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Management of rice root-knot nematode, *Meloidogyne graminicola* in rice (*Oryza sativa*)

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ABSTRACT

A field experiment was conducted during *kharif* season of 2010-12 to study the effect of soil solarization, carbofuran 3G and biocontrol agent *Pseudomonas fluorescens* on growth of rice (*Oryza sativa* L.) seedlings and rice root-knot nematode, *Meloidogyne graminicola*. Combined application of solarization (15 days) either with carbofuran 3G @ 1 kg a.i./ha or *P. fluorescens* @1% WP @ 50g/sq.m, increased the seedling growth up to 30 day after sowing and reduced the number of galls and eggs per egg mass at 24 day after sowing. Therefore, 24 day old seedlings were preferred for transplanting in the main field. We proposed soil application of carbofuran 3G @ 1 kg a.i./ha (3.3 g/m^2) before laying nursery. Thus, this intervention was propagated among the farmers of 4 villages (Nekpur, Salempur Jat, Shahpura, Java) with the help of IARI adopted centre (under out reach programme) at Nekpur village, Bulandshahr district of Uttar Pradesh.

Key words: Carbofuran 3G, *Meloidogyne graminicola, Pseudomonas fluorescens,* Rice root-knot nematode, Solarization

Root nematodes, *Meloidogyne* spp have been reported infecting rice crop worldwide. *M. graminicola* Golden and Birchfield is a serious pest of upland rice and nurseries world over in well-drained soils (Rao *et al*. 1986, Prasad *et al*. 1987). The nematode was also recorded to infest deepwater rice and transplanted rice (Bridge and Page 1985, Prasad *et al*. 1990, Sharma and Prasad 1995). Pockets of heavy infestation of rice nurseries and transplanted crop have been noticed in north-Indian plain zones including Jammu, Punjab, Himachal Pradesh, Haryana, Delhi and Uttar Pradesh (Gaur *et al*. 1993b, Pankaj *et al*. 2006). These infestations are relatively more frequent in fields under rice-wheat cropping system. With conducive soil and agro-climatic conditions and continuous rice-wheat cropping systems without precautions, there is a strong possibility of the increase in distribution and disease intensity in this region.

More than 200 species of PPNs have been reported to be associated with rice (Prot 1994). 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 (*Hirschmanniella* sp.) are problematic on low land rice growing areas of South and Southeast Asia (Prot 1994). Among *Meloidogyne* sp., the rice root-knot nematode attacking rice and wheat, is considered the most serious nematode in upland rice cultivation (Panwar and Rao 1998) and causes economic losses in upland, lowland, and deep water rice and also in rice nurseries (Bridge *et al.* 1990).

The rice root-knot nematode, *M. graminicola* is being one of the major nematode pests in rice-wheat cropping system. Management of this nematode at nursery stage is need of an hour, as the infected seedlings are the major cause of the nematode spread in unifestaed areas. Thus, an investigation was conducted to manage rice root-knot nematode, *M. graminicola* infecting rice cv. Pusa 1121 at nursery stage.

MATERIALS AND METHODS

An experiment was carried out at IARI, New Delhi field during *kharif* season of 2010-11 and 2011-12. The farm is located at 28.08 °N and 77.12 °E, the height above mean sea level being 228.61 m. The field was naturally infested with rice root-knot nematode, *M. graminicola* with an initial population of 182 to 210 J2s per cc soil. Small plots of size 2 m^2 were prepared by pulverizing the soil and mixing thoroughly with the recommended dose of fertilizer. Following treatments were applied in different plots under net house: T1: Solarization for 15 D, T2: Solarization (15 D) + Carbofuran 1 kg a.i./ha, T3: Carbofuran 1 kg a.i./ha; T4: *Pseudomonas fluorescens* 1% WP @ 50g/sq.m: T5: Solarization (15 D) + *P. fluorescens* 1% WP @ 50g/sq m and T6: Control. All the treatments including control were replicated 4 times in randomized block design.

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For effective solarization the land was thoroughly cultivated and leveled to minimize clods. The plots with solarization were irrigated to 50% of its WHC one day prior to spreading of sheet. Solarization was carried out by covering the soil with 100µm thick polythene sheet (size 2.5 × 1.5 m^2) for 15 days during the hot summers (average 41.3°C). The sides of the sheet were buried in the soil. Carbofuran 3G @ 1 kg a.i./ha (3.3 g/m^2) was mixed thoroughly with soil and uniformly distributed. Whereas, *P. fluorescens* (procured from IIHR, Bangalore) was applied along with FYM.

Seeds of rice cv. Pusa 1121 (procured from Division of Genetics, IARI) were surface sterilized with 0.1% Hg_2Cl_2, washed in fresh water and shade dried for 24 hr. The seeds were sown by broadcast method (farmer practice) and small quantity of soil was spread over uniformly so that the seeds get buried. The experiment was irrigated to keep the seeds as well as soil moist.

Observations on seedling growth (height), and number of galls were recorded at 6, 12, 18, 24 and 30 days of sowing. However, number of eggs/egg mass was recorded after 30 DAS. Shoot length in cm of randomly selected five plants per plot was measured with the help of small scale and average per plot was taken. Those plants were uprooted and washed under the tap water and the number of galls was counted through hand lens. The roots were cut and teased open after 30 DAS for all the treatments and the number of eggs/egg mass were counted under the stereoscopic binocular microscope. Three-1-ml aliquots of the egg suspension were observed under a stereo-microscope and eggs were counted. Weather conditions during the crop growth period were recorded.

The experiment was conducted according to a randomized block design (RBD) and each treatments was replicated four times. Analysis of variance was performed for all data and the different treatment means were compared with Duncan's multiple range tests.

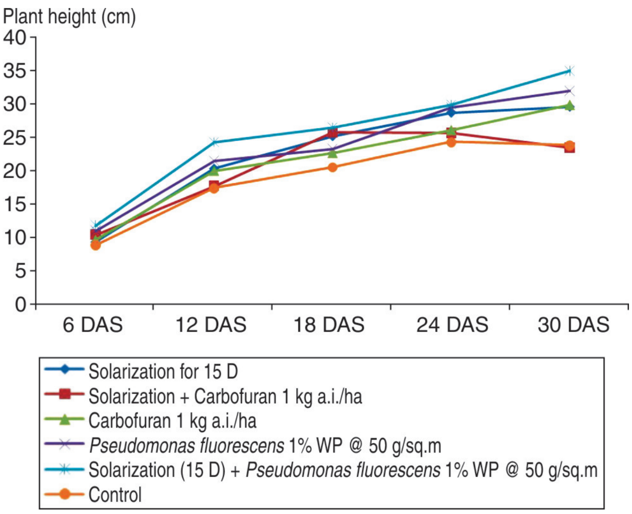


Fig 1 Effect of different treatments on rice seedling growth in nursery bed

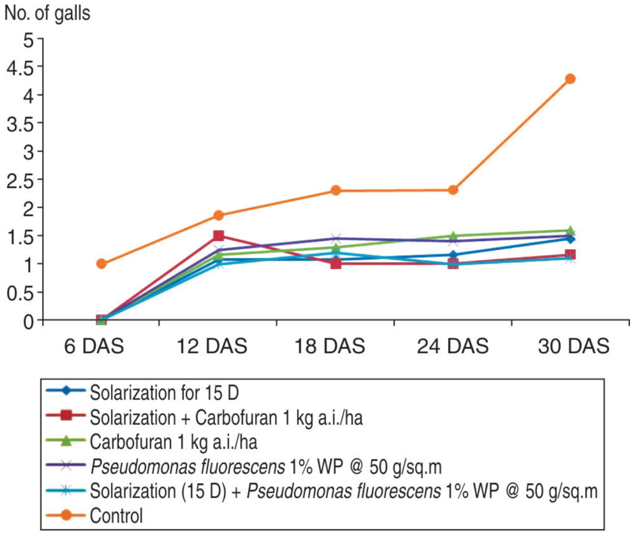


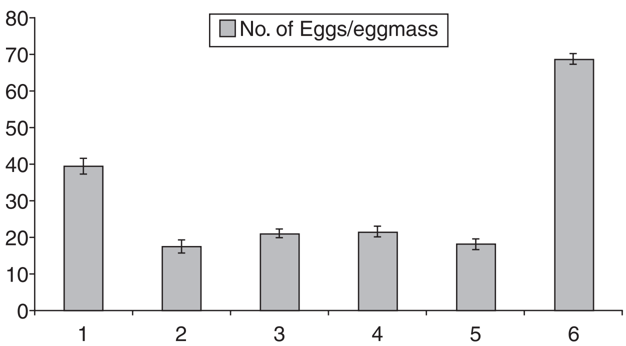
Fig 2 Effect of different treatments on number of galls in rice infected with *Meloidogyne graminicola* in nursery bed

RESULTS AND DISCUSSION

It was observed (Fig 1) that there was significant increase in growth of rice seedlings till 24 DAS, which showed decreasing trend in solarized + carbofuran @ 1 kg a.i./ha as well as untreated beds (control).

In general, all the treatments reduced the number of galls compared to control (Fig 2). Small galls (1 or 2) were observed just after 6 DAS on the infected roots of seedlings. This showed that the infection of *M. graminicola* is immediately triggered and the nematode penetrates and formed the galls within 6 DAS. The number of galls increased with increase in the time interval in control beds till 30 DAS irrespective of treatment. However, there was increase in the number of galls on the roots of rice seedling of solarized beds and treated with carbofuran, this was because of the added effect of solarization (Hossain *et al*. 2007).

There was also a reduction in the average number of



1: Solarization for 15 D, 2: Solarization + Carbofuran 1 kg a.i./ha, 3: Carbofuran 1 kg a.i./ha, 4: *Pseudomonas fluorescens* 1% WP @ 50g/sq.m, 5: Solarization (15 D) + *Pseudomonas fluorescens* 1% WP @ 50g/sq.m, 6: Control

Fig 3 Effect of different treatments on number of eggs/eggmass in rice infected with *Meloidogyne graminicola* in nursery bed eggs produced in each egg mass, which ranged from 42.6 to 74.4%. Maximum reduction in the no. of eggs were observed in solarized bed applied with carbofuran (74.4%) and *P. fluorescens* 1% WP @ 50g/sq.m (73.7%) compared to control and were found significantly at par with each other. Though the reduction was also observed with the individual application of carbofuran (69.3%) and *P. fluorescens* (68.5%) but were significantly less compared to when applied in solarized beds. Thus, the reduction in fecundity of *M. graminicola* was more pronounced with solarization (Hossain *et al*. 2007, Gaur,1994, Ganguly *et al*. 1996).

The field experiments on the control of root-knot nematode, *M. graminicola* in the nursery beds for rice using soil solarization and nematicides have clearly shown that reduction in nematode population levels achieved by this methods resulted in significantly improved health of the rice seedlings. It was observed that better control could be achieved if a small amount of carbofuran is applied at the time of sowing in the pre-solarized nursery beds. Solarization of nursery beds has earlier been found effective for the rice nursery beds by Gaur (1994) and Ganguly *et al*. (1996). Soil solarization has also been effective against several other nematodes in many different crops (Katan 1981, Gaur and Perry 1991, Stapleton and De Vay 1986, Braun *et al.* 1987). During *kharif* season, summers in the rice growing areas are generally hot. Therefore, solarization before sowing seed of rice in the nursery-beds may be a feasible practice. The effective of solarization depends on its duration and the duration depends on the light intensity and day length. Solarization is most effective when done in June and July, however depending on the geographical location it can be effective in May, August and September.

The population of the root-knot nematode, *M. graminicola* was significantly lower in rice roots treated with *P. fluorescens*. There was 46% reduction in the nematode population 12 days after sowing in the *P. fluorescens* treated plants. Earlier reports have proved the effectiveness of *P. fluorescens* in suppression of economically important plant diseases and plant parasitic nematodes (Muthulakshmi *et al.* 2010, Deepa *et al*. 2011). Significant reduction in root and soil population of the rice root nematode, *H. gracilis* was obtained with *P. fluorescens*. Another important species of rice root nematode, *H. oryzae* was also successfully managed by the application of *P. fluorescens*. The suppression of phytonematodes by the application of *P. fluorescens* has been attributed to several mechanisms, such as induced systemic resistance, production of antibiotics and siderophores, competition for nutrients, and alteration of specific root exudates such as polysaccharides and amino acids, which modify nematode behavior (Oostendorp and Sikora 1990, Aalten *et al.* 1998).

The rice root-knot nematode, *Meloidogyne graminicola* has become a major problem under rice-wheat crop rotation and is spreading in the Indo-Gangetic plains. This nematode was first recorded during 2009-10 in Bulandshahr district of Uttar Pradesh, causing an average yield loss of 20-25% and in some cases to the tune of 50-60%. The disease can assume epidemic proportion causing extensive damage to the crop. During the systematic survey it was found that this nematode spread through the use of infested nursery seedlings. We proposed soil application of carbofuran 3G @ 1 kg a.i./ha (3.3 g/m^2) before laying nursery. Thus, this intervention was propagated among the farmers of 4 villages (Nekpur, Salempur Jat, Shahpura, Java) with the help of IARI adopted centre (under out reach programme) at Nekpur village, Bulandshahr district of Uttar Pradesh.

Within a span of 3 years the technology has quickly diffused to neighbours as well as friends and relatives of the early adopted farmers. During this period the incidence of root-knot disease in rice has come down to 10% with improved yield of basmati rice by 10-15% . The farmers were benefited and earned ₹ 4 400 per acre with the application of just 500 g of carbofuran 3G applied in the nursery bed @ 3.3 g/m^2. Therefore, incurring Rs. 36 for carbofuran he earned ₹ 4 400.

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