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A DISEASE OF BLACKGRAM INVOLVING *MELOIDOGYNE JAVANICA* AND *RHIZOCTONIA BATATICOLA*

by

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Summary. Interaction between *Meloidogyne javanica* at 500 and 1000 J_2 per pot and *Rhizoctonia bataticola* at 10 and 20 ml mycelium per pot were evaluated on blackgram (*Vigna mungo*) cv. Pant U-19. In single species inoculation reduction in plant growth, nodulation and yield was significant at both the inoculum levels. In concomitant inoculations the reduction was greater than the additive effect of the pathogens acting independently, indicating a synergistic effect on plant growth, nodulation and yield. Maximum damage was observed when the nematode inoculation preceeded fungal inoculation by ten days. *R. bataticola* at both inoculum levels adversely affected nematode reproduction and root galling.

Blackgram, *Vigna mungo* (L.) Hepper, is an important pulse crop in India which is typically grown on black-cotton soil from July to September. During a survey of blackgram fields in the Aligarh district of Uttar Pradesh, decline of the crop was observed in some fields infested with both *Meloidogyne javanica* (Treub) Chitw. and *Rhizoctonia bataticola* (Taub.) Butler. An investigation was undertaken to establish whether there was an interaction between nematode and fungus and the effect of this on plant growth and yield.

Materials and methods

Seeds of Pant U-19 (locally cultivated) blackgram, susceptible to both nematode and fungus, were sown in 15 cm diam earthen pots filled with autoclaved soil, brought from an infested field and mixed with compost (3:1). Prior to sowing the seed (five per pot) were disinfected by immersion on 3.5% sodium hypochlorite (NaOCl) for five min and subsequently treated with *Rhizobium*. After germinatio, the seedlings were thinned to one per pot. The *M. javanica* population was obtained originally from tomato grown in the field in which blackgram had previously been cultivated, and then cultured on egg plant in a glasshouse. Freshly hatched second stage juveniles (J_2) for inoculation were obtained by hatching eggs (surface sterilized with 1.0% NaOC1 for 5 min) in oxygenated distilled water at 25±2 °C. The *R. bataticola* culture was also obtained from the infested blackgram field, purified and maintained on potato dextrose agar slant. It was multiplied on Richard's liquid medium (Riker and Riker, 1936) for 14 days in a BOD incubator at 25±2 °C, a mycelial suspension was prepared by blending 100 g of mycelial mat in 1000 ml sterilized distilled water. Ten days after germination, roots were inoculated through four depressions made around each plant with 500 or 1000 J_2 of *M. javanica* and/or 10, or 20 ml mycelial suspension of *R. bataticola*, alone, si-

multaneously, or sequentially at ten day intervals (Table I). All treatments, including the control which was without nematodes or fungus, were replicated five times. The plants were lightly watered after inoculation and randomly arranged on a glasshouse bench. Until harvest, pots were watered and weeded as required.

The experiment was terminated 60 days after inoculation. Mean dry weight of shoots and number of pods were determined. The numbers of rhizobial galls and nematode-induced galls were counted. Nematode reproductive factor per treatment (PF/Pi, in roots and soil) was estimated for *M. javanica* (Oostenbrink, 1966). Percentage decrease in each of the parameters was calculated with respect to controls. The data obtained were subjected to statistical analysis for critical difference (CD) and significance of variance was calculated at $P < 0.05$ level (Panse and Sukhatme, 1989).

Results

Results (Table I) indicate that *M. javanica* and *R. bataticola* independently caused significant reduction ($P < 0.05$) in dry shoot weight, nodulation and yield at both the inoculum levels. Individually, *R. bataticola* was more aggressive than *M. javanica* as it caused greater reduction in all the three parameters measured. The rate of nematode multiplication (R-factor) was less (14.3) at an inoculum of 1000 J_2 than at 500 J_2 with more galls (134.3) and females (147.7) per plant at the higher inoculum level (Table II).

TABLE I - *Combined effect of* Meloidogyne javanica *and* Rhizoctonia bataticola *on the growth of blackgram.*

Pathogen	Treatment	Dry shoot weight (g)	Nodules/plant	Pods/plant
Uninoculated	Control	4.57	83.5	29.6
R. bataticola (Rb)	10 ml alone	3.65 (20.2)	62.4 (25.3)	21.3 (28.0)
R. bataticola (Rb)	20 ml alone	3.10 (32.2)	49.3 (40.9)	17.1 (42.2)
M. javanica (Mj)	500 J_2 alone	3.85 (15.8)	72.4 (13.3)	25.3 (14.5)
M. javanica (Mj)	1000 J_2 alone	3.26 (28.7)	60.3 (27.8)	21.4 (27.7)
Mj 500 + Rb 10 ml	Simultaneous	2.49 (45.6)	43.9 (47.7)	14.7 (50.3)
Mj 500 + Rb 20 ml	Simultaneous	1.82 (60.2)	33.2 (60.2)	10.1 (65.9)
Mj 1000 + Rb 10 ml	Simultaneous	1.72 (62.8)	31.4 (62.4)	10.1 (65.9)
Mj 1000 + Rb 20 ml	Simultaneous	1.12 (75.5)	19.7 (76.4)	7.4 (75.0)
Mj 500 + Rb 10 ml	After 10 days	2.03 (55.6)	42.2 (49.5)	13.2 (55.4)
Mj 500 + Rb 20 ml	After 10 days	1.32 (71.1)	29.1 (65.1)	8.9 (69.9)
Mj 1000 + Rb 10 ml	After 10 days	1.42 (68.9)	28.6 (65.7)	8.3 (71.9)
Mj 1000 + Rb 20 ml	After 10 days	0.82 (82.3)	15.8 (81.1)	5.8 (80.4)
Rb 10 ml + Mj 500	After 10 days	2.74 (40.0)	48.3 (42.2)	15.9 (46.3)
Rb 20 ml + Mj 500	After 10 days	2.03 (55.5)	36.2 (56.6)	11.5 (61.1)
Rb 10 ml + Mj 1000	After 10 days	2.03 (55.5)	36.4 (56.4)	11.1 (62.5)
Rb 20 ml + Mj 1000	After 10 days	1.42 (68.9)	23.1 (72.3)	8.1 (72.6)
C.D. (P = 0.05)		0.26	4.12	1.59

Figure in parenthesis indicates per cent reduction over respective control.

TABLE II - *Effect of* R. bataticola *on reproduction of* M. javanica.

Pathogen	Treatment	Females/root	R-factor (root + soil population)	Galls/root
M. javanica 500 (Mj)	Alone	110.4	16.8	98.6
M. javanica 1000 (Mj)	Alone	147.7	14.3	134.3
Mj 500 + *R. bataticola* 10 ml (Rb)	Simultaneous	72.3 (34.5)	10.6 (36.6)	60.8 (38.3)
Mj 500 + Rb 20 ml	Simultaneous	60.5 (45.2)	8.5 (49.3)	48.8 (50.5)
Mj 1000 + Rb 10 ml	Simultaneous	93.6 (36.6)	8.7 (38.9)	79.4 (40.9)
Mj 1000 + Rb 20 ml	Simultaneous	77.3 (47.7)	7.1 (50.6)	64.2 (52.2)
Mj 500 + Rb 10 ml	After 10 days	83.7 (26.2)	12.6 (24.9)	72.8 (26.2)
Mj 500 + Rb 20 ml	After 10 days	75.3 (31.8)	11.1 (33.7)	63.4 (35.7)
Mj 1000 + Rb 10 ml	After 10 days	107.8 (27.0)	10.5 (28.1)	96.4 (28.2)
Mj 1000 + Rb 20 ml	After 10 days	101.7 (31.1)	9.2 (35.8)	84.7 (36.9)
Rb 10 ml + Mj 500	After 10 days	49.2 (55.4)	8.1 (51.5)	45.4 (53.9)
Rb 20 ml + Mj 500	After 10 days	42.6 (61.4)	6.1 (63.8)	33.7 (65.8)
Rb 10 ml + Mj 1000	After 10 days	62.2 (57.9)	6.3 (55.5)	57.6 (57.1)
Rb 20 ml + Mj 1000	After 10 days	47.4 (67.9)	4.6 (67.7)	39.9 (70.3)
C.D. (P = 0.05)		4.98	1.26	4.48

Figure in parenthesis indicates per cent reduction over respective control.

Concomitant inoculations of *M. javanica* and *R. bataticola* in various combinations were more damaging than when either pathogen was inoculated alone. Dry weight of shoots, nodulation and pod formation at each combination was significantly lower than the single species inoculation at the same inoculum level. Reduction in shoot dry weight, nodule development and pod formation in concomitant inoculation of *M. javanica* and *R. bataticola* at each combination was significantly more than the sum total of reductions caused by the same inoculum level of the pathogens in single species inoculations. Thus the total reduction in shoot dry weight caused by 500 *M. javanica* and 20 ml *R. bataticola* in single species inoculation was 2.2 g whereas in simultaneous inoculation with 500 *M. javanica* + 20 ml *R. bataticola* the reduction was 2.7 g.

In combined inoculations *M. javanica* followed after ten days by *R. bataticola* caused greater reduction in shoot dry weight, nodule development and pod formation than the other combinations (Table I). Treatments where *M. javanica* inoculation followed ten days after *R. bataticola* caused a minimum reduction.

The interactive effect of the fungus, *R. bataticola* on *M. javanica* was inhibitory in concomitant inoculations. The rate of nematode multiplication (R-factor), root-galling and females declined in all combinations of nematode and fungus to greater extent than at the same level of inoculum in single species inoculation. The rate of nematode multiplication, gall number and females of 500 juveniles of root-knot in single species inoculation was 16.8, 98.6 and 110.4 respectively, while, the corresponding figures were 10.7, 60.8 and 72.3 in the presence of 10 ml fungus in simultaneous inoculation. Similar reductions also occurred in all other combinations. Inoculation of the fungus ten days prior to nematode inoculation caused greater reduc-

tion in R-factor, root-galling and females compared to simultaneous inoculation as well as treatments where fungus inoculation followed after ten days.

A significant ($P < 0.05$) and linear relationship was obtained between shoot dry weight and nodule plant^{-1} ($r^2 = 0.96$) and nodule plant^{-1} and pod plant^{-1} ($r^2 = 0.92$).

Discussion

Reduction in plant growth, nodulation and yield in presence of nematode or fungus was directly, and nematode multiplication was indirectly, proportional to inoculum levels as observed previously by others (Oostenbrink, 1966, Khan and Husain, 1990). Significant damage to plant growth, nodulation and yield due to pathogenic infection by *M. javanica* or *R. bataticola* even at a low inoculum level indicate that the crop is a good host for both pathogens.

In concomitant inoculation of *M. javanica* and *R. bataticola*, reduction in dry shoot weight of blackgram was more than the sum total of reductions caused by the pathogens in single species inoculations at the same inoculum level, thus showing a synergistic relationship (positive interaction). The greatest reduction in plant growth and maximum disease intensity was seen in plants inoculated with nematodes prior to the fungus and was least in plants infected by the fungus and followed by nematodes, possibly associated with nematode-induced physiological alterations in the host tissue. In adition, it appears that the nematode acted as a predisposing agent as there was significantly greater reduction of growth in plants inoculated with nematodes prior to fungus as well as with simultaneous inoculations. Although, studies were not conducted to determine how *M. javanica* predisposed blackgram plants to fungus attack it can be assumed that the nematode caused stress in the plants. Less damage resulted when fungus inoculation was prior to nematode inoculation and it is likely that by the time the plants were inoculated with nematodes the fungus had sufficient time to colonize the cortex, thus making it less suitable for nematode attack.

Reduced nematode multiplication and poor root-knot development in the presence of *R. bataticola* is due to tissue destruction caused by the fungus before completion of the nematode's life cycle. Moreover, competition between *M. javanica* and *R. bataticola* for infection loci or feeding sites and the reduction in root growth may also partly be explained by the reduction in reproduction and root galling.

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