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INTERACTION BETWEEN ROOT-KNOT AND STUNT NEMATODES ON TOMATO

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A survey of vegetable fields in Aligarh revealed that root-knot, *Meloidogyne incognita* (Kofoid *et* White) Chitw. and stunt, *Merlinius brevidens* (Allen) Siddiqi, nematodes were invariably associated with tomato crops. It was, therefore, considered interesting to investigate the relationship between these endo- and ecto-parasitic nematodes.

Materials and Methods

Seedlings of tomato (*Lycopersicon esculentum* Mill.) cv. Bonny Best were grown in autoclaved soil contained in wooden trays and were transplanted at the three leaf stages into 15 cm clay pots filled with an autoclaved soil, sand, compost mixture (3:2:1). Seedlings were inoculated with larvae of root-knot nematodes and freshly isolated specimens of stunt nematode at two inoculum levels (1000 and 10,000 specimens per pot). Root-knot nematodes were obtained from a single eggmass culture maintained on tomato. Stunt nematodes were obtained from a single female culture maintained on cabbage, *Brassica oleracea* var. *capitata* or cauliflower, *B. oleracea* var. *botrytis*. The nematode species were inoculated separately or together simultaneously and sequentially (10 or 20 days prior to each other) in all combinations. Treatments were replicated 5 times. The pots were kept on benches in a greenhouse.

In the experiment with simultaneous inoculation plants were up-

rooted 70 days after inoculation. In the sequential inoculation the experiment was terminated 70 days after the first inoculation. Soil populations of each nematode species were extracted by a modified Cobb's sieving and decanting technique and nematodes in the roots by staining with cotton blue-lactophenol and then comminuting them in a Waring blendor (Southey, 1970). The size of adult females of root-knot nematodes and the giant cells induced by them was determined planimetrically (Bird, 1970).

Results

Both nematode species increased in numbers in all treatments with 3 exceptions (Table I). The ratio Pf/Pi for the stunt nematode was 0.63 when the seedlings were inoculated with root-knot nematode 20 days prior to the stunt nematode in the combination consisting of 10,000 specimens of each nematode. Pf/Pi was 0.96 and 0.76 for the root-knot nematode when the seedlings were inoculated 20 days in advance with the stunt nematode in the combinations consisting of 1000 root-knot + 10,000 stunt nematodes or 10,000 specimens of each nematode.

A significant reduction in the density of root-knot nematode populations occurred in combinations consisting of either the highest inoculum level (10,000) of each species or 1000 root-knot + 10,000 stunt nematodes of simultaneous inoculations. Similar results were obtained when seedlings were inoculated with root-knot nematodes 10 or 20 days before the stunt nematode. A significant percent reduction of the final population of root-knot nematodes occurred when seedlings were first inoculated with the stunt nematode. A maximum reduction of 85.7% of root-knot nematodes occurred when 1000 root-knot + 10,000 stunt nematodes were inoculated with the stunt nematode 20 days in advance of the root-knot nematodes.

The final density of the stunt nematode was significantly reduced in the simultaneous combinations consisting of 10,000 specimens of each nematode or 10,000 root-knot + 1000 stunt nematodes. The final density of stunt nematode was reduced significantly in all the combinations except that in which 1000 root-knot nematodes were inoculated 10 days prior to 1000 stunt nematodes. The percent reduction was far greater when seedlings were inoculated with the root-knot nematode 20 days prior to the stunt nematode (in the combination

Table I - *Influence of simultaneous and sequential inoculations of tomato cv. Bonny Best with* Meloidogyne incognita *(MI) and* Merlinius brevidens *(MB) on their population development.*

Treatments Inoculum level ($\times 10^3$)	Pf/Pi									
	Simultaneous inoculation		Sequential inoculation							
			MI days prior to MB				MB days prior to MI			
			10		20		10		20	
	MI	MB	MI	MB	MI	MB	MI	MB	MI	MB
MI and MB alone										
1. 1	6.8	5.3	—	—	—	—	—	—	—	—
2. 10	3.0	2.8	—	—	—	—	—	—	—	—
MI + MB										
3. 1 + 1	6.7 (−1.3)	5.6 (+5.7)	6.6 (−2.2)	5.8 (+9.5)	6.8 (+1.2)	3.2 (−38.3*)	5.6 (−17.3*)	6.1 (+15.0*)	3.5 (−48.8*)	7.1 (+34.8*)
4. 1 + 10	3.1 (−54.1*)	2.4 (−13.0)	4.8 (−28.4*)	2.3 (−18.1*)	5.1 (−24.5*)	1.8 (−37.0*)	3.8 (−44.5*)	2.4 (−16.1*)	0.96 (−85.7*)	2.5 (−12.2)
5. 10 + 1	2.9 (−5.0)	3.1 (−41.0*)	2.9 (−1.5)	2.8 (−46.5*)	3.3 (+9.9)	1.5 (−71.1*)	2.7 (−11.8)	2.2 (−25.6*)	1.4 (−54.0*)	3.8 (−26.9*)
6. 10 + 10	1.5 (−49.9*)	1.6 (−42.2*)	1.6 (−47.7*)	1.6 (−44.1*)	2.1 (−31.4*)	0.63 (−77.7*)	1.3 (−34.4*)	1.7 (−40.9*)	0.76 (−74.9*)	1.9 (−33.1*)

Figures in parenthesis indicate per cent increase (+) or decrease (−) in the final population calculated over final population in control;

* = data significant (LSD, P=0.01) − mean values in treatments 3, 4, 5 and 6 were compared with mean values in treatments 1 and 2 against their respective population level.

consisting of 1000 root-knot + 10,000 stunt nematodes or 10,000 specimens of each nematode species). There were similar reductions in the final density of the stunt nematode when seedlings were inoculated with it 10 or 20 days prior to the root-knot nematode in all combinations except one (consisting of 1000 specimens of each species) where the population increased significantly.

The male/female ratio of the root-knot nematode increased as the inoculum level increased (Table II). It also increased significantly when seedlings were inoculated with both nematode species simultaneously in combinations consisting of 1000 root-knot + 10,000 stunt nematodes or 10,000 specimens of each species. When seedlings were inoculated with the root-knot nematode 10 days prior to the stunt nematode, there was a significant increase in male/female ratio in the combination constiting of 1000 root-knot + 10,000 stunt nematodes or 10,000 specimens of each nematode. No significant change in sex ratio was observed when seedlings were inoculated with root-knot 20 days prior to the stunt nematode. Similar results were obtained for treatments where seedlings were inoculated with the stunt nematode 10 or 20 days before the root-knot.

The male/female ratio of the stunt nematode also increased as the inoculum level increased (Table II). A significant increase was observed when seedlings were inoculated with both nematodes simultaneously or sequentially 10 or 20 days prior to each other, except that no significant change in the sex ratio was observed when 1000 stunt nematodes were inoculated 20 days before inoculation with 10,000 root-knot nematodes.

Increasing inoculum levels of the root-knot nematode resulted in a reduction in size of adult females and the giant cells induced by them (Table III). Reduction in the size of the adult females and the giant cells also was observed in treatments when the stunt nematode was inoculated 20 days prior to root-knot. The greatest reductions with both simultaneous and sequential inoculations were obtained with inoculations of 10,000 of each nematode species.

Discussion

The results of the experiments showed that the final population of each nematode species was repressed when both of them were present in the rhizosphere at high initial inoculum level (10,000

Table II - *Influence of simultaneous and sequential inoculation of tomato cv. Bonny Best with* Meloidogyne incognita *(MI) and* Merlinius brevidens *(MB) on their sex differentiation.*

Treatments Inoculum level ($\times 10^3$)	Sex ratio (male/female)									
	Simultaneous inoculation		Sequential inoculation							
			MI days prior to MB				MB days prior to MI			
			10		20		10		20	
	MI	MB	MI	MB	MI	MB	MI	MB	MI	MB
MI and MB alone										
1. 1	0.04	0.50	—	—	—	—	—	—	—	—
2. 10	0.40	1.30	—	—	—	—	—	—	—	—
MI + MB										
3. 1 + 1	0.03	0.50	0.01	0.50	0.03	0.70	0.07	0.60	0.09	0.50
4. 1 + 10	0.13*	1.40	0.09*	1.30	0.06	1.60	0.20*	1.30	0.37*	1.30
5. 10 + 1	0.40	0.70*	0.40	0.90*	0.40	1.90*	0.41	1.80*	0.60	0.70
6. 10 + 10	0.90*	2.30*	0.90*	2.10*	0.45	2.60*	0.87*	2.20*	1.10*	1.70*

* = data significant (LSD, P=0.01) – mean values in treatments 3, 4, 5 and 6 were compared with mean values in treatments 1 and 2 against their respective population level.

Table III - *Influence of simultaneous and sequential inoculation of tomato cv. Bonny Best with* Meloidogyne incognita *(MI) and* Merlinius brevidens *(MB) on size of adult females of* M. incognita *and of the giant cells.*

Treatments Inoculum level ($\times 10^3$)	Size of adult females ($\times 10^3$ μm^2)			Size of giant cells ($\times 10^3$ μm^2)		
	Simultaneous inoculation	Sequential inoculation		Simultaneous inoculation	Sequential inoculation	
		MI 20 days prior to MB	MB 20 days prior to MI		MI 20 days prior to MB	MB 20 days prior to MI
MI and MB alone						
1. 1	30.5	—	—	57.8	—	—
2. 10	19.9	—	—	49.7	—	—
MI + MB						
3. 1 + 1	26.3	27.7	24.9*	56.7	57.6	53.8
4. 1 + 10	24.8*	22.5*	20.7*	50.5*	52.6	40.3*
5. 10 + 1	18.2	17.6	16.5*	44.8*	45.3	40.5*
6. 10 + 10	13.6*	16.8*	12.2*	39.8*	40.2*	31.7*

* = data significant (LSD, P=0.01) – mean values in treatments 3, 4, 5 and 6 were compared with mean values in treatments 1 and 2 against their respective population level.

specimens/pot). Also that the final population of one species was repressed by the other if the latter species outnumbered the former species at the time of inoculation e.g. 1000 + 10,000 specimens/pot. This repressive interaction can be attributed to indirect nutritional stress on the host. Obviously reduction in the size of giant cells is likely to hamper the development of the females of the root-knot nematode and thus adversely influence the fecundity of the nematode or skew the sex ratio towards males (Tables I and II). The role of limited food and space on development of entrant larvae of root-knot nematode has been identified by several authors (Tyler, 1933; Triantaphyllou, 1960; Davide and Triantaphyllou, 1967). In the experiments is appears plausible that changes in host physiology including growth hormones might have occurred as suggested by Estores and Chen (1972) and McIntyre and Miller (1976). An antagonistic interaction resulting in repression in the final population of one species by another on various hosts has been reported by various workers (Ross, 1964; Johnson, 1970; Johnson and Nusbaum, 1970; Turner and Chapman, 1972; Gay and Bird, 1973) but in such interactions population density was not the determinant of the antagonism. The relationship between *M. incognita* and *M. brevidens* may be a 'competition-resource use' type of interaction as defined by Odum (1971).

SUMMARY

The interrelationship between *Meloidogyne incognita* and *Merlinius brevidens* was studied in the greenhouse by inoculating tomato seedlings simultaneously and sequentially with the nematodes at two inoculum levels. One species reduced the other or both reduced each other significantly in treatments where one numerically dominated over the other (the combination being 10,000 + 1000 specimens/pot) or where both of them were present at the highest inoculum level (10,000 specimens/pot of each species) in simultaneous or sequential inoculation treatments. The size of adult females of *M. incognita* and the giant cells was significantly reduced while the male/female ratio of both the nematodes increased significantly in both simultaneous and sequential inoculations.

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