Studies on the Pathogenicity of Different Inoculum Levels of Meloidogyne incognita and Rhizoctonia solani on Mungbean (Vigna radiata (L.) Wilczek)

Naseer Hussain Shah[1]*, Abdul Rashid Dar[2], Irfana Amin Qureshi[3], Afroza Akhter[4], Mohammad Rafiq Wani[5], Mohd. Yaqoob Baba[6] , Lubna Andleeb[7]

[1,2,3,4,5,6]Department of Botany, Abdul Ahad Azad Memorial Degree College Bemina, Srinagar–190018, Jammu and Kashmir, (India)

[7]Department of Botany, Govt. Degree College Ganderbal- 191201, Jammu and Kashmir, (India)

ABSTRACT

Investigations on the pathogenicity of Meloidogyne incognita and Rhizoctonia solani confirmed the damaging effect of these two pathogens on mungbean cv. T-44. Lowest inoculum levels of both the test pathogens caused no significant damage, however significant damage to plant growth/dry weight occurred at/or above 1000 J2 of M. incognita and/or 1.0g or above of R. solani/kg soil. The test pathogens also reduced the number of nodules/plant. A significant reduction in nodulation was recognized at 500 J2 of nematode and/or 0.5g of fungus/plant. R. solani was more damaging than M. incognita. The rate of nematode reproduction (RF) decreased with an increase in the inoculum level of nematode. Root galling was however, directly proportional to the inoculum levels. Similar trend was observed with respect to root rot index with increasing inoculum levels of the fungus.

Keywords: mungbean, nematode, Meloidoygne incognita, pathogenicity, Rhizoctonia solani

I.INTRODUCTION

Pulses, well known as grain legumes are valued for their richness in protein which makes them essential along with cereals in daily human diet. Pulses due to their high genetic potential to thrive well under varied environmental conditions and soil ameliorative properties have become the most important component of the sustainable agriculture particularly in dry land areas. The productivity of pulses in India is considerably low when compared with the average global mean productivity of 496.4 kg ha^{-1} [1]. Mungbean being one of the important pulse crops of India, is an excellent source of low cost and high quality protein [2] and contributes about 14% of the total protein of average diet of an Indian. Since mungbean roots fix atmospheric nitrogen through symbiosis with nitrogen-fixing rhizobia, this crop is valuable both economically as well as nutritionally and is widely used in different cropping systems [3].

Unfortunately like other pulses crops, the production of mungbean is subjected to several constraints including those of pests and diseases which play a leading role in the yield reduction. Mungbean is susceptible to large number of diseases which cause heavy loss to this crop every year [4]. The diseases caused by various fungi and nematodes are of major concern. Among nematodes, the root-knot nematode (*Meloidogyne incognita*) and the fungus *Rhizoctonia solani* have been reported to be widely associated with the reduction of mungbean production. Significant reduction in growth characters of different crops due to *M. incognita* and *R. solani* infestations have been reported by various workers [5-11]. During the course of preliminary survey of Aligarh District of Uttar Pradesh State, the root-knot nematode *M. incognita* and root-rot fungus *R. solani* happens to be dominant species with unthrifty growth of this crop.

The present study was an attempt to investigate the effect of *M. incognita* and *R. solani* separately on the growth characters and nodulation of mungbean cv. T-44.

II.MATERIALS AND METHODS

Five uniform surface sterilized (0.1% of mercuric chloride solution) seeds of mungbean (*Vigna radiata* (L.) Wilczek) cv. T-44, treated with mungbean strains of *Rhizobium* (*R. phaseoli*) obtained from Indian Agricultural Research Institute (IARI) were sown in 15cm diameter earthen pots containing potting mixture (soil and compost 3:1 V/V). After germination, seedlings were thinned and only one seedling was allowed to grow in each pot. Seven day old seedlings were inoculated with different inoculum levels viz., 250, 500, 1000, 2000 and 4000 freshly hatched second stage juveniles (J2) of *M. incognita* and 0.25, 0.5, 1.0, 2.0 and 4.0 grams of fungal culture of *R. solani* per plant separately. Uninoculated plants served as control. Each treatment was replicated three times. Watering was done as per the requirement. After sixty days of inoculation, the experiment was terminated and the data on plant growth, plant dry weight, root nodules and root system was recorded. For the isolation of nematodes from soil, Cobb's sieving and decanting method followed by modified Bearman funnel technique [12] was used. Root galling was estimated by counting the number of galls per root system. Root-rot index was assessed accordingly to the rating scale (1-5) of Batten and Powell [13]. The data obtained was statistically analyzed.

III.RESULTS

It is evident from the data (Tables 1-2; Figs. 1-5), that irrespective of the reduction of pathogen, the reduction in plant growth was directly proportional to the inoculum levels of each pathogen. The plant growth (total dry weight) was adversely affected by both the pathogens. There was a gradual decrease in plant dry weight (root+shoot) with the corresponding increase in the inoculum levels of each pathogen alone. However, statistically significant ($P<0.05$) reduction in plant dry weight over control was found only when 1000 J2 or more of *M. incognita* and/or 1.0g mycelium or more of *R. solani* was inoculated per plant/kg of soil. A considerable reduction in root nodulation was also observed due to the parasitism of both the test pathogens. However, significant reduction in nodulation over the control occurred only when 500 J2 or more of *M. incognita* and/or 0.5g or more of fungus *R. solani* was inoculated/plant. The reduction in plant growth/dry weight and nodulation was comparatively higher in *R. solani* treatments than in *M. incognita* treatments. The final nematode was highest in and around the plants inoculated with 4000 J2/plant and lowest in those inoculated with 250 J2/plant. The rate of nematode multiplication decreased with increase in the inoculum levels from 250 to 4000, suggesting it to be a density dependent phenomenon. Maximum nematode reproduction (RF=29.3) occurred at lowest (250 J2/plant) inoculum level and minimum (RF= 8.82) at highest (4000 J2/plant) inoculum level. Root galling increased significantly with increase in initial inoculum levels of the nematode. The number of galls increased from 62-165 with corresponding increase in the inoculum levels of *M. incognita* from 250-4000 J2 larvae. Similarly, the root-rot index also showed a gradual increase in the inoculum levels of fungus *R. solani*. The root-rot indices ranged between (1.5-3.5) in the increased inocula of fungus from 0.25g to 4.0g.

IV.DISCUSSION

The damaging threshold levels of *Meloidogyne incognita* on mungbean have been determined by several workers [6, 14-15] but their findings have been at variance. The present findings (1000 infective stages of *M. incognita* as the damaging threshold level) are in conformity with those of [15, 9, 10]. The differences observed in the damaging threshold levels by different workers can be attributed to the differences in the experimental conditions, cultivars used and the races of the nematodes involved. Similarly, the increased root rotting and resultant decrease in plant growth and nodulation with increase in inoculums levels of *R. solani* in different crops at or above 1.0g of fungus/plant have also been reported by several workers [5, 7-8] which substantiate the present findings. The reduction in plant growth may be due to the structural and physiological aberrations caused by the test pathogens [16]. Reduced nodulation in different pathogenic treatments may be attributed to nutritional interferences particularly carbohydrates or physiological changes brought about by the nematode infestation [17, 18] or to the secretion of toxic metabolites by fungal infection [19-21]. Inhibitory effects of nematode and/or fungal parasitism on nodulation have also been reported by several workers [8, 14, 16]. Increased numbers of galls with an increase in the inoculum levels of nematode are in agreement with the findings of [22, 6, 23, 10, 24] in soybean, chickpea and mungbean. The reason for the reduced nematode multiplication with increasing inoculum levels may be due to competition for food and space [25-27]. The progressive decrease in plant growth and nematode multiplication with increasing inoculum levels of nematode has also been reported by [29-31, 10, 27-28].

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Table 1: Effect of different inoculum levels of *Meloidogyne incognita* on plant dry weight, nodulation, nematode reproduction and gall formation

Inoculum levels	Plant dry weight		Nodules/root system		Nematode reproduction Rf=Pf/Pi	Number of galls/root system
	Root+Shoot (g)	Per cent reduction over control	Number	Per cent reduction over control		
Control (Un-inoculated)	3.30	-	49	-	-	-
250 Mi	3.15	2.54	44	10.20	29.30	62
500 Mi	2.98	9.96	32	43.69	23.53	86
1000 Mi	2.73	17.27	27	44.89	15.73	112
2000 Mi	2.46	25.45	21	57.14	12.83	142
4000 Mi	2.28	30.90	17	65.30	8.82	165
C. D. (P(0.05)	0.43		12.52		2.78	7.69
C. D. (P(0.01)	0.61		17.18		4.05	11.19

Table 2: Effect of different inoculum levels of *Rhizoctonia solani* on plant dry weight, nodulation, and root-rot development

Inoculum levels	Plant dry weight		Nodules/root system		Root-rot index
	Root+Shoot (g)	Per cent reduction over control	Number	Per cent reduction over control	
Control (Un-inoculated)	3.30	-	49	-	-
0.25g Rs	3.03	8.18	41	16.32	1.5
0.50g Rs	2.85	13.63	27	44.89	1.5
1.0g Rs	2.68	18.78	23	53.06	2.0
2.0g Rs	2.33	29.39	18	63.26	2.5
4.0g Rs	1.89	42.72	14	71.42	3.5
C. D. (P(0.05)	0.56		10.96		0.27
C. D. (P(0.01)	0.79		15.58		0.39

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Each value is mean of three replicates.

Mi= Meloidogyne incognita, Rs= Rhizoctonia solani, Rf= Nematode reproduction factor, Pf= Final population, Pi= Initial population.

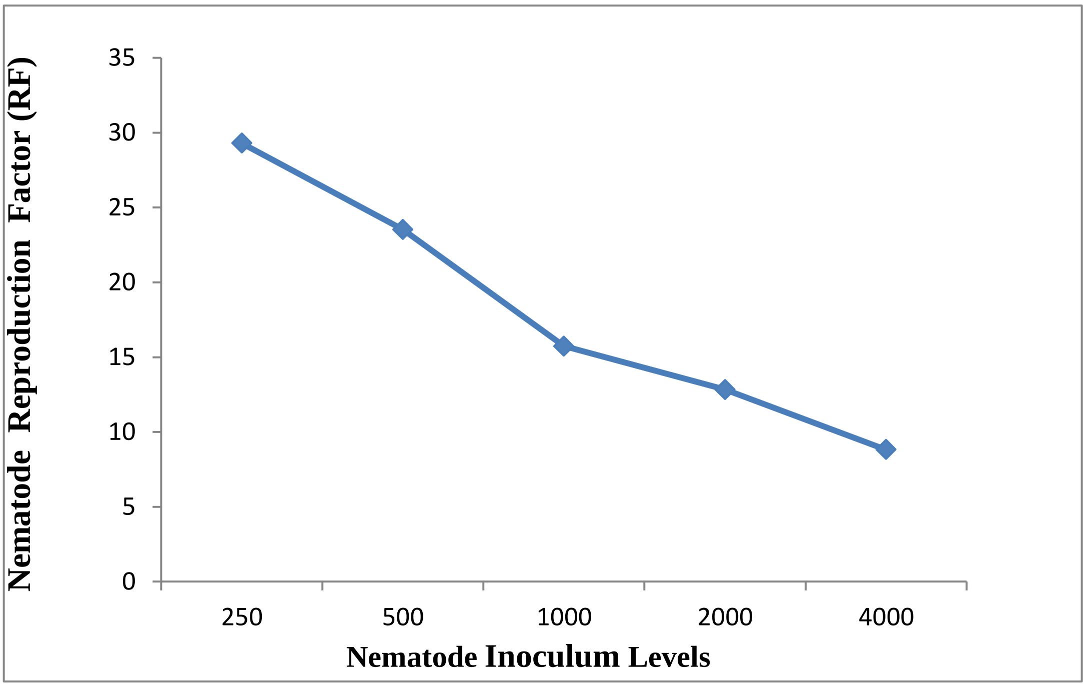


Fig. 1. Effect of different inoculum levels of *Meloidogyne incognita* on nematode reproduction (RF).

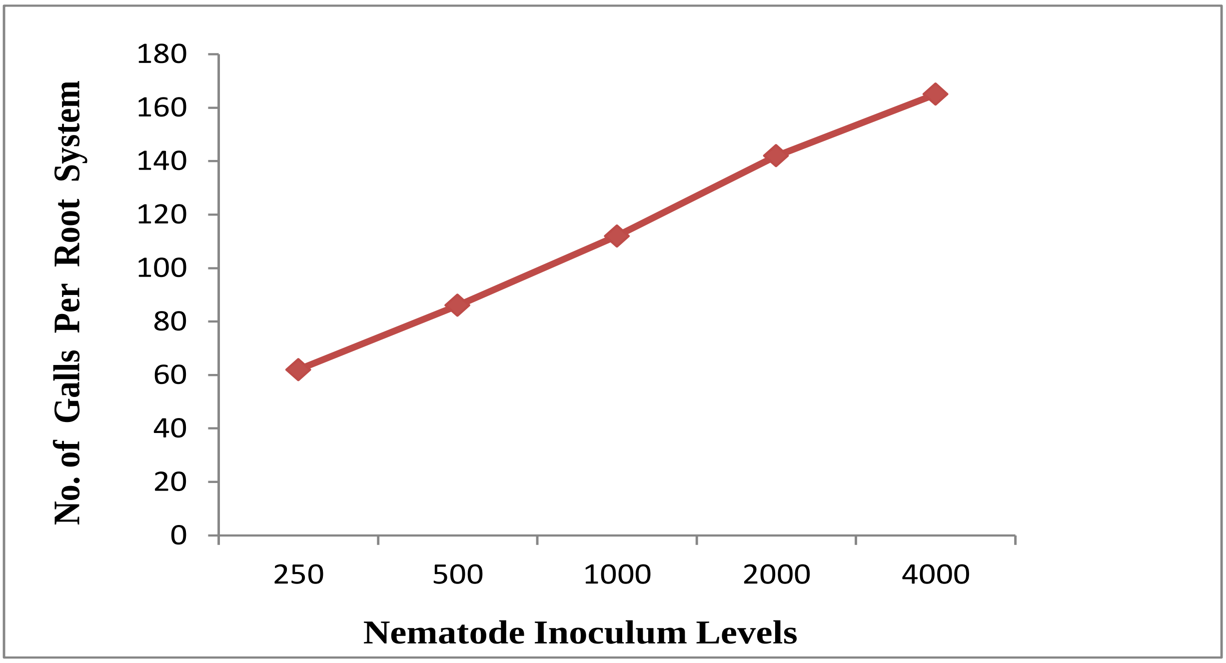


Fig. 2. Effect of different inoculum levels of *Meloidogyne incognita* on gall formation per root system.

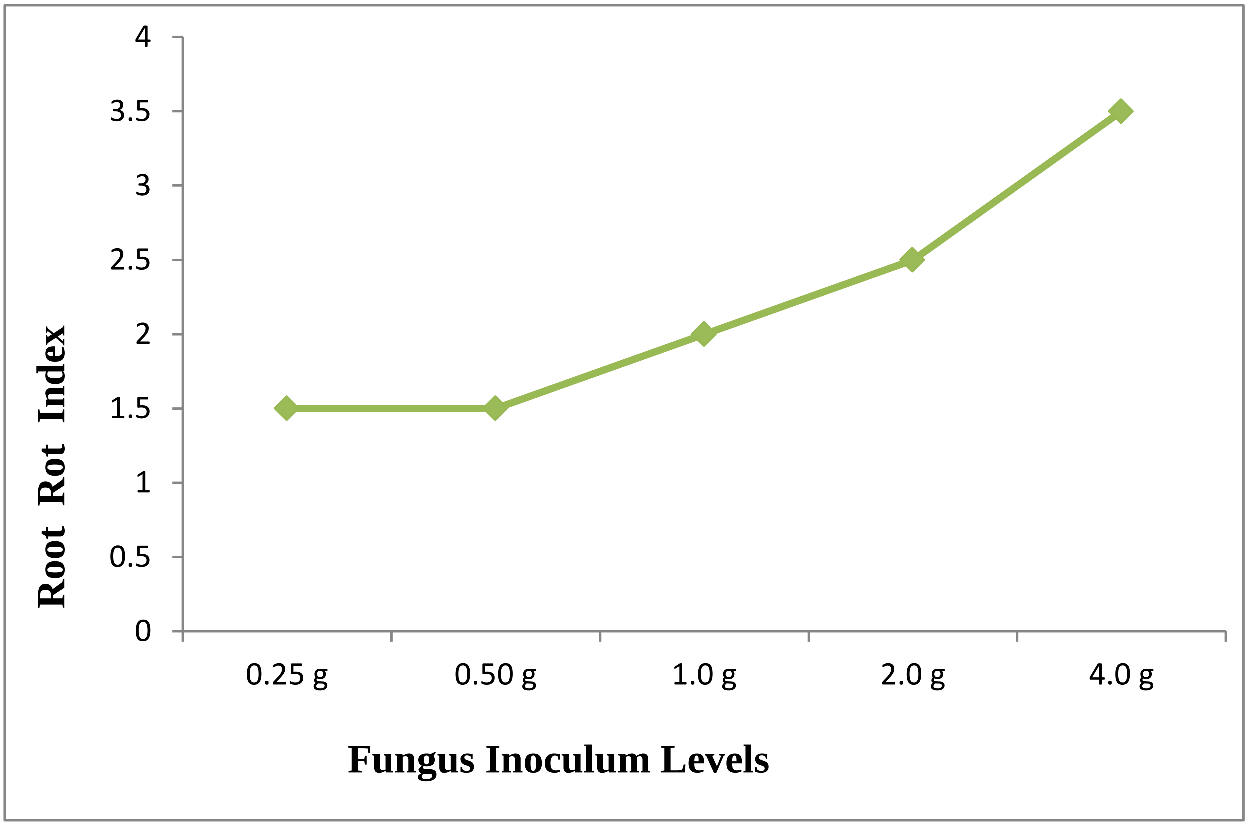


Fig. 3. Effect of different inoculum levels of *Meloidogyne incognita* on root rot system.

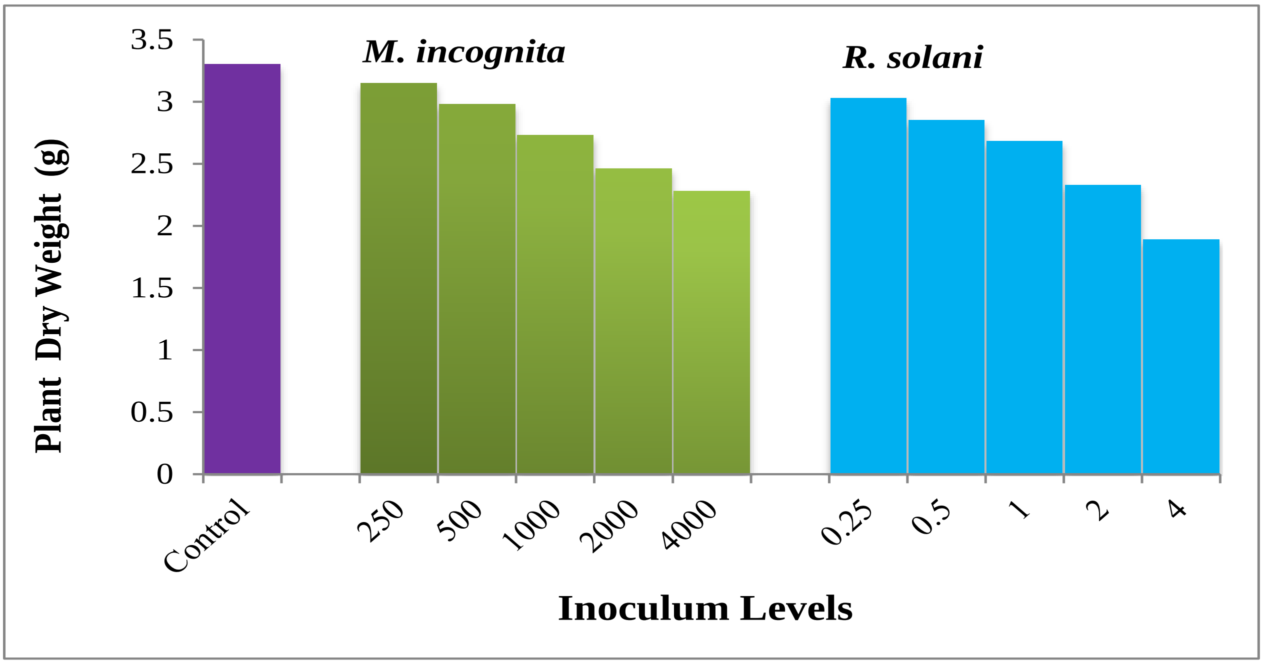
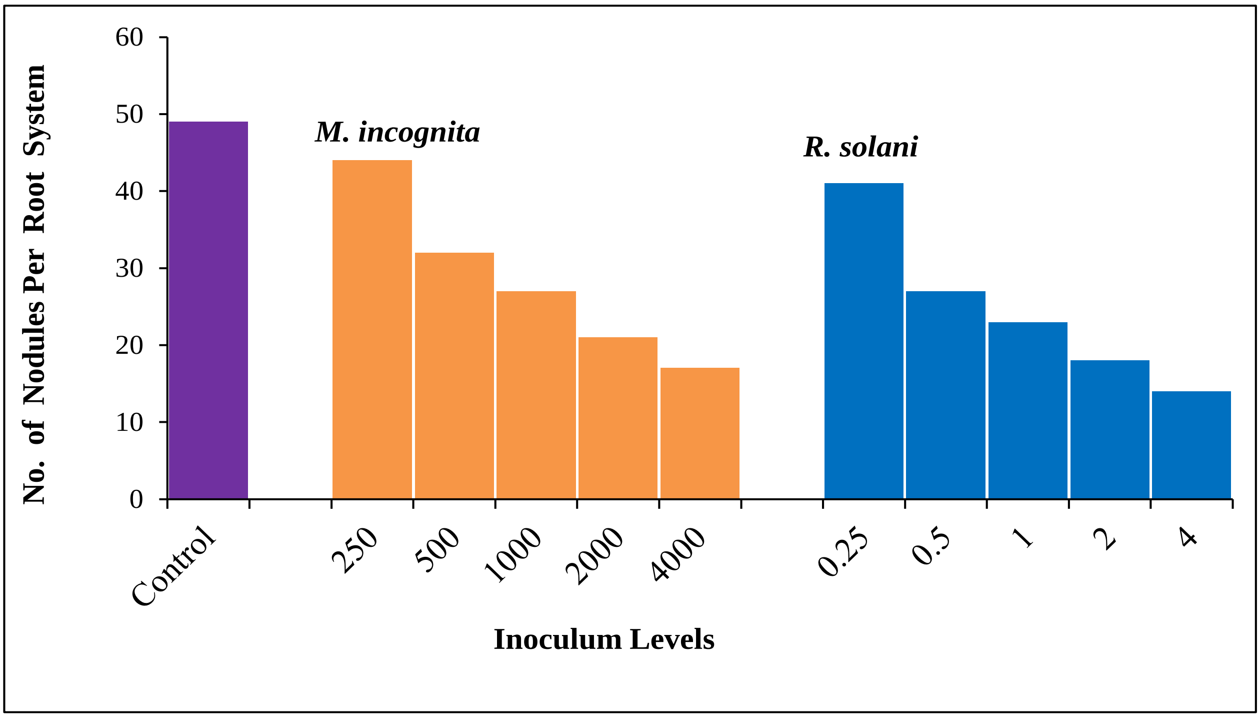


Fig. 4. Effect of different inoculums levels of *M. incognita* and *R. solani* on plant dry weight.

Fig. 5. Effect of different inoculums levels of *M. incognita* and *R. solani* on number of nudules per



root system.