (Khan and Parvatha Reddy 1992). Therefore, using bulb as a planting material potentially disseminates root knot nematode from one place to another. The level of nematode inoculum of *M. incognita* is directly related to the damage on tuberose (Babu and Vadivelu 1988, Mohanty and Das 1996, Kumar 2000), and similar relationship has been demonstrated for *M. arenaria* (Babu and Vadivelu 1988; Kumar *et al*. 2001) and *M. javanica* (Babu and Vadivelu 1988) infecting tuberose. Further, root knot nematodes attacks large number of crops and weed hosts and their

**Table 3. Plant and soil nematodes from tuberose cv. Calcutta single growing areas of West Bengal during 2011-2012.**

| District/block | Locality | Sample | PI ± SD (Range) | PDI ± Sd (Range) | Stalk length (cm) (± Sd) | Foliar nematode population per stalk (*Aphelenchoides besseyi*) | | | |
|---|---|---|---|---|---|---|---|---|---|
| **West Midnapore(8)*** | | | | | | Male | Female | Juvenile | Total |
| Debra | Dabadari | 3 | 72.72 ± 8.26 (72.72 - 88.88) | 43.16 ± 6.82 (34.09 - 53.12) | 35.44 ± 13.93 | 124.00 | 284.67 | 196.33 | 605 |
| | Gayespur | 2 | 76.26 ± 10.96 (63.63 - 83.33) | 44.10 ± 0.45 (43.75 - 44.44) | 35.90 ± 11.20 | 126.70 | 430.90 | 126.50 | 683.47 |
| | Rathulia | 3 | 77.01 ± 6.80 (69.23 - 81.81) | 48.05 ±11.64 (34.61 - 55.00) | 38.02 ± 13.55 | 107.07 | 334.93 | 98.07 | 540.07 |
| **Nadia (18)** | | | | | | | | | |
| Ranaghat (13) | Chapra | 5 | 78.87 ± 6.23 (72.72 - 88.88) | 52.35 ± 8.97 (43.18 - 61.11) | 35.40 ± 12.25 | 170.96 | 1822.84 | 672.68 | 2666.48 |
| | Purnanagar | 4 | 81.84 ± 10.71 (66.66 - 91.66) | 47.86 ± 5.98 (42.85 - 56.25) | 37.89 ± 13.99 | 143.80 | 1817.30 | 207.00 | 2168.10 |
| | **Debipur | 3 | 86.11 ± 3.92 (83.33 - 88.88) | 38.22 ± 7.26 (30.00 - 43.75) | 38.58 ± 13.83 | 192.27 | 1766.80 | 236.27 | 2195.34 |
| | Pansberia | 1 | 87.5 | 34.37 | 37.40 ± 14.83 | 112 | 1168 | 240 | 1520 |
| Krishnanagar (5) | | | | | | | | | |
| | Ruipara | 5 | 76.22 ± 18.19 (55.55 - 90.90) | 39.69 ± 11.55 (28.57 - 56.81) | 37.48± 12.97 | 222.52 | 1446.20 | 233.72 | 1902.44 |
| **North 24- Pargonas (6)** | | | | | | | | | |
| Bongaon Developmental block | Bongaon | 6 | 70.92 ± 11.87 (50.00 - 83.33) | 41.16 ± 11.91 (20.83 - 53.57) | 45.49 ± 4.10 | 81.53 | 689.27 | 135.23 | 906.03 |

*Number of fields surveyed in each block; **Only locality where Calcutta double variety was available.

**Table 4. Plant and soil nematodes from tuberose cv. Calcutta single growing areas of West Bengal during 2011-2012.**

| District/block | Locality | Sample | Soil nematode population/200 $cm^3$ soil | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Rot | Hel | Mel | Hop | Other | Total |
| **West Midnapore(8)*** | | | | | | | | |
| Debra | Dabadari | 3 | 25.47 (19.40 - 30.00) | 28.93 (18.00 - 40.00) | 31.07 (20.00 - 45.00) | 14.40 (10.00 - 18.80) | 128.87 (120.00 - 131.60) | 228.74 |
| | Gayespur | 2 | 51.50 (33.00 - 70.00) | 15.50 (11.00 - 20.00) | 61.00 (42.00 - 80.00) | - | 316.00 (132.00 - 500.00) | 444.00 |
| | Rathulia | 3 | 40.13 (33.60 - 50.00) | 24.80 (16.80 - 30.00) | 30.13 (18.40 - 42.00) | 14.20 (8.40 - 20.00) | 203.73 (101.20 - 300.00) | 312.99 |
| **Nadia (18)** | | | | | | | | |
| Ranaghat (13) | Chapra | 5 | 58.48 (28.80 - 81.00) | 40.64 (26.00 - 76.80) | 109.32 (60.00 - 172.00) | 30.65 (13.00 - 68.00) | 517.04 (392.00 - 616.00) | 756.13 |
| | Purnanagar | 4 | 386.40 (232.00 - 812.00) | 46.70 (26.00 - 84.00) | 80.10 (26.00 - 140.00) | 21.93 (13.00 - 28.00) | 517.60 (372.00 - 756.00) | 1052.73 |
| | **Debipur | 3 | 347.73 (143.20 - 620.00) | 178.27 (156.00 - 350.00) | 81.73 (60.00 - 115.20) | 20.50 (15.00 - 26.00) | 665.40 (547.20 - 735.00) | 1293.63 |
| | Pansberia | 1 | 78 | 117 | 130 | 26 | 897 | 1248.00 |
| Krishnanagar (5) | | | | | | | | |
| | Ruipara | 5 | 413.16 (272.00 - 570.00) | 79.88 (52.00 - 140.00) | 67.60 (42.00 - 104.00) | 17.27 (13.00 - 24.80) | 709.52 (468.00 - 1106.00) | 1287.43 |
| **North 24- Pargonas (6)** | | | | | | | | |
| Bongaon Developmental block | Bongaon | 6 | 766.20 (102.00 - 1512.00) | 31.53 (18.00 - 58.80) | 74.30 (28.80 - 171.00) | 29.03 (19.20 - 36.00) | 295.50 (120.00 - 621.00) | 1196.56 |

*Number of fields surveyed in each block, Rot = *Rotylenchulus reniformis*, Hel = *Helicotylenchus* spp., Mel = *Meloidogyne* spp., Hop = *Hoplolaimus indicus*, Other = Saprozoic nematodes; **Only locality where Calcutta double variety was available.

population in field remains in dynamic state. Therefore, growing of susceptible crops in a rotational sequence enhance its population and can infect severely on any crop including tuberose. In the present study, large population of *R. reniformis* was found in some locations but visual symptoms were not distinctive for the nematode species. However, *R. reniformis* is established as a potential pathogen of tuberose cv. Calcutta single (Mohanty and Das 1995) and at relatively high densities of *R. reniformis* caused decline of plant growth parameters. Other plant parasitic nematodes *viz., Hoplolaimus indicus, Helicotylenchus* spp. and *Tylenchorhynchus mashhoodi* are indentified from the tuberose rhizosphere in the present study but their pathogenic potential has not yet been established.

Findings of the study conducted for consecutive two years (2010-2011 and 2011-2012) in three districts (Nadia, North 24-Paraganas and West Midnapore) of West Bengal and reveal that the highest foliar nematode infestation (PDI and PI) was found in Nadia followed by West Midnapore and North 24-Parganas districts. The flower stalk contains greater numbers of *A. besseyi* in the samples from Nadia followed by West Midnapore and North 24-Parganas district. The numerical abundance of male, female and juveniles of *A. besseyi* in the infested tuberose flower stalk indicate that male is less frequent than other stages. The relative flower stalk lengths of tuberose cultivars (Calcutta single, and Calcutta double) at different locations shows wide variations between the years. The nematode density and diversity obtained from the tuberose rhizosphere also shows that saprozoic nematodes (free-living nematodes) are most abundant; they are mostly belonging to the groups of cephalobids, rhabditids, aphelenchids, mononchids, dorylaimids etc. Soil inhabiting plant feeding nematodes are also obtained at varying level but root knot and reniform nematodes is found in rhizosphere and those may be problem for profitable cultivation of tuberose.

The study generated information on nematode infestation, density and diversity in tuberose from West Bengal and relatively high infestation of foliar nematode (*A. besseyi*) was recorded in Nadia followed by Midnapore (West) and 24-Paragnas districts. Infestation of foliar nematode is continued to be a major problem for tuberose cultivation in West Bengal. Among the other nematodes, reniform nematode (*R. reniformis*) prevails in large densities in some locations but the extent of damage to be caused by this nematode species has not yet been realized.

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*(Manuscript received on 30 December, 2014; revised on 27 December, 2015)*