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Infestation of Rice Root-Knot Nematode in Rice Nurseries in Chitwan

N. K. Dangal[1], S. M. Shrestha[2], D. Sharma-Poudyal[3] and C. Adhikari[4]
[1]*Dabur Nepal Pvt. Ltd., Kathmandu, Nepal*
[2]*Institute of Agriculture and Animal Science, Rampur, Chitwan, Nepal*
[3]*Department of Plant Pathology, Washington State University, Pullman, WA, USA*
[4]*CIMMYT-SARO, Singha Durbar Plaza, Kathmandu, Nepal*
e-mail: nabindgl@yahoo.com

Abstract

A survey was conducted during June-July 2006 in Chitwan to find out the natural infestation of rice root-knot nematode (*Meloidogyne graminicola* Golden & Brichfield) in rice nurseries. Thirty nurseries were surveyed and 100 seedlings from each nursery were evaluated. Field survey revealed that *M. graminicola* was widely distributed in most rice growing areas of Chitwan District. Rice root-knot disease was more prevalent in dry bed condition than wet bed. Most of the farmers grew seedlings in upland (dry) soil and there was more rice root-knot disease and second stage juvenile (J2) population in both nursery soil and seedling root. The galled (diseased) seedlings had significantly shorter roots and shoots. Most of the farmers did not know about the nematode problem and did not follow any management practices to control it in nurseries and/or in the main field. This indicated high risk of multiplication of the nematodes and huge loss in rice production. Thus, it is essential to manage *M. graminicola* in rice nurseries in order to produce healthy seedlings.

Key words: dry bed, lowland, *Meloidogyne graminicola,* upland, wet bed

Introduction

Rice (*Oryza sativa* L.) is the first leading cereal of Nepal representing about 25% of total cultivated area and about 28% of total cereal production (NARC 2001). It is the most preferred staple food in Nepal and mainstay for the food security of rural population. The crop is grown in all agro-ecological zones like Terai (100-300 masl), valleys, foot hills (300-1000 masl) and high hills up to 2600 masl (Dhital *et al.* 1995).

The major constraints in rice production are plant diseases and insects; nutrient deficiency; mid and late season water stress; water management, and weeds for direct seeded rice (Kataki *et al.* 2001). Kataki (2001) reported that pests and diseases were paramount problem in rice. Among the foliar diseases, blast, bacterial blight, and sheath blight are considered as the important ones (Dahal *et al.* 1995) whereas the soil borne diseases specially diseases caused by plant parasitic nematodes (PPNs) are major bottlenecks to crop productivity in the high input intensive cropping systems such as the rice and wheat based cropping systems (Sharma & Rahaman 1998).

More than 200 species of PPNs have been reported to be associated with rice (Prot 1994). Rice root-knot nematodes (*Meloidogyne* spp.), rice root nematode (*Hirschmanniella oryzae*), white tip nematode (*Aphlenchoides besseyi*) and stem nematode (*Ditylenchus angustus*) are the important PPNs associated with rice based cropping systems (Sharma & Rahaman 1998). Among them, the rice root-knot nematodes (*Meloidogyne* sp.) are considered as the major problem in rainfed, upland and lowland rice fields whereas the rice root nematodes (*Hirchmanniella* sp.) are problematic on low land rice growing areas of South and Southeast Asia (Prot 1994). Among *Meloidogyne* sp., the rice root-knot nematode (*M. graminicola* Golden and Birchfield) attacking rice and wheat, is considered the most serious nematode in upland rice cultivation (Panwar & Rao 1998) and causes economic losses in upland, lowland, and deep water rice and also in rice nurseries (Bridge *et al.* 1990). This pest has been reported from the main rice growing areas of Nepal (Pokhrel 2001, Pokharel and Sharma-Poudyal 2001, Sharma *et al.* 2001, Sharma-Poudyal *et al.* 2002, Dangal *et al.* 2008). Pokharel and Sharma-Poudyal (2001) observed high population levels of *M. graminicola* in farmers' rice fields in Chitwan, Rupendehi, Bara, Parsa, and Rautahat districts of Nepal. Furthermore, Sharma *et al.* (2002) also reported rice root-knot nematode in both rice and wheat fields under rice-wheat system from Bara, Parsa and Rauthat districts. Recently Pokharel (2007) reported that *M. graminicola* was the only root-knot nematode identified from 33 rice-wheat fields representing diverse rice growing areas from the hills to Terai in Nepal.

Soriano *et al.* (2000) reported that rice cultivar tolerance to *M. graminicola* varied with water regime. Similarly, adaptability of *M. graminicola* in different physiographic regions further aggravates the disease situation in Nepal (Pokharel 2007). However, detail information on the biology of root-knot nematode in rice field as well as its sustainable management are limited in Nepal (Pokharel 2007). Since, most of the commonly grown Nepalese rice cultivars are susceptible to *M. graminicola* (Sharma-Poudyal *et al.* 2004, Pokharel 2007), there may be rice yield loss in every *M. graminicola* infested nursery and field. Hence there is an urgent need of practical nematode management options for the farmers of Nepal. Thus, this study was conducted to study the level of infestation of *M. graminicola* in rice nurseries in Chitwan district.

Materials and Methods

A survey was conducted during June-July 2006 in eastern (Khairahani and Chainpur V.D.C.) and western (Patihani, Shivanagar, Gunjanagar, Sukranagar, Parsadhap, Meghauli, Divyanagar, Bhimnagar and Saradanagar V.D.C.) parts of Chitwan district to find out the natural infestation of *M. graminicola* in rice nurseries. Information on cropping history, type of soil, seeding methods, rice varieties, date of seeding, type of seed bed, seed and soil treatment etc were gathered from 30 fields. Plants were sampled from 10 spots in 'M' fashion from each nursery. From each spot, 10 plants were gently uprooted and washed with running tap water to remove soil and other materials. Root length, shoot length, fresh root and shoot weight were recorded. *M. graminicola* second juveniles (J2) present in root and soil were also assessed. The cleaned roots were indexed for root lesion indexing with the help of the following 0-4 scale according to Sharma-Poudyal *et al.* (2002):

0 = Healthy roots, without lesion,
1 = Lesion up to 25% of roots or 25% roots rotten,
2 = Lesion up to 50% of roots or 50% roots rotten,
3 = Lesion up to 75% of roots or 75% roots rotten and
4 = Lesion more than 75% of roots or more than 75% roots rotten.

The roots were also indexed for root-knot indexing by the use of 0 (no root swellings or galls) to 10 (all roots galled) scale according to Bridge *et al.* (2005). Root-knot severity index and root lesion severity index were calculated as follows:

$$\text{Severity index} = \frac{\text{Sum of all numerical ratings}}{\text{Total number of ratings} \times \text{Maximum grade}} \times 100$$

The rice roots were thoroughly washed and chopped into small pieces of about 10 mm length for extracting *M. graminicola* second juveniles (J2). About 2 g of chopped roots were placed in an electric blender with 100 ml of water, blended for 2 minutes and placed in a modified Baermann tray for extraction (Schindler 1961). Similarly, for extracting J2 nematodes from the rhizosphere soil, it was homogenized and 100 g working sample was taken and processed by modified Baermann tray method (Schindler 1961). After 48 hours of processing, nematode suspension was collected in plastic tubes (50 ml). After allowing standing for an hour, the final volume of suspension was reduced to 20 ml with the help of a glass pipette. Two milliliter (10%) aliquot was sampled from the 20 ml suspension in counting disc, allowed to settle for five minutes. J2 were counted under a binocular microscope (Bridge *et al.* 2000).

Nematode counts were transformed in logs ($x + 1$) for statistical analysis (Gomez & Gomez 1984). Microsoft Excel was used to conduct the analyses.

Results

The survey data indicated that majority of the farmers (53%) grew rice seedlings in fallow land and 20% of them grew after maize harvest. Others grew after linseed, sesame, kidney bean, cucumber, potato, tomato and onion (3.33% each). 'Mansuli' was the dominant variety of rice (36.6%) cultivated in the survey sites which was followed by 'Sabitri' (23.3%). Other varieties were Barkhe 2001, Butche, Jhapali, Radha 4, Basmati, Loknath, OR and Sona Mansuli. None of the farmers used chemicals for seed and soil treatment, except one farmer, who treated seeds with Thiodan (an insecticide). Both shoot and root lengths were significantly higher in non-galled seedlings than galled seedlings (Figure 1). Galling of seedlings varied from 0 to 86% in different nurseries. Root-knot severity index and root lesion severity index were up to 19.9% and 55% respectively. Number of second stage juveniles (J2) recovered from 2g root and 100g soil were up to 33 and 37 respectively.

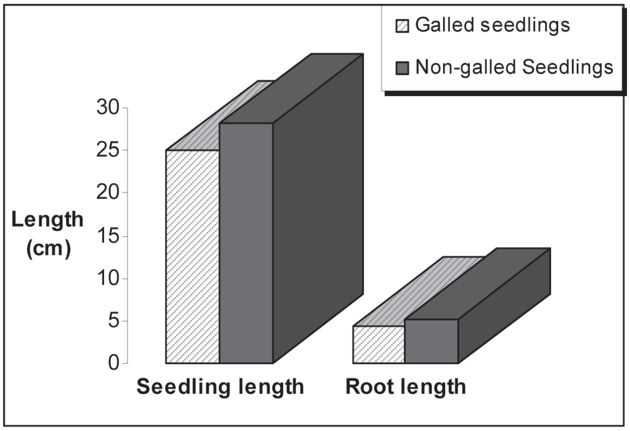

Fig. 1. Comparison of seedling and root length between galled and non-galled seedlings

Table 1. Comparison of population of *M. graminicola* (J2) and development of rice root-knot disease between upland and lowland

S.N.	Parameters	Upland	Lowland
1	J2 in Root	12.26	0
2	J2 in soil	13.39	0
3	Root galling percentage	26.03	0
4	Root knot severity index	4.66	0
5	Root lesion severity index	31.12	47.50

Table 2. Comparison of population of *M. graminicola* (J2) and development of rice root-knot disease between dry and wet seedbed

S.N.	Parameters	Dry bed	Wet bed
1	J2 in Root	15.78	1.04
2	J2 in soil	16.32	3.65
3	Root Galling Percentage	33.73	1.63
4	Root knot severity index	6.06	0.24
5	Root lesion severity index	27.39	43.44

Twenty nine farmers (96.67%) grew seedlings in upland condition and only one in lowland. Under upland seedbed, approximately 26% seedlings were galled with the root-knot severity index of 4.66% and average number of *M. graminicola* J2 extracted form 2g root and 100g soil were 12 and 13 respectively (Table 1). However, there were no root-knots, J2 in soil and root under lowland seedbed but root lesion severity index was higher (47.5%) than under upland seedbed (31.12%)**.** Approximately 73% farmers grew seedlings in dry bed and rest in wet bed. Percentage of galled seedling, root-knot severity index and number of J2 recovered from 2g root and 100g soil were significantly lower in wet bed than dry bed (Table 2). However, root lesion severity index was higher in wet bed (43.44%) than in dry bed (27.39%)**.**

Discussion

Seedlings infected with *M. graminicola* grew slowly (Bridge & Page 1982) because of root damage. As a result, galled seedlings had lower plant height and shorter roots. Since wet bed was kept in saturated condition by frequent irrigation, rice roots might escape invasion by *M. graminicola* (Bridge & Page 1982) and/ or limited the spread of the nematode (Prot & Matias 1995). Due to lower infection under wet bed condition, plant height, root length and root weight were increased but root-knot index and J2 number in root and soil were lower as compared to dry bed condition which was favorable for infection and development of *M. graminicola*. Similarly, under upland condition *M. graminicola* was able to infest most of the roots and resulted in drastic reduction in root development and consequential reductions in shoot growth (Prot & Matias 1995). More damage from *M. graminicola* occurred in the aerobic upland systems (Soriano & Reversat 2003). However, under lowland (continuous flooding), rice roots might escape invasion by *M. graminicola* (Bridge & Page 1982) and limited the spread of the nematode (Prot & Matias 1995). Permanent flooding might limit the migration of J2 between roots of the same system (Bridge & Page 1982) resulting in a lower root damage. Reduced aeration due to high moisture levels for prolonged periods allowed poor respiration and movement of nematodes and reduced the population of *M. graminicola* (Garg *et al.* 1995). In addition to direct effects on the nematode, continuous flooding in lowland might increase tolerance of the rice seedlings towards *M. graminicola* (Soriano *et al.* 2000). Because of the lower infection and better plant health, plant height and root length were increased but root-knot index, root lesion index and J2 number in root and soil were decreased significantly in seedbed under lowland than under upland. Higher root lesion severity index observed in both lowland and wet bed may be due to the presence of other nematodes including *Hirchmanniella* sp.

Most of the farmers did not know about the nematode problem and did not follow any management practices to control it in nurseries and/or in the main field. So, there is high risk of multiplication of the nematodes which may cause huge loss in rice production. Thus, it is essential to manage *M. graminicola* from rice nurseries in order to produce healthy seedlings.

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