



Status of *Meloidogyne graminicola* in Rice (*Oryza sativa* L.) and its Host Range under Bihar Conditions

Nishi Keshari¹, Gajja Bharath Goud¹, G. Mallikarjun¹, K.N. Pathak¹

10.18805/ag.D-6173

ABSTRACT

Background: Paddy is the main crop in Bihar during *kharif* season. Farmers are growing different varieties under rainfed condition. This crop is infested by many pests, diseases and nematodes. Amongst the plant parasitic nematodes, the root knot nematode, *Meloidogyne graminicola* and root rot nematode, *Hirschmaniella oryzae* are found to be the main limiting factors of productivity. However, *M. graminicola* is found in nearly every variety. The current experiment was done during *Kharif*, 2019 to survey the rice root knot nematode infestation in rice nurseries in different districts of Bihar and also to find the host status in different varieties of paddy as well as in millets and vegetables.

Methods: The root and soil samples of the crops were brought from the rice field from the paddy nurseries of different villages of Samastipur, Muzaffarpur, Darbhanga and Vaishali districts. These soil and root samples were analysed for the population of root knot nematodes. For host status, the different varieties of paddy, millets and vegetables were grown in the soil infested with *Meloidogyne graminicola*. The nematode multiplication parameters were recorded after 30 days.

Result: Results from the present study revealed that, the frequency of occurrence of *M. graminicola* in these three districts ranged between 80-90%. Maximum nematode population, number of females, eggs and juveniles were found in Samastipur district and minimum infestation is in Darbhanga district. Among rice varieties screened against *M. graminicola*, significantly highest root knots per plant, number of females per root knot, eggs and juveniles per egg mass and root knot index were recorded in variety, BPT-5204 and lowest root knot index was observed in variety, Rajendra Saraswati. Among millets, finger millet (varieties, RAU-3 and RAU-8) and foxtail millet (variety, RAU-1) did not reveal any gall on the roots. Except onion, no other vegetable revealed any sign of host parasite interaction on the host.

Key words: Host status, *Meloidogyne graminicola*, Millets, Paddy, Rice nursery, Vegetables.

INTRODUCTION

Rice (*Oryza sativa*) is a staple crop of Bihar, India and various parts of the world. It is a major cereal crop of Bihar State. It contains rich source of carbohydrates (75 %) and proteins (7%). -. (the softness of rice due to sarch but not Gluten) Rice protein is also known as Oryzenin. It not only contains carbohydrates and proteins but also lipids, vitamins and minerals. It is the most staple food in the world, with more than one-third of the population playing a competitive role in the food economy and is produced annually in 165 million ha area with 523.9 million tonnes of global annual production. India is the world's second largest producer of rice, accounting for about 26% of the global production. Other top rice producing countries include Bangladesh, Indonesia and Vietnam (FAO, 2023). This crop is highly vulnerable to several insect pests (Prasad *et al.*, 2006).

Rice root-knot nematode, *Meloidogyne graminicola* is distributed globally and caused up to 70 % yield loss (Bridge *et al.*, 2005). In India, losses range between 16 and 32 % under irrigated conditions and between 11 and 73 % under flooded conditions (Prasad *et al.*, 1986) and 11% to 73% reported by Soriano *et al.* in 2000. It became a serious issue in the nurseries, upland rice, deep water and irrigated rice and also many parts of India (Prasad *et al.*, 1985; Bridge *et al.*, 2005; Jairajpuri and Baqri, 1991). The *Meloidogyne* species is highly economic species, causing

¹Department of Plant Pathology and Nematology, Post Graduate College of Agriculture, Rajendra Prasad Central Agricultural University, Pusa, Samastipur-848 125, Bihar, India.

Corresponding Author: Nishi Keshari, Department of Plant Pathology and Nematology, Post Graduate College of Agriculture, Rajendra Prasad Central Agricultural University, Pusa, Samastipur-848 125, Bihar, India. Email: nishi@rpcu.ac.in

How to cite this article: Keshari, N., Goud, G.B., Mallikarjun, G. and Pathak, K.N. (2025). Status of *Meloidogyne graminicola* in Rice (*Oryza sativa* L.) and its Host Range under Bihar Conditions. Agricultural Science Digest. 1-7. doi: 10.18805/ag.D-6173.

Submitted: 28-08-2024 **Accepted:** 24-02-2025 **Online:** 13-05-2025

diseases in many crops (Singh *et al.*, 2019, Singh *et al.*, 2021, Sumita and Vivekananda, 2023) because it is a polyphagous species, but, the species, *Meloidogyne graminicola* affects only paddy and other graminaceous crops and weeds. It causes typical hook shaped root galls on all the vulnerable hosts. *M. graminicola* has various host range (Ou, 1972; Sabir and Gaur, 2005) that includes many varieties of paddy and also some common weeds of rice fields. Its occurrence in various host plants of fodder, fruits, ornamentals and weeds, was found by MacGowan and Langdon (1989). It was reported that rice, sorghum, pearl millet, oats and wheat were good hosts of *M.*

graminicola but brinjal, okra, tomato, green gram and barley did not support its multiplication (Dabur *et al.*, 2004). The main hosts of rice root knot nematode in the family, poaceae, includes rice, sorghum, barley, oat and wheat (Vaish *et al.*, 2012).

The most prominent symptoms of *M. graminicola* on the root system are swollen and hooked root tips which are characteristic for *M. graminicola* and *M. oryzae* (Bridge *et al.*, 2005). Typical above ground symptoms include stunting and chlorosis leading to reduced tillers and yield (Narasimhamurthy *et al.*, 2016). The *Meloidogyne* genus is considered the most important mainly due to its wide host range that includes more than 3,000 species of wild and cultivated plants. *M. graminicola* is an obligate sedentary endoparasite adapted to flooded conditions. Until recently, *M. graminicola* was present mainly in irrigated rice fields in Asia, parts of the Americas and South Africa. This pest was included in the EPPO Alert List because of its wide host range and ability to survive during long periods in environments with low oxygen content, represent a threat for rice production in the European Union (Rusinek *et al.*, 2021). Rice root knot nematode (*M. graminicola*) has emerged as a major threat worldwide and because of its magnitude, has occupied a position of global pest (Narasimhamurthy *et al.*, 2018).

Management of this minuscule crop pest is a herculean task before the nematologists. Traditional practices like crop rotation, fallowing, removing of alternate hosts like weeds have been proven to reduce the nematode population but they are impractical or economically unviable. Three bio-agents (*Bacillus pumilus*, *Bacillus subtilis* and *Pseudomonas fluorescence* @ 20 g/ m²) have been found effective against this nematode (Kumar *et al.*, 2024). There are very few nematicides available for this nematode management and that too are highly expensive. Although, biological control is a promising alternative, it is still in its infancy. The use of resistant cultivars offers a sustainable solution to manage this shrewd microscopic enemy (De Waele *et al.*, 2013; Yao *et al.*, 2020).

MATERIALS AND METHODS

The survey was done during *kharif* season of 2019 in four districts of Bihar viz., Samastipur, Muzaffarpur, Darbhanga and Vaishali, to find out the infestation of *M. graminicola* in rice nurseries. The root and soil samples of the crops were brought from the rice field, along with the information of village name, variety, date of sowing, latitude and longitude, crop rotation practices, soil type and seed treatment, gathered from the farmers from 20 fields (Fig 1 and 2). Plants for sampling were selected based on the typical symptoms, i.e. yellowing and stunting of plants. Plants were sampled from 5 spots from each nursery. From each spot, 5 plants were gently uprooted from the depth of 10-15 cm with the help of a scoop. The soil samples, collected from different places in a nursery were kept together and composite representative sample of 200 g of soil along with roots and

other plant materials, was collected and packed in the polythene pouches and tagged with labels. Samples were brought to the P.G. laboratory of Department of Nematology, RPCAU, Pusa, Samastipur, Bihar for further processing and data recording. Soil from the roots was removed by gently shaking the plant and the data of root-knot nematode was recorded by the presence of galls with naked eyes. The number of root galls, number of females per root gall, number of eggs and second stage juveniles (J₂) were recorded from the plants. Incidence of root-knot disease was measured by root gall index (1-5 scale), as given by Hartman and Sasser (1985), 1 = no galling; 2 = 1-10 galls; 3 = 11-30 galls; 4 = 31-100 galls; 5 = more than 100 galls/ root system. In the laboratory, nematodes were extracted using Cobb's sieving and decanting method. The extracted nematodes were killed and fixed in double strength formalin solution and then proceeded for clearing. After clearing in Sienhorst's solution 1 and 2, permanent slides were prepared with glycerol for further observation.

Frequency of distribution was calculated using below mentioned formula:

$$\text{Frequency of occurrence} = \frac{\text{No. of infected sample}}{\text{Total no. of samples}} \times 100$$



Fig 1: Sample collection at farmers field in Samastipur district of Bihar.



Fig 2: Sample collection at farmers field in Vaishali district of Bihar.

Nematode culture

The pure culture of *M. graminicola* population, used in this study, was maintained in the field laboratory of Nematology, RPCAU, Pusa, from single egg mass of infected rice roots. The infected plants were uprooted and egg masses were carefully detached from the galled roots. The egg masses were stirred with 0.5 % NaOCl solution and kept in Modified Baermann Funnel Technique (MBFT) for hatching and approximately 1000 J₂s were used to infect paddy (susceptible variety, PB 1121) roots in pots. After 30 days of infection, nematode females and egg masses were extracted (Hussey and Barker, 1973). Using perineal patterns (Eisenback *et al.*, 1980), identity of *M. graminicola* was confirmed. Egg masses were collected (Hussey and Barker, 1973) from the infected roots at 30 days post-inoculation (dpi), surface sterilized with 0.1% HgCl₂ for 1 min, followed by rinsing in sterile water. Egg masses were kept for hatching in a double-layered tissue paper placed on a wire mesh in a Petri plate containing sterile distilled water. Freshly hatched J₂s were used for the inoculation.

Screening of rice root knot nematode against various host ranges

The experiment was conducted in pots to study the host differential test of *Meloidogyne graminicola* on different varieties of rice (*viz.*, Rajendra Sarsawati, Rajshree, BPT 5204, Rajendra Neelum, Rajendra Prabhat, Rajendra Sahbhagi, Rajendra Abhishek, Rajendra Shweta and Rajendra Vaidehi), coarse cereal, bajra (HHB-67) and millets like, barnyard millet (Dholi-1), finger millet (BR-407, RAU-3, RAU-8) and Foxtail millet (RAU-1) with vegetables like brinjal (BR-112), onion (*Kharif*) and tomato (Selection-120), sown in infested soil, collected from Pusa farm of rice field. Each treatment was replicated three times and the experiment was conducted in CRD design. The plants were uprooted 30 days after inoculation, each seedling was packed in polythene pouch and tagged with replication and treatment number and brought to the laboratory. Roots were properly and gently washed in running tap water and then staining was done using 0.1% fuchsin acid lactophenol. The stained roots were observed under binocular microscope for the following observations: number of root-knots, number of females, number of juveniles, number of eggs and juveniles per egg mass and root-knot index.

RESULTS AND DISCUSSION

During survey of the rice nurseries, the highest nematode population was observed in Samastipur (5000 nematodes/200 cc of soil) and lowest nematode population was found in Dharbhanga (2200 nematodes/200 cc of soil). Highest number of root knots/plant was observed in Vaishali district (55) and lowest was found in Muzaffarpur (20 root knots / plant). Highest root knot index was (3.66) in Vaishali district and lowest root knot index was 2.33, found in Darbhanga district. Highest number of eggs and juveniles was found in Samastipur district (62.55 per egg mass) and lowest was found in Muzaffarpur district (20.0 per egg mass). Highest number of females was observed in Samastipur (3.33) and lowest was found in Dharbhanga (0.66) district, as shown in Table 1. The results obtained in the present study are similar to Khan *et al.* (2019) who conducted survey in major rice growing districts of Uttar Pradesh and concluded that highest frequency of disease in rice fields was observed in Aligarh (44.6%), followed by Muzaffarnagar, Shahjahanpur and Kheri Lakhimpur (29.3, 28.0 and 27.4 respectively). Similarly Narsimhamurthy *et al.* (2017) recorded population density of *M. graminicola* in different districts of Karnataka in the range of 586.33 to 841.00 J₂/100 cc of soil. Rana *et al.* (2016) evaluated 50 germplasm of basmati rice, out of which Pusa 1637-18-7-6-20 was found to be resistant with scale 2, while, two germplasm, Shaan (Hybrid) and UPR 3805-12-2-7 were evaluated to be susceptible with scale 4. Jabbar *et al.* (2015) observed its prevalence from last three years in rice-wheat cropping system in Faisalabad and Chiniot districts of Punjab in Pakistan and results showed 20% infestation rate in Faisalabad and 17% in Chiniot district.

Table 2, reveals that, among rice varieties, significantly highest root knots per plant and root knot index was recorded in BPT-5204 (13.0 and 3.0) whereas lowest number of root knots and root knot index was noticed in Rajendra Saraswati (7.66 and 2.0). The varieties, Rajshree and Rajendra Prabhat have shown the reaction at par. Similarly, when observation on number of females per root knot, number of juveniles per root knot and number of eggs and juveniles per egg mass were noticed, same trend was observed *i.e.*, maximum number in BPT-5204 and minimum in Rajendra Saraswati.

Among millets, Finger millet (BR-407), Barnyard millet (Dholi-1) and Bajra (HHB-67) are at par showing

Table 1: Population dynamics of root-knot nematode, *Meloidogyne graminicola* in four different districts of Bihar (Average of three replications).

Districts	No. of root knots per plant	No. of females per root knot	No. of eggs and juveniles per egg mass	Nematode population in soil (200 cc)	Root knot index
Samastipur	28.33	3.33	62.55	5000	3.33
Muzaffarpur	20.00	1.00	26.0	2200	3.00
Vaishali	55.00	2.33	51.89	3000	3.66
Darbhanga	26.00	0.66	35.5	2400	2.33

appearance of root knots (6.67, 6.00 and 6.67 respectively), where the nematode parasite produced maximum females being 4.33 on Barnyard millet (Dholi-1) whereas Finger millet (RAU-3), (RAU-8) and Foxtail millet (RAU-1) did not reveal any gall on the roots, exactly same trend was shown when we observe number of females per root knot, number of juveniles per root knot and number of eggs and juveniles per egg mass among millets which were tested.

Except onion, no other vegetables revealed any sign of host parasite interaction on the host *i.e.*, neither knots were found on the roots, nor the females have developed inside the root. Obviously, eggs were not found and no juveniles were reported. In onion crop, number of root knots per plant, number of juveniles per root knot and number of eggs and juveniles per egg mass were up to the tune of 7.67, 3.33, 4.00 and 4.33, respectively. This result is in conformity with Dabur *et al.* in 2004 who reported that rice, sorghum, pearl millet, oats and wheat were good hosts of *M. graminicola* but brinjal, okra, tomato, green gram and barley did not support its multiplication. Similar finding was obtained by Dhurvey *et al.* (2019) as maximum number of galls per plant (36.66 and 57) in paddy varieties, Pusa basmati and JR 503 respectively while the 6 cultivars, IR64, JR75, Poornima, Shyamla, PS3 and Madhuri showed resistant reactions against *M. graminicola* and the result

is also supported by Subudhi *et al.* (2017) who found that the paddy varieties *viz.*, Satabdi, Sabita, PR114, Savitri, Geetanjali, Tapaswini, Pooja, Sambhamahasuri, Ratna *etc.* were found to be highly susceptible having score 5. Khanish, Uday, Basmati-370, Jogen, Dinesh, Vanaprava and ASD-16, were found to be moderately resistant against this nematode.

From the result of current research, it is inferred that the nematode parasite multiplied best in the rice variety, BPT-5204, followed by Rajendra Prabhat, Rajshree,



Fig 3: Adult females in Rajendra Neelum.

Table 2: Population dynamics of root-knot nematode, *Meloidogyne graminicola* in different varieties of rice and other crops.

Variety	No. of root knots per plant	No. of females per root knot	No. of juveniles per root knot	No. of eggs and juveniles per egg mass	Root knot index
Paddy					
PB1121 (check)	108.0	6.33	16.66	28.00	5.00
BPT-5204	13.0	3.33	3.00	10.00	3.00
Rajendra Sweta	10.0	1.00	5.66	14.33	2.33
Rajendra Sahbhagi	8.33	2.00	5.00	13.33	2.00
Rajendra Saraswati	7.66	1.66	3.00	8.67	2.00
Rajshree	11.66	0.667	3.66	7.00	3.00
Rajendra Neelum	10.33	2.33	1.00	9.33	2.33
Rajendra Prabhat	12.00	1.33	3.66	13.00	3.00
Rajendra Vaidehi	11.66	0.667	4.00	7.00	2.67
Rajendra Abhishek	10.66	3.33	2.67	7.00	2.67
Millets					
Finger millet (RAU-3)	0.00	0.00	0.00	0.00	0.00
Finger millet (RAU-8)	0.00	0.00	0.00	0.00	0.00
Finger millet (BR-407)	6.67	1.33	1.667	4.66	2.00
Foxtail millet (RAU-1)	0.00	0.00	0.00	0.00	0.00
Barnyard millet (Dholi-1)	6.00	4.33	3.00	7.00	2.00
Coarse cereal					
Bajra (HHB-67)	6.67	1.33	2.00	5.33	2.00
Vegetables					
Tomato (Selection-120)	0.00	0.00	0.00	0.00	0.00
Brinjal (BR-112)	0.00	0.00	0.00	0.00	0.00
Onion (Kharif)	7.67	3.33	4.00	4.33	2.00
S.Em (±)	0.44	0.35	0.31	0.69	0.15
CD at 5 % (P =0.05)	1.26	1.01	0.88	1.99	0.44

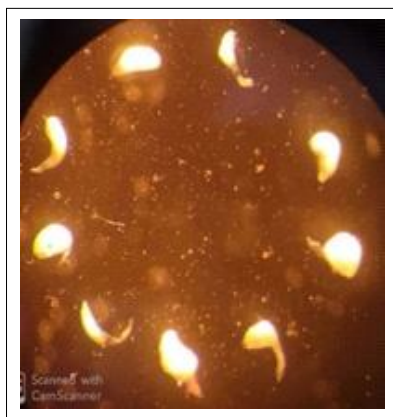


Fig 4: Different life stages of root knot nematode in Finger millet (BR-407).

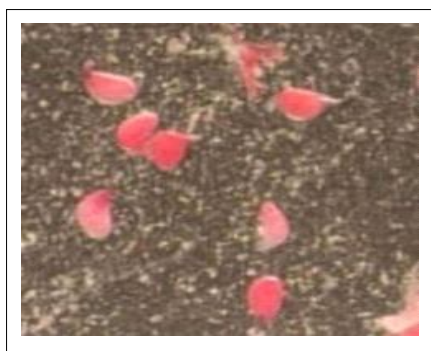


Fig 5: Adult females of Rajendra Abhishek.

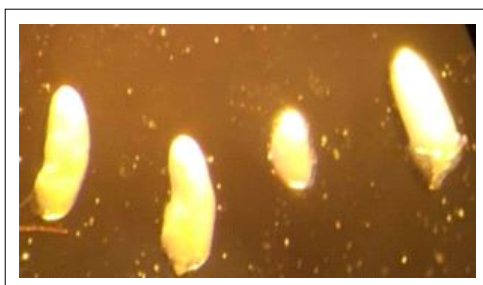


Fig 6: Adult female in Onion (Kharif).

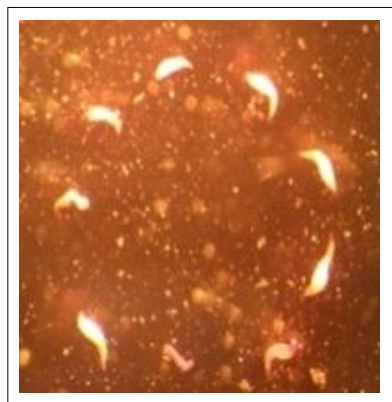


Fig 7: Juveniles of *Meloidogyne graminicola* in paddy, variety Rajshree.



Fig 8: Late stage juveniles in paddy, variety, Rajendra Vaidehi.

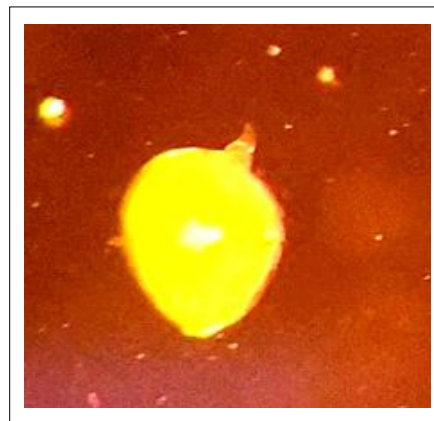


Fig 9: Adult female in Rajshree.

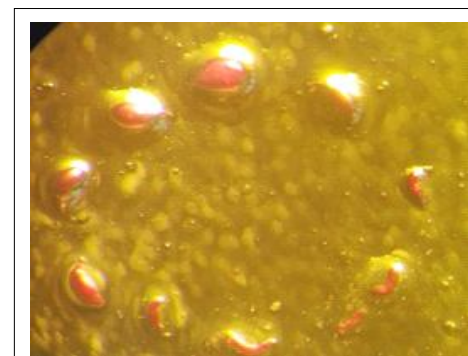


Fig 10: Juveniles in R. Vaidehi.

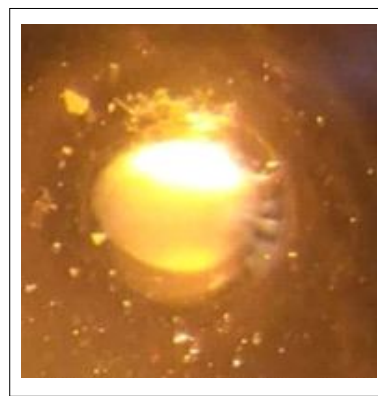


Fig 11: Adult female of *Meloidogyne graminicola* in paddy, variety, Rajendra Bhagwati.



Fig 12: Different stages of *Meloidogyne graminicola* in paddy, variety, Heera.

Rajendra Vaidehi, Rajendra Abhishek, Rajendra Neelum, Rajendra Sahbhagi and Rajendra Saraswati (Fig 3 to Fig 12). Among millets, the nematode multiplied only on finger millet (BR-407), Barnyard millet (RAU-1) and Bajra (HHB-67), whereas among vegetables, only onion supported nematode multiplication but to a lower extent. Salalia (2015) when studied 14 populations of *M. graminicola* from India, observed that six varieties of rice, two *kharif* weeds and brinjal were found as hosts, tomato (hybrid PKM 1) was non-host for all the populations, but status of pearl millet and sorghum was not clearly discernible.

CONCLUSION

From the present study it is concluded that, infestation of *M. graminicola* in nursery of paddy, was maximum in Samastipur district and minimum in Darbhanga district. The host status of *M. graminicola* on different varieties of paddy, different millets and in vegetables showed that all varieties of rice were infested in different intensity and cause losses. Among the millets, foxtail millet (RAU-1), finger millet (RAU-3 and RAU-8) did not show any nematode infestation, but, barnyard millet (Dholi-1), finger millet (BR-407) and bajra (HHB-67) did get the infestation. And for the vegetables, only onion showed the nematode infestation and rest two vegetables, brinjal and tomato did not reveal gall symptoms. So, it can be concluded that the paddy varieties are good host of *M. graminicola* while some millets also showed the positive response. Vegetables still do not prove a good host of *M. graminicola*. This nematode has a very high adaptation of new hosts as reported by many workers, specially different paddy varieties and many weeds. So, the management options should be explored with antagonistic plants or through trap crops, which are the best management options. This nematode is highly adaptive to the host and so, it is expanding its host range, covering many crops. So, the future research may be done on some other graminaceous crops and weeds to get the knowledge of host diversity to get the management insights regarding crop rotation and antagonistic crops.

ACKNOWLEDGEMENT

The authors gratefully acknowledge Dr. Rajendra Prasad Central Agricultural University, Samastipur, Pusa, Bihar, India for providing the laboratory and other important facilities and ICAR for granting National Talent Scholarship (NTS) for the present research.

Conflict of interest

There is no any conflict of interest between the authors.

REFERENCES

- Bridge, J., Luc, M., Plowright, R.A. and Peng, D. (2005). Nematode Parasites of Rice. In: Plant Parasitic Nematodes in Tropical and Subtropical Agriculture. Luc, M., Sicora, R.A., Bridge, J (Eds.), CABI, UK. 87-130.
- Dabur, K.R., Taya, A.S. and Bajaj, H.K. (2004). Life cycle of *Meloidogyne graminicola* on paddy and its host range studies. Indian Journal of Nematology. 34: 80-84.
- De Waele, D., Das, K., Zhao, D., Tiwari, R.K.S., Shrivastava, D.K., Vera-Cruz, C. and Kumar, A. (2013). Host response of rice genotypes to the rice root-knot nematode (*Meloidogyne graminicola*) under aerobic soil conditions. Archives of Phytopathology and Plant Protection. 46(6): 670-681.
- Dhurwey, D.S., Bhatt, J. and Singh, S.N. (2019). Screening of different cultivar of paddy and wheat against root-knot nematode *meloidogyne graminicola*. International Journal of Current Microbiology and Applied Science. 8(6): 3082-3085.
- Eisenback, J.D., Hirschmann, H. and Triantaphyllou, A.C. (1980). Morphological comparison of *Meloidogyne* female head structures, perineal patterns and stylets. Journal of Nematology. 12: 300-313.
- Food and Agriculture Organization (FAO) (2023). Food outlook-Biannual report on global food markets—, FAO, Rome, pp.104.
- Hartman, K.M. and Sasser, J.N. (1985). Identification of *meloidogyne* species on the basis of differential host test and perineal pattern morphology. An advanced treatise on Meloidogyne. 2: 69-77.
- Hussey, R.S. and Barker, K.R. (1973). A comparison of methods of collecting inocula of *Meloidogyne* spp., including a new technique. Plant Disease Reporter. 57: 1025-1028.
- Jabbar, A., Javed, N., Khan, S.A. and Ali, M.A. (2015). Meloidogyne graminicola an emerging threat to rice and wheat in Punjab province in Pakistan. Pakistan Journal of Nematology. 33(2): 227-228.
- Jain, R.K., Khan, M.R. and Kumar, V. (2012). Rice root-knot nematode (*Meloidogyne graminicola*) infestation in rice. Archives of Phytopathology and Plant Protection. 45(6): 635-645.
- Jairajpuri, M.S. and Baqri, Q.H. (1991). Nematode Pests of Rice. Oxford and IBH Publication Co., New Delhi. p. 66.
- Khan, M.R., Jain, R.K., Ghule, T.M. and Pal, S. (2019). Root knot nematodes in India. A comprehensive monograph. All India Co-ordinated Research Project on Plant Parasitic Nematodes with Integrated Approach for their control. Indian Agricultural Research Institute, New Delhi, pp: 78-29.

- Kumar A., Khilari K., Kumar S.J. (2024). Efficacy of bio-agents in the management of root knot nematode (*Meloidogyne graminicola*) in basmati rice. *Agricultural Science Digest*. 44(1): 152-155. doi: 10.18805/ag.D-5326.
- MacGowan, J.B. and Langdon, K.R. (1989). Hosts of the rice root-knot nematode, *Meloidogyne graminicola*. *Nematology*. 172: 1-4.
- Narasimhamurthy, H.B. and Ravindra, H. (2016). Invasion studies and symptomatology of rice root-knot nematode, *Meloidogyne graminicola*, *Advances in Life Sciences*. 5(22): 10408-1041.
- Narasimhamurthy, H.B., Ravindra, H., Sehgal, M., Ekabote, S.D. and Ganapathi, G. (2017). Bio-management of rice root-knot nematode (*Meloidogyne graminicola*). *Journal of Entomology and Zoology Studies*. 5(4): 1433-1439.
- Narasimhamurthy, H.B., Ravindra, H., Mukesh Sehgal, R.N. and Suresha, D. (2018). Biology and life cycle of rice root-knot nematode (*Meloidogyne graminicola*). *Journal of Entomology and Zoology Studies*. 6(1): 477-479.
- Ou, S.H. (1972). Rice diseases. *Common Wealth Mycological Institute, Kew, England*. p. 368.
- Prasad, J.S., Panwar, M.S. and Rao, Y.S. (1985). Occurrence of root knot-nematode, *Meloidogyne graminicola* in semi-deep-water rice. *Current Science*. 54: 387-388.
- Prasad, J.S., Panwar, M.S. and Rao, Y.S. (1986). Screening of some rice cultivars against the root-knot nematode *Meloidogyne graminicola*. *Indian Journal of Nematology*. 16: 112-113.
- Prasad, J.S., Vijayakumar, C.H.M., Sankar, M., Varaprasad, K.S., Prasad, M.S. and Rao, Y.K. (2006). Root-knot nematode resistance in advanced backcross populations of rice developed for water stress conditions (*Oryza sativa* L.). *Nematologia Mediterranea (Italy)*. 34(1).
- Rana, R., Khilari, K., Gaje Singh, M., Jain, S., Bansal, A. and Dwivedi, A. (2016). Screening of basmati rice germplasms against rice root-knot nematode, *Meloidogyne graminicola*. *Journal of Pure and Applied Microbiology*. 10(3): 2261-2265.
- Rusique, L., Maleita, C., Abrantes, I.E.J. and Inácio, M.L. (2021). *Meloidogyne graminicola*-A threat to rice production: Review update on distribution, biology, identification and management. *Biology*. 10(11): 1163. <https://doi.org/10.3390/biology10111163>.
- Sabir, N. and Gaur, H.S. (2005). Comparison of host preferences of *Meloidogyne triticroyzae* and four Indian populations of *M. graminicola*. *International Journal of Nematology*. 15: 230-237.
- Salalia, R. (2015). Study on the diversity, ecology and biomanagement of rice root-knot nematode, *Meloidogyne graminicola* Golden and Birchfield, 1965. Ph. D. thesis submitted to CCS Haryana Agricultural University Hisar. pp 80+x.
- Singh T., Prajapati A., Maru A.K., Chaudhary R., Patel D.J. (2019). Root-knot nematodes (*Meloidogyne* spp.) infecting pomegranate: A review. *Agricultural Reviews*. 40(4): 309-313. doi: 10.18805/ag.R-1945.
- Singh N., Jat Kumar M., Singh B. (2021). Outbreak of leaf miner and root knot nematode-wilt disease complex on cucumber-A new threat under protected cultivation in District Gurugram Haryana. *Agricultural Science Digest*. 41(3): 460-463. doi: 10.18805/ag.D-5250.
- Soriano, I.R.S., Prot, J. and, Matias, D.M. (2000). Expression of tolerance for *Meloidogyne graminicola* in rice cultivars as affected by soil type and flooding. *Journal of Nematology*. 32: 309-317.
- Subudhi, H.N., Dash, S.K., Meher, J., Mohapatra, S. and Mishra, C.D. (2017). Evaluation of rice varieties for rice root knot Nematode (*Meloidogyne graminicola*). *Journal of Entomology and Zoology*. 5(5): 1213-1215.
- Sumita K., Vivekananda Y (2024). A southern root-knot nematode (*Meloidogyne incognita*) first reported on cucumber in Manipur. *Indian Journal of Agricultural Research*. 58(3): 548-550. doi: 10.18805/IJARE.A-6105.
- Vaish, S. and Pandey, S. (2012). Root-knot disease caused by *Meloidogyne graminicola*: A limiting factor for growth and yield of barley (*Hordeum vulgare* L.). *Current Nematology*. 23: 7-12.
- Yao, S.M., Huang, Y.F. and Yang, J.I. (2020). The screening of resistance against *Meloidogyne graminicola* in oats. *Agriculture*. 10(8): 352.