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Effect of different inoculum levels of *Meloidogyne graminicola* Golden and Birchfield on growth and biochemical parameters of rice (*Oryza sativa* L.)

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ABSTRACT: The experiment was carried out to study the effect of *Meloidogyne graminicola* on growth and biochemical parameters of rice, *Oryza sativa* cv. Uma under green house conditions by inoculating with different inoculum levels *i.e.*, 0 (uninoculated), 100, 500, 1000, 5000 and 10,000 second stage juveniles per pot. With the increase in inoculum levels of *M. graminicola*, there was a progressive decrease in growth and biochemical characters of the crop. Significant reduction in plant height, fresh weight of plant, dry weight of shoot and root, chlorophyll, protein and starch content of grain at 500 J_2. Beyond this level the damage is stagnating and even at 20 times higher level the plant survives till maturity. © 2015 Association for Advancement of Entomology

KEYWORDS: *Oryza sativa*, *Meloidogyne graminicola*, rice root knot nematode, chlorophyll, protein, starch

INTRODUCTION

Rice is the world's most important staple food and is cultivated in around 162 mha with an annual global production of 464 mmt (FAOSTAT, 2013). About 53% of the world's rice is grown under irrigated conditions that provide 75% of total global production (Bridge *et al.*, 2005). Root knot nematode is an important nematode pest of rice viz. *M. graminicola, M. oryzae, M. javanica*, and *M. arenaria* (Gaur and Pankaj, 2010). Among these species, *M. graminicola* is a primary pest of rice and poses a substantial threat to rice cultivation (Dutta *et al.*, 2012). The incidence of root knot nematode, *M. graminicola* in seedling stage and active tillering stages of rice was reported from Kerala (Sheela *et al.*, 2005). The changes in growth and biochemical parameters of rice with different inoculum levels of root knot nematode were studied through a pot culture experiment.

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MATERIALS AND METHODS

The experiments were conducted at College of Agriculture, Vellayani during 2014-2015. Each treatment was replicated five times and the pots were arrainged in complete randomized block design (CRD). Uninoculated set of plants served as control. Pure culture of *M. graminicola* was raised from egg masses collected from infested rice roots and multiplied on rice plants maintained in sterilized soil. Subculturing was done periodically to ensure availability of sufficient larval population for inoculation following standard procedures.

Seeds of rice were surface sterilized with 0.1 per cent mercuric chloride and soaked overnight for sprouting. The sprouted seeds were sown in pots filled with steam sterilized soil. Seven days after sowing, seedlings were inoculated with freshly hatched juveniles at the rate of 0, 100, 500, 1000, 5000 and 10,000 J_2 per pot through the holes around the plant within a radius of two centimeters and plugged with the sterilized soil soon after inoculation. To maintain soil moisture in the pot, regular watering was done. Each treatment was replicated five times and the pots were arranged in CRD. Two such lots were setup one lot for 45th day observation and another at maturity.

Forty five days after inoculation, the biometric characters *viz*. plant height, fresh plant weight, dry weight of shoot and root and total chlorophyll content (mg/ g leaf) were estimated from the first set of pots. Protein and starch content of grain (per cent) were estimated from plants in second lot of pots. Chlorophyll was estimated by the method of MacKinney (1941), protein content by Folin- phenol method of Lowry *et al*., (1951) and starch content by Anthron method (Sadasivam and Manickam, 2008). The data were subjected to analysis of variance.

RESULTS AND DISCUSSION

Lowest level of nematode population (100 J_2/ pot) caused significant reduction in plant height (51.46 cm) compared to control (56.52 cm). In next level (500 J_2/ pot) there was further significant reduction (46.80 cm). Though the remaining treatments showed progressive reduction (46.80 to 44.76 cm) in plant height, levels of 1000 and 5000 J_2/ pot came on par with 500 J_2/ pot. 10,000 J2/ pot showed the least and significantly lower plant height (44.76 cm) compared to rest of the treatments (Table 1). Similarly Patil and Gaur (2014) reported that the rice cultivars non-basmati Pusa-44 and basmati Sugandh-5 showed significantly lower plant height with increasing nematode population. Similar results were reported by Abbasi and Hisamuddin (2014) in green gram. They reported that the plant height of green gram inoculated with 800 J_2/ pot and 1600 J_2/ pot decreased by 32.02% and 38.05% significantly over the uninoculated plant. Khan *et al*. (2012) reported that rice grown in nematode infested soil exhibited considerable degree of reduction in plant growth which varied with cultivars.

Lowest level of nematode population (100 J_2/ pot) caused significant reduction in fresh weight of plant (6.53 g) compared to control (7.03 g). In the next level (500 J_2/ pot) there was further significant reduction (5.41 g). Levels of 500 and 1000 J_2/ pot came on par with each other.

Table1: Effect of different inoculum levels of *Meloidogyne graminicola* on growth, chlorophyll content of plants and protein and starch content of grain in *Oryza sativa*

Treatments	Plant height (cm)	Fresh weight of plant(g)	Dry weight (g)		Chlorophyll (mg per g leaf)	Protein content in grain (%)	Starch content in grain(%)
			Shoot	Root			
T1(uninoculated)	56.52	7.03	2.25	1.67	0.93	2.65	86.78
T2 (100 J_2)	51.46	6.53	2.09	1.09	0.79	2.38	65.18
T3 (500 J_2)	46.80	5.41	1.84	0.91	0.74	2.22	68.19
T4 (1000 J_2)	46.10	5.08	1.76	0.84	0.71	2.15	59.83
T5 (5000 J_2)	46.94	4.81	1.73	0.80	0.71	1.62	55.12
T6 (10000 J_2)	44.76	4.53	1.47	0.74	0.68	1.54	50.82
CD (P<0.05)	5.660	0.438	0.118	0.219	0.011	0.246	9.023

Each value is a mean of five replications

Progressive reduction was showed from 1000 to 10,000 J_2/ pot (5.08 to 4.53 g). 10,000 J_2/ pot showed the least and significantly lower fresh weight of plant (4.53 g) compared to rest of the treatments (Table 1). Abbasi and Hisamuddin (2014) reported that in comparison to uninoculated plant, the fresh weight of the whole plant decreased with an increase in nematode inoclum levels. Patil and Gaur (2014) also reported that weight of root and shoot were decreased with increasing nematode population in pot culture experiment.

A progressive decrease in the dry weight of root and shoot were also noted with increase in the inoculum levels of *M. graminicola*. Lowest level of nematode population (100 J_2/ pot) caused significant reduction in dry weight of shoot and root (2.09 g and 1.09 g) compared to uninoculated plants (2.25 g and 1.67 g). The remaining treatments showed progressive reduction (1.84 to 1.47 g and 0.91 to 0.74 g) in dry weight of shoot and root, levels of 500, 1000 J_2/ pot came on par with 5000 J_2/ pot. 10,000 J_2/ pot showed the least and significantly lower dry weight of shoot and root (1.47 g and 0.74 g) compared to rest of the treatments (Table 1). Khan *et al*. (2012) found that the greatest decrease of dry weight of shoot was recorded in the rice cvs. Samba Mahsuri (46.40%) and Sugandh (29.20%). They also reported that the dry weight of root was decreased by 28% (cv. Sugandh) and 23% (cv. R-Dhan). Plowright and Bridge (1990) reported that high nematode population density of *M. graminicola* caused wilting of seedlings along with severe reduction in growth parameters while low population caused only reduction in growth parameters.

In comparison to uninoculated plant, the amount of chlorophyll in the leaves of rice decreased at different inoculum levels. Lowest level of nematode population (100 J_2/ pot) caused significant reduction in chlorophyll content (0.79 mg per g leaf) compared to control (0.93 mg per g leaf). The remaining treatments showed progressive reduction (0.74 to 0.68 mg per g leaf) in chlorophyll content, the levels of 1000 and 5000 J_2/ pot were on par with each other. 10,000

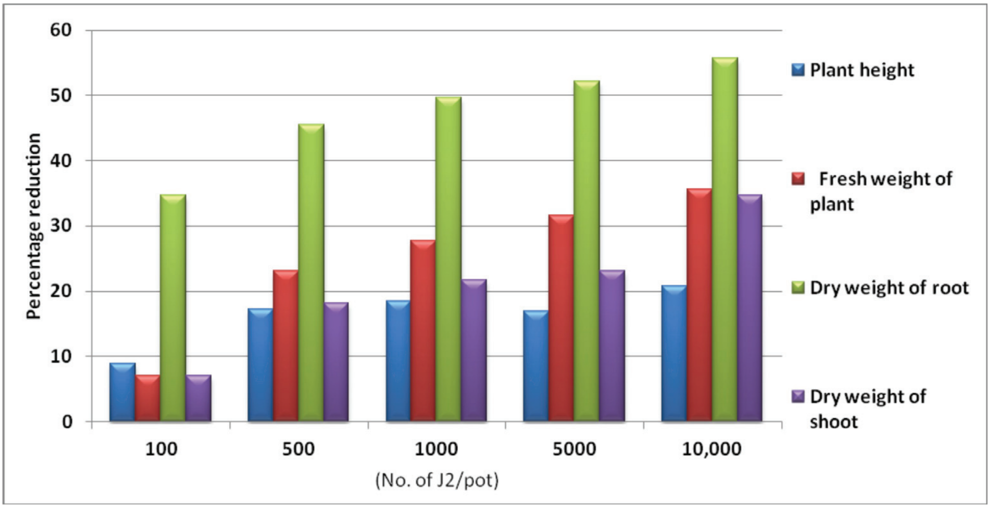

Fig 1. Percentage reduction in Plant growth parameters of rice at different inoculum levels of *M. graminicola* over uninoculated plant

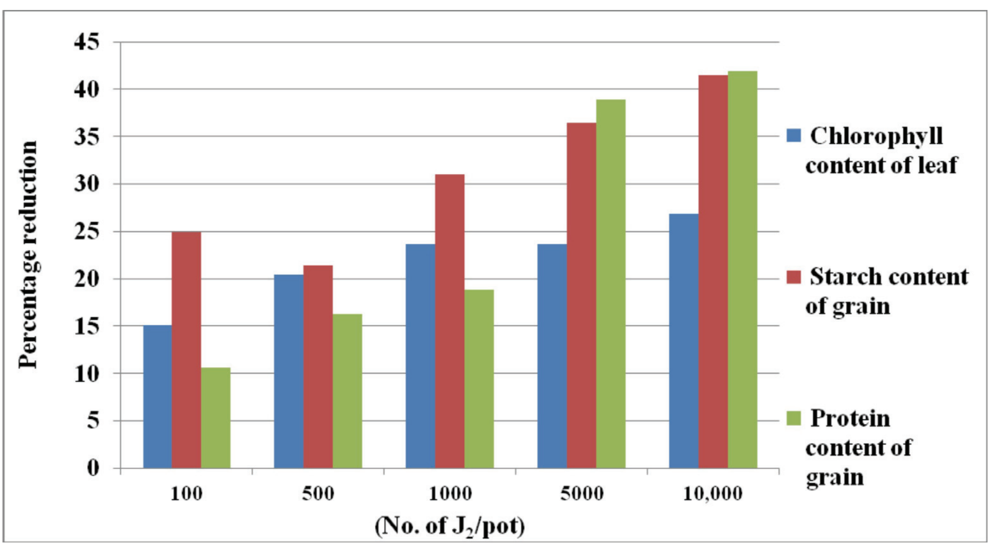

Fig 2. Percentage reduction in chlorophyll content of leaf, starch and protein content of grain at different inoculum levels of *M. graminicola* over uninoculated plant

J2/ pot showed the least and significantly lower chlorophyll content (0.68 mg per g leaf) compared to rest of the treatments (Table 1). There were similar results in tomato, beans, French bean and rice due to root-knot nematode (Lovely and Bird, 1973; Melakeberhan *et al*., 1986; Swain and Prasad, 1988; Ramakrishnan and Rajendran, 1998). Reduction in chlorophyll content of root knot nematode infected plants has been reported by Vashishth *et al*. (1994), Poornima and Vadivelu (1998) and Praveen *et al*. (2006).

Lowest level of nematode population (100 J_2/ pot) caused significant reduction in protein content of grain (2.38%) compared to uninoculated plant (2.65%). Though the remaining treatments showed progressive reduction (2.22 to 1.54 %) in protein content of grain, levels of 100, 500 J_2/ pot came on par with 1000 J_2/ pot. The protein content of grain in plants inoculated with 5000 was on par with that of the protein content of grains in 10, 000 J_2 inoculated plants. 10,000 J_2/ pot showed the least and significantly lower protein content of grain (1.54%). The starch content of grains exhibited reduction at different nematode inoculums levels compared to uninoculated plants. Lowest level of nematode population (100 J_2/ pot) caused significant reduction in starch content of grain (65.18%) compared to control (86.78%). The remaining treatments showed progressive reduction (68.19 to 50.82%) in starch content of grain. Levels of 100, 500 J_2/ pot came on par with 1000 J_2/ pot. 10,000 J_2/ pot showed the least and significantly lower starch content of grain compared to rest of the treatments. Similarly, Abbasi and Hisamuddin (2014) reported that the protein content of green gram reduced at different nematode inoculum levels. Mohanty and Pradhan (1989) reported that the protein contents decreased and amount of free amino acid and amides increased after root knot nematode inoculation in susceptible as well as resistant cultivars of green gram. Patil and Gaur, (2014) reported that the rice grains produced on plants infected with the nematode, *M. graminicola* had poorer nutrient qualities, such as amylase and protein content. Korayem *et al*. (2013) found that crude protein and fat contents decreased in peanut seeds influenced by *M. arenarea*.

The present study revealed that *M. graminicola* affects both growth and biochemical parameters of the plants. Reduction was observed in all the growth characters viz. plant height, fresh weight of plant, dry weight of root and shoot and biochemical characters viz. chlorophyll content of leaf, starch content of grain and protein content of grain with increase in nematode inoculum levels. The highest reduction was observed at the nematode inoculum level of 10,000 J_2/ pot (Fig. 1 and 2). Based on the results of the study, *M. graminicola* was considered as a potential threat to the cultivation of rice. It affected the growth of the rice and quality of the grains. Reduction in chlorophyll content of the leaves reduced the photosynthetic rate of the plant and thus reduced the growth and yield of rice.

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