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**Ramesh Chand**
Department of Nematology, Narendra Deva University of Agriculture and Technology Kumarganj, Ayodhya, Uttar Pradesh, India

**Manish Kumar**
Department of Nematology, Narendra Deva University of Agriculture and Technology Kumarganj, Ayodhya, Uttar Pradesh, India

**Vipin Kumar Verma**
Department of Nematology, Narendra Deva University of Agriculture and Technology Kumarganj, Ayodhya, Uttar Pradesh, India

**Shyam Babu Gautam**
Department of Nematology, Narendra Deva University of Agriculture and Technology Kumarganj, Ayodhya, Uttar Pradesh, India

**Vinay Kumar Verma**
Department of Plant Pathology, Narendra Deva University of Agriculture and Technology Kumarganj, Ayodhya, Uttar Pradesh, India

**Correspondence**
**Ramesh Chand**
Department of Nematology, Narendra Deva University of Agriculture and Technology Kumarganj, Ayodhya, Uttar Pradesh, India

# Studies on the life cycle of *Meloidogyne graminicola* on rice and wheat crop

**Ramesh Chand, Manish Kumar, Vipin Kumar Verma, Shyam Babu Gautam and Vinay Kumar Verma**

**Abstract**
The experiment work was carried out at Narendra Deva University of agriculture and technology, Narendra Nagar (Kumarganj), Ayodhya (U.P.) during the year 2016-2017. Studies on the management of rice root-knot nematode, *Meloidogyne graminicola* revealed that the larvae of *M. graminicola* complete their life cycle within 20 days on rice plant var. Jaya and take 23 days on wheat variety PBW-154, further is also revealed that wheat varieties support less number of nematode populations as compared to the rice varieties under Studies.

**Keywords:** rice, wheat, *Meliodogyne graminicola*, life-cycle

## Introduction
Rice (*Oryza sativa* L.) is the staple food of a vast majority of the population in the East and South East Asian, African and South American countries. In addition to its direct food value, rice grain is used in manufacturing of several industrial and commercial products. The paddy is most important cereal crop in India occupying 44.48 million hectares of area with an annual production of 112.91 million tones with the productivity of 19.56 quintals per hectare during 2017-18. Rice is grown in diverse environment either as a sole crop (rainfed, irrigated or deep water) or as major component in various cropping systems. Cropping systems, involving different year specific crop sequences or fallow in a given area, create conditions of varying favorability for microbes and weeds and thus affect the flora and fauna. Since, rice cultivation cover large area in India, even a smallest pest problem would have great impact on yield and farmers' income. Soil borne diseases are becoming increasingly important in the rice-based cropping systems. One of the most important soil born pests is plant parasitic nematode in rice crop. About 300 nematode species belonging to 35 genera have been reported infesting rice. Among them, *Meloidogyne graminicola* (Golden and Birchfield) is considered as most important constraint in rice production. *Meloidogyne graminicola* reduce rice yield by more than 17% in a greenhouse experiment and the yield losses might go as high as 98% (Bridge & Plowright 1990) [2] in pot experiment under favorable conditions. To prevent further yield losses and improve productivity, it is necessary to find out the effective sustainable management strategy. Many species of *Meloidogyne* have been reported by various scientists throughout world. *M. graminicola* is reported as an important nematode pest of rice from countries like South East Asia, Burma, Bangladesh, Laos, Thailand, Vietnam, India, China, Philippines, Nepal and USA. *Meloidogyne oryzae* an another species of this genus is also reported on irrigated rice from Surinam and *M. incognita* is reported from Costa Rica, Cuba, Egypt, Ivory Coast, Nigeria, South Africa and Japan, *M. javanica* in Brazil, Egypt, Comoro Islands, Nigeria and Ivory Coast. Apart from this *M. arenaria is reported from* Nigeria, Egypt and South Africa and *M. salasi* in Costa Rica and Panama on upland rice.

The root-knot nematode is making its importance felt in almost all the rice growing areas. *M. triticoryzae* infecting rice including some monocot weeds is also reported from India Upadhyay V., (2014) [8] and its occurrence is restricted to a few areas. In India, *M. graminicola* is the dominant species infecting rice. *M. graminicola* has been found infecting rice in different parts of India namely, Assam, Andhra Pradesh, Karnataka, West Bengal, Orissa, Kerala, Tripura and Madhya Pradesh. *M. graminicola* is a serious pest of upland rice Panwar & Rao (1998) [5, 10] and nurseries world over in well drained soils. The nematode was reported on irrigated rice in Andhra Pradesh and Karnataka. The nematode can infect and multiply on semi-deep or deepwater rice also. *Meloidogyne graminicola* described by Golden and

Birchfield cause root-knot disease on rice. The monitoring of nematode movement around host roots is easy due to the excellent transparency of the gel (Wang *et al*., (2009a) [9].

**Materials and Methods**

An experiment was conduct on life cycle of rice root knot nematode, *Meloidogyne graminicola* at experimental field of department of nematode N.D. University of Agriculture and Technology, Kumarganj, Ayodhya during 15th August to 15th Sept., 201(rice) and 15th October to 15th November, 2015 (wheat). The temperature during experimentation prevailed between 25 to 32˚c(aug.- sept.) and 15 to 20˚c (octo.- nov.). The observation was recorded on each day from 2nd to 26th day of the seed germination of rice and wheat in earthen pots. The experiment was prepared in pots containing infected soil of rice root knot nematode, *M. graminicola*, 3 larvae/g soil. Whereas the susceptible variety of rice Jaya and wheat PBW154 were sown in pots. The observation were record on life cycle J2, J3, J4 adult and egg population of *M. graminicola* at each day starting from second day.

**Collection and storage of soil and root samples**

The soil and root samples were collected randomly from root zone (15 cm depth) of rice crop infected with root -knot nematode with the help of auger and kept in polythene bags. The bags were sealed with rubber bands and brought carefully to the laboratory.

**Extraction of nematode from soil samples**

The soil samples were processed using Cobb's sieving and decanting technique (Southey, 1986) [6]. The soil sample was put in large bucket containing water and stirred until all of the clods were broken. When heavy soil particles setteled at the bottom, nematode suspension was poured through the coarse sieve of 16 mesh, leaving the heavy particles in the bucket. The whole aliquot was then passed through 60, 100, 200 and 350 mesh sieves. The suspension was collected in a beaker and poured over wire gauge fitted with double layer tissue paper. The wire gauge was kept on Baermann's funnel and the suspension was poured over it until it touched the tissue paper. The nematode suspension was collected next day by opening the clip. The nematodes thus collected in the suspension was taken in a counting dish to count the nematodes under stereoscopic microscope.

**Morphometric measurement**

The second stage juvenile ($J_2$) and eggs were obtained by blending galled root segments in 1% sodium hypochlorite solution for 1-3 min and rinsing them several times with tap water. The eggs were allowed to hatch in tap water for 48 hr., Juveniles were picked randomly, placed in a drop of water on a glass slide, killed by gentle heat and covered with a glass cover slip. Thirty to five J2 were selected from each sample and measured. Measurements included body length and width, stylet length, tail length and length from the anterior end to the end of the esophagus. The A value (body length/maximum body width), B value (body length/esophagus length) and C value (body length/tail length) were calculated for each individual.

**Preparation of Perineal pattern of *M. graminicola***

Identification of rice root-knot nematode was carried out following Taylor and Sasser's (1978) [7] technique. The mature females were picked up from galled roots of rice and placed on a glass slide in a drop of water. The posterior end was cut with a sharp razor blade and cleaned. The glass slide with the female end (cut side down) was covered with a cover slip and sealed. Ten female perineal patterns were analyzed per isolate. Each was examined under a compound microscope.

**Staining of root**

After 2 minutes the roots were removed from warm acid fuchsine solution and rinsed into water to wash out the excess of stain if any. The stained roots were transferred in lacto-phenol solution for further studies. Adult female nematodes from roots were obtained by teasing them with the help of dissecting needles under stereoscopic microscope. Adult females were transferred in a drop of lacto-phenol taken on glass slide and the posterior end of the nematodes (perineal pattern) was cut with the help of sharp razor blade. These perineal patterns were transferred over other slide in a drop of lacto- phenol, covered with glass cover and the perineal pattern was examined under compound research microscope.

**Counting of galls**

For determining the number of galls, the root system of plant was carefully removed after expiry of the experimental period and washed free of soil. The total numbers of galls present on the roots were counted under a stereoscopic binocular microscope.

**Result and Discussion**

The life cycle of *Meloidogyne graminicola* on rice was studied on var. jaya in sandy loam garden soil of N.D university of Agriculture and Technology, Kumarganj, Faizabad during 15th August to 15th Sept., 2015. The temperature during experimentation prevailed between 25 to 32˚c. The observation was recorded on each day from 2nd to 26th day of the transplanting of Sarju-52 in earthen pots. The data revealed that $J_2$ started penetrating the plant root system from 2nd day of the seed germination. The number of larvae penetrated the roots were 2.00, 5.00, 19.00, 37.00, 16 and 2.50 on 2nd, 3rd, 4th, 5th, 6th and 7th day. $J_3$ stage in the root appeared on the 4th day $J_4$ on the 6th, eggs on the 18th and the hatched out $J_2$ appeared on the 19th day of seed germination.

The life cycle of *Meloidogyne graminicola* on wheat was studied on var. PBW-154 in sandy loam garden soil of N.D university of Agriculture and Technology, Kumarganj, Faizabad during 15th October to 15th November, 2015. The temperature during experimentation prevailed between 15 to 20˚c. The observation was recorded on each day from 2nd to 26th day of the seed germination of PBW-154 in earthen pots. The data revealed that J2 started penetrating the plant root system from 2nd day of the seed germination. The number of larvae penetrated the roots were 2.00, 5.00, 19.00, 37.00, 16 and 2.50 on 2nd, 3rd, 4th, 5th, 6th and 7th day. $J_3$ stage in the root appeared on the 6th day J4 on the 8th, eggs on the 28th and the hatched out J2 appeared on the 21st day of seed germination. The recorded observations showed that the *M. graminicola* nematode completed its life cycle in 21 days at 26-35˚C temperature and 57-91 % relative humidity in rice. Whereas present observation indicates nematode complete its life cycle in same days 21 at 10-20$^0$C temperature and 70 % relative humidity in wheat. These results are in confirmation of the Bridge *et al*., (1990) [2] results, who reported that this nematode completed its life cycle within 19 days at an ambient temperature of 22-29˚C. They further noted that the generation time of *M. graminicola* could be as little as 13 days, however, at an ambient temperature of 25-35˚C. Khan and Shahid (2012) [4] also reported that females lay eggs in 20

days after inoculation of J2 of *Meloidogyne graminicola.* whereas Jain *et al.,* (2013) reported that *M graminicola* had a very short life cycle (less than 3 weeks at 22-29°C) However, there were considerable amount of variations in length of life cycle of this nematode which ranged from 19 days (Bridge and Page 1982) [1] to 51 days in Indian rice fields depending on the season of the year (Rao *et al.* 1988) [5, 10]. These deviations could be due to population variations, hosts and environmental factors influencing biology of the nematode.

**Statistical analysis of data**

The experiments were carried out in completed randomized block design with four replications of each treatment. The variance of each mean value was analyzed at five percent confidence limit.

**Table 1:** Life cycle of *Meloidogyne graminicola* on rice variety Jaya. (Observations are the mean four replications)

| Nematode stages | Days after sowing of rice var. Jaya | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |
| J2 | - | 2.5 | 5.00 | 18.50 | 36.00 | 15.00 | 3.00 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| J3 | - | - | - | 1.75 | 9.75 | 15.75 | 25.00 | 34.50 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| J4 | - | - | - | - | - | 3.00 | 10.25 | 18.25 | 32.75 | 42.75 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Mature females | - | - | - | - | - | - | - | - | 2.50 | 7.00 | 15.50 | 28.25 | 33.50 | 38.25 | 40.00 | 36.75 | - | - | - | - | - | - | - | - | - |
| Male | - | - | - | - | - | - | - | - | - | - | - | 3.25 | 7.00 | 11.50 | 10.00 | 12.50 | 9.00 | 8.00 | 11.00 | 7.25 | 11.75 | 7.75 | 10.50 | 11.00 | 10.50 |
| Eggs/plant | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0.50 | 1.75 | 3.75 | 6.50 | 5.00 | 2.25 | 1.25 | 1.00 |
| J2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1.00 | 4.00 | 5.25 | 6.25 | 8.75 | 9.50 |

*egg in hundred

**Table 2:** Life cycle of *Meloidogyne graminicola* on wheat PBW-154. (Observations are the mean four replications)

| Nematode stages | Days after sowing on wheat PBW-154 | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 |
| J2 | - | **1.0** | **2.5** | **13.50** | **19.00** | **12.00** | **1.50** | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| J3 | - | - | - | 1.00 | 4.50 | 8.50 | 12.50 | 19.25 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | |
| J4 | - | - | - | - | - | 1.5 | 7.75 | 10.25 | 19.72 | 20.25 | - | - | - | - | - | - | - | - | - | - | - | - | | - | - | - | - |
| Mature females | - | - | - | - | - | - | - | - | 1.75 | 4.00 | 10.25 | 17.25 | 19.50 | 25.75 | 21.75 | - | - | - | - | - | - | - | - | - | - | - | |
| Male | - | - | - | - | - | - | - | - | - | - | - | 2.5 | 5.50 | 6.75 | 7.00 | 8.00 | 8.25 | 7.25 | 8.5 | 4.25 | 8.25 | 6.00 | 7.5 | 8.00 | 8.50 | - | - |
| Eggs/plant | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1.00 | 1.50 | 2.00 | 5.50 | 3.00 | 2.00 | 1.50 | 1.00 | - | - |
| J2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1.00 | 2.00 | 3.25 | 4.00 | 5.50 | 5.75 |

*egg in hundred

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