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INTERACTION OF *MELOIDOGYNE INCOGNITA* RACE-3 AND *MACROPHOMINA PHASEOLINA* IN A ROOT-ROT DISEASE COMPLEX OF CHICKPEA

by
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Summary. The growth of chickpea and nodulation was adversely affected by the presence of both *Meloidogyne incognita* race-3 and *Macrophomina phaseolina*. Disease severity increased with increasing inocula and various combinations of *M. incognita* and *M. phaseolina* had a synergistic effect on plant growth reduction. The rate of nematode multiplication was density dependent. Increase in the inoculum level of *M. phaseolina* progressively decreased nematode multiplication and root galling while root-rotting increased with the increase in the combined inocula of *M. phaseolina* and *M. incognita*.

Chickpea, *Cicer arietinum* L., is an important pulse crop in India, which is susceptible to root-knot nematode *Meloidogyne incognita* (Kofoid *et* White) Chitw. and *Macrophomina phaseolina* (Tassi) Goid. During a survey of chickpea crops, many plants were found to be infected with both. They were usually stunted with extensive galling on the roots.

The present investigation was carried out to determine the effect of interaction of different inoculum levels of *M. incognita* race-3 and *M. phaseolina* in the root-rot disease complex of chickpea.

Materials and methods

Seeds of chickpea, surfaced sterilized with 0.1% mercuric chloride for 2 minutes and washed three times with distilled water, were treated with a chickpea strain of *Rhizobium* before sowing. Sucrose solution was used as sticker for bacterization. Five treated seeds were sown in 15 cm earthen pots containing 1 kg steam sterilized soil but after germination only one seedling per pot was maintained. One week after germination seedlings were inoculated with the different inocula of *M. incognita* race-3 and *M. phaseolina* as listed in Table I.

M. incognita, identified as race 3, was collected from a chickpea field and multiplied on eggplant (*Solanum melongena L.*) by single egg mass technique. For the inoculum, egg masses were hand picked and freshly hatched juveniles were used.

M. phaseolina was isolated from infected chickpea roots and a culture was maintained on PDA. The fungus inoculum was prepared by culturing the isolate in Richard's liquid medium for 15 days at 25°C. Tha mycelium was collected on blotting paper to absorb excess water and the inoculum prepared by comminuting 100 g mycelium in 1000 ml distilled water, using 10 ml suspension to provide 1 g mycelium per pot.

Each treatment was replicated three times. Ninety days after inoculation the experiment was terminated when data were recorded on dry plant weight, nodule number, root-knot and root-rot indices and nematode density. Nematodes were extracted from the soil by Cobb's sieving decanting technique. To estimate the number of eggs, juveniles and females in the roots 1g root sample was comminuted for 45 seconds in a Waring blender and the nematodes stages counted in the suspension thus obtained. Root- knot index was based on a 0-5 scale where 0 = no gall, 1 = 1-10 galls; 2 = 11-20 galls; 3 = 21-30 galls; 4 = 31-100 galls and 5 = more than 100 galls per root system. Root-rot index was determined by scoring the severity of disease on a scale ranging from 0 (no disease) to 5 (severe root-rot).

Results and discussion

Various inoculum combinations of *M. incognita* and *M. phaseolina* caused significant decreases in plant growth except at the lowest inoculum level (500 juveniles of *M. incognita* plus 0.25 g *M. phaseolina*) (Table I). The highest inoculum of *M. phaseolina* and *M. incognita* caused severe early rotting and wilting as compared to their lowest combined inoculum. Rotting and wilting, however, increased

with the increase in time. *Macrophomina phaseolina*, a root-rot fungs, caused sufficient damage to the host root system that hampered the uptake of water resulting in wilting of plants even when sufficient soil moisture was present. Total reduction in dry shoot weight caused by both pathogens together was mostly greater than the sum of the independent effects, resulting in a synergistic interaction. Synergistic interaction was probably due to predisposition of plants by *M. incognita* to fungus attack (Batten and Powell 1971, Tu and Cheng 1971). Total number of root galls pro-

TABLE I - *Effect of interaction of variable inoculum levels of* Meloidogyne incognita *and* Macrophomina phaseolina *on dry weight, nodulation, disease development and nematode multiplication.*

Treatment	Dry wt. (g)		No. of nodules	Final nematode population (10^3)	% reduction in dry shoot wt.	% reduction in nodulation	Nematode multiplication	Root-knot index	Root-rot index
	Shoot	Root							
Control	5.7	1.8	37	—	—	—	—	—	—
M. incognita (MI)									
MI 500 juveniles/pot	5.2	1.7	28	19.5	8.8	24.3	39.0	5	—
MI 1000	4.7	1.5	25	31.1	17.5	32.4	31.1	5	—
MI 2000	4.3	1.3	23	44.5	24.6	37.8	22.8	5	—
MI 4000	3.9	1.1	19	54.3	31.6	48.7	13.6	5	—
MI 8000	3.2	0.9	14	72.7	43.9	62.2	9.1	5	—
M. phaseolina (MP)									
MP 0.25 g/pot	5.3	1.7	31	—	7.0	16.2	—	—	2
MP 0.50	4.8	1.6	28	—	15.8	24.3	—	—	4
MP 1.00	4.4	1.3	22	—	22.8	40.5	—	—	4
MP 2.00	3.8	1.1	19	—	33.3	48.7	—	—	5
MP 4.00	3.3	1.0	17	—	42.1	54.1	—	—	5
MP 0.25 + MI 500	4.9	1.5	24	17.6	14.0	35.1	35.2	5	4
MP 0.25 + MI 1000	4.2	1.3	20	25.4	26.3	46.0	25.4	5	5
MP 0.25 + MI 2000	3.5	1.0	18	36.6	38.6	51.4	18.3	5	5
MP 0.25 + MI 4000	2.8	0.9	15	50.0	50.9	59.5	12.5	5	5
MP 0.25 + MI 8000	2.2	0.8	11	59.6	61.4	70.2	7.5	5	5
MP 0.50 + MI 500	4.3	1.4	21	14.5	24.6	43.2	29.0	5	5
MP 0.50 + MI 1000	3.8	1.1	17	21.8	33.3	54.1	21.8	5	5
MP 0.50 + MI 2000	3.0	1.0	12	33.4	47.4	67.6	16.7	5	5
MP 0.50 + MI 4000	2.4	0.8	8	43.5	57.9	78.4	10.9	5	5
MP 0.50 + MI 8000	1.8	0.6	6	54.0	68.4	83.8	6.8	5	5
MP 1.00 + MI 500	3.8	1.1	17	13.8	33.3	54.1	27.6	5	5
MP 1.00 + MI 1000	3.0	1.0	12	18.6	47.4	67.6	18.6	5	5
MP 1.00 + MI 2000	2.5	0.9	8	28.9	56.1	78.4	14.5	5	5
MP 1.00 + MI 400	1.9	0.8	5	38.4	66.7	86.5	9.6	5	5
MP 1.00 + MI 8000	1.7	0.5	4	49.4	70.2	89.2	6.2	5	5
MP 2.00 + MI 500	3.1	1.0	13	10.2	45.6	64.9	20.4	4	5
MP 2.00 + MI 1000	2.6	0.9	8	15.6	54.4	78.4	15.6	5	5
MP 2.00 + MI 2000	2.1	0.7	5	25.5	63.2	86.5	12.8	5	5
MP 2.00 + MI 4000	1.7	0.6	2	33.9	70.2	94.6	8.5	5	5
MP 2.00 + MI 8000	1.1	0.5	0	43.9	80.7	100.0	5.5	5	5
MP 4.00 + MI 500	2.6	0.8	7	8.4	54.4	81.1	16.8	4	5
MP 4.00 + MI 1000	2.0	0.7	4	12.8	64.9	89.2	12.8	5	5
MP 4.00 + MI 2000	1.5	0.4	4	20.0	73.7	89.2	10.0	5	5
MP 4.00 + MI 4000	0.9	0.4	0	27.7	84.2	100.0	6.9	5	5
MP 4.00 + MI 8000	0.6	0.3	0	34.9	89.5	100.0	4.4	5	5
LSD P = 0.05	0.76	0.23	5.07	0.67					
LSD P = 0.01	1.01	0.30	6.73	0.89					

duced by *M. incognita* progressively decreased with the increase in the inoculum levels of *M. phaseolina* but root rotting increased with the increase in the combined inocula of *M. phaseolina* and *M. incognita*.

Reduction in nodulation was significant over control at P = 0.01 level in all treatments except when 0.25 g *M. phaseolina* was used alone. Reduction in nodulation increased more significantly with the increase in combined inoculum. Hundred percent reduction in nodulation was observed when 2 g *M. phaseolina* plus 8000 nematodes or 4 g *M. phaseolina* plus 4000 nematodes or 4 g *M. phaseolina* and 8000 nematodes were inoculated together.

When present alone nematode multiplication was density dependent, being highest at 500 inoculum level and lowest at 8000 inoculum level. Nematode multiplication consistently decreased in combined inoculations with the increase of *M. phaseolina* inoculum probably due to adverse effect on nematode penetration and direct fungus invasion of giant cells disrupting nematode feeding and subsequent reproduction (Powell 1971).

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