Research Paper

EFFECT OF RICE HUSK ON GROWTH AND ROOT-KNOT NEMATODE DISEASE OF TOMATO PLANT

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Abstract

Plant growth (length and fresh weight of shoot and root) increased gradually upto 50% composted rice husk amendments, but optimum was being found at 40%. Although onward to 50% amendments, rice husk was proved detrimental to growth. Root-knot nematode (*Meloidogynejavanica*) also did reductions to tomato's growth but were nematode density (inoculum level) dependent. Maximum reduction was observed at 3000 nematode inoculums level. Reductions to plant growth were marginally masked at 4000 and 5000 compared to 3000 inoculum level but still greater than nematode uninoculated treatments. Rice husk has been proved beneficial for number of galls upto 40%. However, it became detrimental to root galling at higher levels. But egg mass numbers were reduced gradually with progressive rice husk additions. The gall and egg mass production were reduced to nil at 90 and 100% husk amendments. GI (Gall Index) and EMI (Egg Mass Index) were not much affected by rice husk and/or nematodes inoculations, particularly at initial levels. Both the nematode parameters were highest at 3000 inoculum level.
Key words: Rice husk, *Meloidogynejavanica*, detrimental, amendment, reduction.

INTRODUCTION

Rice husk, an important agricultural waste, is produced in large quantity in rice husk producing countries like India (Panigrahi and Overand, 1997) as most of our population feeds upon rice. Its disposal especially through burning is a matter of concern because of the addition of fine silica (Singh *et al*., 2002) particles despite of dust pollution. Rice husk deposition causes varied responses of the plants depending upon the level (Chang and Sipio, 2001). Improved plant growth and yield was reported by various workers (Aliyu, 2011; Mbah and Onweremadu, 2009) due to rice husk additions.

Root-knot nematodes parasitize on different crops all over the world with their widest host range. Most plants showed reduced growth and yield due to their infection (Hussey, 1985). The damage was recorded 20 to 30% on an average but might exceeded to 50% in individual field (Sasser, 1980; Sasser and Carter, 1982). Nutrients quality and quantity (Prasad *et al*., 1969; Dasgupta, 1962; Srivastava, 1969; Rao and Biswas, 1973) happen to be the important determinants for plant growth, as they can alter the growth significantly. Since tomatoes are one amongst their favourite host, so are frequently

attacked by them (Jacquet*et al.*, 2005). Peoples are mostly using the costly synthetic nematicide to control them. But these nematicides are proved hazardous not only to plants but for animals also including the humans (Nagaraju *et al.*, 2010). So there has been an intense search for any other healthy substitute which would be neither detrimental to living world nor to ecosystem.The rice husk fits in that criteria with huge potentiality of nematode control. This experiment was conducted to explore the efficacy of rice husk to improve the tomatoe's growth on one hand and to control the root-knot nematode on the other.

MATERIALS AND METHODS

Rice husk was procured from rice mill situated at Harduaganj, 10 km. away from the Aligarh. It was allowed to be composted for three months in a dug out pit. Thereafter, it was mixed with sandy loam field soil (68% sand, 24% silt, 8% clay and 3% organic matter) in order to obtain its different levels (i.e. 10%, 20%, 30% …. 90% and 100% v/v). Soil or so called mixture was then filled in clay pots having diameter x depth as 30 x 60 cm. Now pots, with soil and/or mixture, were autoclaved by maintaining the $120^{o}C$ temperature continuously upto12 to 19 minutes at 20 lbs. Before tomato seedling transplantation, pots were left undisturbed to three weeks for stabilization under the controlled conditions. Two-week- old tomato seedlings (two/pot) were transplanted in each pot. The pots, which were designated to receive*Meloidogynejavanica,* were inoculated with 1000, 2000, 3000, 4000 and 5000 freshly hatched second stage juveniles (J_2) of root-knot nematodes after one week of seedling transplantation.

M. javanica species was confirmed through cutting the perineal patterns of females from each single egg mass population (Eisenback*et al.*, 1981). Second stage juveniles (i.e. J_2) of *M. javanica* were obtained by incubating eggmasses collected from the roots of egg plants maintaining single egg mass culture. Each treatment was replicated five times and the pots were arranged randomly on glass house benches (at $30\pm2^{o}C$) of botanical garden, D.S. College, Aligarh. For the data presented horizontally, treatments with different rice husk levels were considered as controls. Similarly treatments with different nematode inoculum levels were taken as controls for the data presented vertically in the tables. However, those neither having rice husk nor nematode were considered as control for both (nematode or rice husk) treatments. Following were the treatments.

T_0 -   Plant + soil
T_1 -   Plant + 10% rice husk
T_2 -   Plant + 20% rice husk
T_3 -   Plant + 30% rice husk
T_4 -   Plant + 40% rice husk
T_5 -   Plant + 50% rice husk
T_6 -   Plant + 60% rice husk
T_7 -   Plant + 70% rice husk
T_8 -   Plant + 80% rice husk
T_9 -   Plant + 90% rice husk
T_{10} -   Plant + 100% rice husk

Each of the above treatment (i.e. T_0 to T_{10}) was further inoculated by 1000, 2000, 3000, 4000 and 5000 nematodes separately. With the help of this two factors were available (i.e. one with rice husk and another with root-knot nematode) for the data interpretation. The analysis of the data was done through the Fischer method (1950), in which LSD (at P=0.05) was calculated for the abovesaid factors, separately as well as

jointly. Termination of the experiment was done after 90 days of sowing. An excess amount of water was added to the pots prior to the termination of the experiment in order to soften the soil. Length and fresh weight of the shoot and root were measured in the laboratory immediately after the harvesting.

Different root-knot disease parameters were also evaluated after the termination. For this to be done, tomato roots were washed under the tap water and examined for the presence of galls. Number of galls per root system werecounted manually. Roots were immersed in an aqueous solution of phloxin-B (0.15 g/tap water) for 15 minutes to stain the egg masses. Egg mass/root system was thus counted. GI and EMI indices were determined on the 0-5 scale (Taylor and Sasser, 1978).

RESULTS AND DISCUSSION

Obtained results showed that plant growth, in terms of length and fresh weight of shoot and root, increased gradually with progressive increase in rice husk level up to 40% in all the treatments irrespective of the presence or absence of root-knot nematode (tables 1-4). Improvement in plant growth upto 40% levels can be justified through soil enrichment with organic (Haxo and Mehta, 1975) and inorganic (Muthadi*et al*., 2007) constituents due to rice husk additions. Availability of such compounds may have helped the soil to improve its physico-chemical properties (Ebaid*et al*., 2005). A number of workers have already reported the improvement in the abovesaid soil properties due to the rice husk addition (Ebaid and Refaee, 2007; Tekwa*et al*.,2010). Its addition to soil increases the supplementation of cationswith surplus quantity (Muthadi*et al*., 2007) duly accompanied with macro and micro-nutrients availability (Tekwa*et al*., 2010), probably via fast mineralization and humification of the rice husk in the soil. Such nutrient rich and physico-chemically improved soil could be able to foster the healthy tomatoes which is reflected back in the form of enhanced growth. The nutrient status and soil properties might have improved optimally at 40% rice husk addition, that's why maximization of the growth was occurred at that level. However, reverse effect of husk was observed on the growth of tomato plants beyond 40% in all the nematode inoculated or uninoculated treatments. Accumulation of heavy metals beyond threshold level in 40% onward rice husk amendments (Jai Prakash, 2013) could be held responsible for such an adverse impacts on the growth. Presence of heavy metals in untolerable amount are reported to dwindle the plant growth (Gupta *et al*., 2000).

Meloidogyne javanica reduced the growth significantly at all the levels but they (reduction) were gradual up to 3000 inoculum levels. Gradual decrease in plant growth, in progressive increase in root-knot nematode inoculum levels, was also reported earlier (Sharma and Sethi, 1975).Root-knot nematode causes several physiological and anatomical transformations in the host plant such as breaking in continuity of vascular elements due to development of galls (Jones and Northcote, 1972b) thereby restricted the water movements to the aerial parts (Meon*et al*., 1978). Reduction to growth also occurred at 4000 and 5000 nematode inoculum levels (although greater than controls) but less than 3000 level. Comparative less growth reductions at 4000 and 5000 nematode levels could be due to the development of intraspecific competition amongst them due to overcrowding at these levels. However, such competition could be ruled out at the lower levels due to sufficient availability of food and/or space in the host-roots.

Similar but greater reductions due to nematode infection were occurred to tomatoe's growth at higher rice husk levels. The rice husk and root-knot nematode might have interacted synergistically in causing more losses to crop growth than of

their either presence. This synergism would become more conspicuous at higher husk levels as greater adverse impact went on to the plant growth in joint treatments.

Number of galls increase upto 40% husk levels but decrease in onward amendments (table-5). However, gradual decrease in number of egg masses was observed in all the progressive rice husk amendments (Table-6). Number of galls and egg masses were totally absent in 90% and 100% amendments. Gall numbers at initial rice husk levels might have been increased due to better and appropriate water holding capacity and porosity of the added soil (Ebaid*et al.*, 2005). Such improved physico-chemical properties could have provided easy movement of J_2 in the soil and thereby greater opportunities for them to enter into the host root. Increased ingression of J_2 to roots would subsequently might be transcended into more females and thereby the galls. Reverse effects on soil characters due to of higher rice husk amendment could be advanced as a healthy reason behind reduced galling.However, egg masses remain in direct physical contact with external environment so the rice husk was proved detrimental at all the levels.

Number of galls and eggmasses were maximum in 3000 nematode inoculation levels in both rice husk amended ornonamended treatments. They were reduced in 3000 onward nematode inoculations probably due to the intraspecific competition amongst them. GI and EMI were found maximum somewhere in between 10 to 50% husk level but suppressed slightly at higher level although insignificantly (Table 7-8).

The above piece of work shows that rice husk upto 40% was proved beneficial to plant growth but detrimental to root-knot nematode (except galling). However, the plant growth as well as the root-knot nematode disease were adversely affected in 50% or onward rice husk amendments. Thereby this agricultural waste product not only improves the plant growth but also check the nematode disease if utilized meticulously as a soil amendor. So it can be used as a healthy alternate of manure or synthetic nematicide.

Table 1:Effect of rice husk on length of shoot (cm) of tomato plants

Husk concentration	Inoculation levels						
	0	1000	2000	3000	4000	5000	Mean
0%	38.24	36.32ns	32.80*	26.14*	27.08*	27.02*	31.27
10%	40.30*	37.60ns	34.30*	30.50*	32.70*	31.90*	34.55#
20%	42.10*	39.70ns	36.20*	33.10*	35.20*	33.90*	36.70#
30%	44.60*	40.80*	37.40ns	35.30*	36.90ns	35.20*	38.37#
40%	45.70*	41.90*	38.70ns	36.60ns	37.90ns	36.80ns	39.60#
50%	39.60ns	37.60ns	34.70*	32.20*	34.50*	33.90*	35.42#
60%	37.10ns	35.30*	33.10*	30.60*	32.20*	30.10*	33.07#
70%	29.80*	28.30*	26.80*	24.90*	26.00*	25.58*	26.90#
80%	26.70*	24.12*	21.90*	19.20*	21.50*	20.20*	22.27#
90%	23.90*	21.10*	19.70*	18.00*	18.90*	18.50*	20.02#
100%	18.15*	16.30*	15.50*	13.72*	14.80*	13.92*	15.46#
Mean	35.14	32.64@	30.10@	27.30@	28.88@	27.91@	
LSD at 5%	Husk	0.597	Nematode inoculation	0.809	Interaction	1.982	

* = data significant with 0 inoculation level & 0% husk concentration at *P*=0.05

ns = Not significant

\# = data significant within a column at *P* = 0.05

@ = data significant in a row at *P* = 0.05

Table 2: Effect of rice husk on length of root (cm) of tomato plants

Husk concentration	Inoculation levels						Mean
	0	1000	2000	3000	4000	5000	
0%	18.58	17.36^{ns}	16.78^{ns}	14.72^{ns}	15.80^{ns}	15.00^{ns}	16.37
10%	19.80^{ns}	18.70^{ns}	17.70^{ns}	15.90^{ns}	16.50^{ns}	16.00^{ns}	17.43$^{\#}$
20%	21.50^{ns}	20.00^{ns}	18.80^{ns}	16.90^{ns}	17.60^{ns}	17.00^{ns}	18.63$^{\#}$
30%	23.70^{ns}	22.10^{ns}	21.00^{ns}	17.50^{ns}	18.80^{ns}	18.10^{ns}	20.20$^{\#}$
40%	24.20^{ns}	22.90^{ns}	21.80^{ns}	19.50^{ns}	20.52^{ns}	18.92^{ns}	21.47$^{\#}$
50%	19.30^{ns}	17.80^{ns}	15.30^{ns}	14.20^{ns}	15.80^{ns}	15.00^{ns}	16.23^{ns}
60%	16.50^{ns}	15.10^{ns}	14.90^{ns}	12.70^{ns}	14.00^{ns}	13.60^{ns}	14.47$^{\#}$
70%	15.50^{ns}	14.30^{ns}	13.70^{ns}	13.00^{ns}	13.60^{ns}	13.20^{ns}	13.88$^{\#}$
80%	14.70^{ns}	13.20^{ns}	12.00^{ns}	11.20^{ns}	11.80^{ns}	11.50^{ns}	12.40$^{\#}$
90%	13.20^{ns}	12.50^{ns}	11.80^{ns}	10.90^{ns}	11.50^{ns}	10.86^{ns}	11.79$^{\#}$
100%	12.80^{ns}	11.70^{ns}	11.00^{ns}	10.00^{ns}	10.80^{ns}	10.30^{ns}	11.10$^{\#}$
Mean	18.16	16.88@	15.89@	14.23@	15.16@	14.59@	
LSD at 5%	Husk	0.455	Nematode inoculation	0.615	Interaction	NS	

* = data significant with 0 inoculation level & 0% husk concentration at *P*=0.05
ns = Not significant
\# = data significant within a column at *P* = 0.05
@ = data significant in a row at *P* = 0.05

Table 3: Effect of rice husk on fresh weight of shoot (g) of tomato plants

`	Inoculation levels						Mean
	0	1000	2000	3000	4000	5000	
0%	35.20	33.08^{ns}	31.50^{ns}	27.44^{ns}	29.22^{ns}	28.64^{ns}	30.85
10%	38.70^{ns}	35.60^{ns}	33.20^{ns}	30.00^{ns}	32.80^{ns}	31.70^{ns}	33.67$^{\#}$
20%	40.30^{ns}	37.30^{ns}	35.80^{ns}	32.30^{ns}	34.20^{ns}	33.50^{ns}	35.57$^{\#}$
30%	42.70^{ns}	39.50^{ns}	37.50^{ns}	34.70^{ns}	36.80^{ns}	35.90^{ns}	37.85$^{\#}$
40%	43.80^{ns}	40.70^{ns}	38.40^{ns}	35.80^{ns}	37.70^{ns}	37.00^{ns}	38.90$^{\#}$
50%	38.80^{ns}	35.20^{ns}	32.40^{ns}	29.80^{ns}	31.30^{ns}	30.80^{ns}	33.05$^{\#}$
60%	34.50^{ns}	30.70^{ns}	27.50^{ns}	24.30^{ns}	25.70^{ns}	24.61^{ns}	27.89$^{\#}$
70%	30.00^{ns}	28.50^{ns}	25.30^{ns}	22.00^{ns}	23.30^{ns}	22.80^{ns}	25.32$^{\#}$
80%	28.80^{ns}	26.30^{ns}	23.20^{ns}	19.90^{ns}	21.60^{ns}	21.60^{ns}	23.57$^{\#}$
90%	27.00^{ns}	25.00^{ns}	22.50^{ns}	19.00^{ns}	20.70^{ns}	20.00^{ns}	22.37$^{\#}$
100%	26.00^{ns}	24.30^{ns}	21.40^{ns}	18.30^{ns}	19.40^{ns}	19.20^{ns}	21.43$^{\#}$
Mean	35.07	32.38@	29.88@	26.69@	28.43@	27.80@	
LSD at 5%	Husk	0.915	Nematode inoculation	1.239	Interaction	NS	

* = data significant with 0 inoculation level & 0% husk concentration at *P*=0.05
ns = Not significant
\# = data significant within a column at *P* = 0.05
@ = data significant in a row at *P* = 0.05

Table 4: Effect of rice husk on fresh weight of root (g) of tomato plants

Husk concentration	Inoculation levels						
	0	1000	2000	3000	4000	5000	Mean
0%	13.50	12.90^{ns}	11.80^{ns}	10.10^{ns}	11.70^{ns}	11.20^{ns}	11.87
10%	14.80^{ns}	13.80^{ns}	12.00^{ns}	11.20^{ns}	11.90^{ns}	11.60^{ns}	$12.55^{\#}$
20%	16.00^{ns}	14.80^{ns}	13.50^{ns}	12.50^{ns}	13.20^{ns}	13.00^{ns}	$13.83^{\#}$
30%	18.30^{ns}	15.90^{ns}	14.80^{ns}	13.30^{ns}	14.50^{ns}	14.20^{ns}	$15.17^{\#}$
40%	18.90^{ns}	16.50^{ns}	15.30^{ns}	14.10^{ns}	14.90^{ns}	14.30^{ns}	$15.67^{\#}$
50%	16.80^{ns}	14.30^{ns}	13.60^{ns}	12.50^{ns}	13.20^{ns}	12.90^{ns}	$13.88^{\#}$
60%	14.80^{ns}	13.30^{ns}	12.80^{ns}	11.30^{ns}	12.40^{ns}	11.90^{ns}	$12.75^{\#}$
70%	13.20^{ns}	12.50^{ns}	12.00^{ns}	10.60^{ns}	11.50^{ns}	11.00^{ns}	11.80^{ns}
80%	12.50^{ns}	11.80^{ns}	11.00^{ns}	10.00^{ns}	10.60^{ns}	10.30^{ns}	$11.03^{\#}$
90%	11.02^{ns}	10.30^{ns}	10.80^{ns}	9.20^{ns}	10.12^{ns}	9.70^{ns}	$10.19^{\#}$
100%	10.20^{ns}	9.80^{ns}	9.30^{ns}	8.50^{ns}	9.00^{ns}	8.70^{ns}	$9.25^{\#}$
Mean	14.55	$13.26^{@}$	$12.45^{@}$	$11.21^{@}$	$12.09^{@}$	$11.71^{@}$	
LSD at 5%	Husk	0.359	Nematode inoculation	0.486	Interaction	NS	

* = data significant with 0 inoculation level & 0% husk concentration at P=0.05
ns = Not significant
\# = data significant within a column at P = 0.05
@ = data significant in a row at P = 0.05

Table 5: Effect of rice husk on number of galls of root-knot nematode on tomato plants

Husk concentration	Inoculation levels						
	0	1000	2000	3000	4000	5000	Mean
0%	0.0	75.0^{*}	87.0^{*}	104.0^{*}	96.0^{*}	91.0^{*}	75.50
10%	0.0^{ns}	90.0^{*}	105.6^{*}	117.0^{*}	112.0^{*}	108.0^{*}	$88.8^{\#}$
20%	0.0^{ns}	108.0^{*}	116.0^{*}	125.0^{*}	120.0^{*}	110.0^{*}	$96.5^{\#}$
30%	0.0^{ns}	115.0^{*}	123.0^{*}	132.0^{*}	128.0^{*}	125.0^{*}	$103.8^{\#}$
40%	0.0^{ns}	121.2^{*}	135.0^{*}	147.0^{*}	142.0^{*}	138.0^{*}	$113.9^{\#}$
50%	0.0^{ns}	100.0^{*}	113.0^{*}	126.0^{*}	120.0^{*}	115.0^{*}	$95.7^{\#}$
60%	0.0^{ns}	72.0^{*}	85.0^{*}	98.0^{*}	93.0^{*}	88.0^{*}	$72.7^{\#}$
70%	0.0^{ns}	35.0^{*}	42.0^{*}	52.0^{*}	47.0^{*}	44.0^{*}	$36.7^{\#}$
80%	0.0^{ns}	15.0^{*}	28.0^{*}	25.0^{*}	23.0^{*}	22.0^{*}	$18.8^{\#}$
90%	0.0^{ns}	0.0^{ns}	0.0^{ns}	0.0^{ns}	0.0^{ns}	0.0^{ns}	$0.0^{\#}$
100%	0.0^{ns}	0.0^{ns}	0.0^{ns}	0.0^{ns}	0.0^{ns}	0.0^{ns}	$0.0^{\#}$
Mean	0.00	$66.5^{@}$	$75.9^{@}$	$84.2^{@}$	$80.1^{@}$	$76.5^{@}$	
LSD at 5%	Husk	2.132	Nematode inoculation	2.887	Interaction	7.072	

* = data significant with 0 inoculation level & 0% husk concentration at P=0.05
ns = Not significant
\# = data significant within a column at P = 0.05
@ = data significant in a row at P = 0.05

Table 6: Effect of rice husk on number of egg masses of root-knot nematode on tomato plants

Husk concentration	Inoculation levels						
	0	1000	2000	3000	4000	5000	Mean
0%	0.0	37.0*	48.0*	60.0*	57.0*	52.0*	42.33
10%	0.0ns	34.0*	40.0*	54.0*	50.0*	47.0*	37.5#
20%	0.0ns	27.0*	34.0*	49.0*	45.0*	40.0*	32.5#
30%	0.0ns	23.0*	28.0*	42.0*	37.0*	33.0*	27.2#
40%	0.0ns	17.0*	24.0*	36.0*	32.0*	27.0*	22.7#
50%	0.0ns	12.0*	17.0*	29.0*	25.0*	21.0*	17.3#
60%	0.0ns	8.0*	13.0*	25.0*	21.0*	18.0*	14.2#
70%	0.0ns	5.0*	8.0*	13.0*	10.0*	8.0*	7.3#
80%	0.0ns	3.0ns	6.0*	9.0*	7.0*	6.0*	5.2#
90%	0.0ns	0.0ns	0.0ns	0.0ns	0.0ns	0.0ns	0.0#
100%	0.0ns	0.0ns	0.0ns	0.0ns	0.0ns	0.0ns	0.0#
Mean	0.00	15.09@	19.82@	28.82@	25.82@	22.91@	
LSD at 5%	Husk	NS	Nematode inoculation	1.805	Interaction	4.421	

* = data significant with 0 inoculation level & 0% husk concentration at P=0.05
ns = Not significant
# = data significant within a column at P = 0.05
@ = data significant in a row at P = 0.05

Table 7: Effect of rice husk on gall index (GI) of root-knot nematode on tomato plants

Husk concentration	Inoculation levels						
	0	1000	2000	3000	4000	5000	Mean
0%	-	4	4	5	4	4	4.2
10%	-	4	5	5	5	5	4.8
20%	-	5	5	5	5	5	5.0
30%	-	5	5	5	5	5	5.0
40%	-	5	5	5	5	5	5.0
50%	-	5	5	5	5	5	5.0
60%	-	4	4	4	4	4	4.0
70%	-	4	4	4	4	4	4.0
80%	-	3	3	3	3	3	3.0
90%	-	-	-	-	-	-	-
100%	-	-	-	-	-	-	-
Mean		3.54	3.63	3.72	3.63	3.63	
LSD at 5%	Husk	0.00	Nematode inoculation	0.00	Interaction	0.00	

* = data significant with 0 inoculation level & 0% husk concentration at P=0.05
ns = Not significant
# = data significant within a column at P = 0.05
@ = data significant in a row at P = 0.05

Table 8: Effect of rice husk on egg mass index (EMI) of root-knot nematode on tomato plants

Husk concentration	Inoculation levels						
	0	1000	2000	3000	4000	5000	Mean
0%	-	4	4	4	4	4	4.0
10%	-	4	4	4	4	4	4.0
20%	-	3	4	4	4	4	3.8
30%	-	3	3	4	4	4	3.6
40%	-	3	3	4	4	3	3.4
50%	-	3	3	3	3	3	3.0
60%	-	2	3	3	3	3	2.8
70%	-	2	2	3	3	2	2.4
80%	-	2	2	2	2	2	2.0
90%	-	-	-	-	-	-	-
100%	-	-	-	-	-	-	-
Mean		2.36	2.55	2.81	2.81	2.63	
LSD at 5%	Husk	0.00	Nematode inoculation	0.00	Interaction	0.00	

* = data significant with 0 inoculation level & 0% husk concentration at P=0.05

ns = Not significant

\# = data significant within a column at P = 0.05

@ = data significant in a row at P = 0.05

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