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Plant Pathology and Plant Nematology Laboratories
Department of Botany, Aligarh Muslim University, Aligarh-202001, India

COHABITATION OF *MELOIDOGYNE INCOGNITA* AND *ROTYLENCHULUS RENIFORMIS* IN TOMATO ROOTS AND EFFECT ON MULTIPLICATION AND PLANT GROWTH

by
R. M. KHAN, M. W. KHAN and A. M. KHAN

Pathogenicity associated with plant parasitic nematodes is influenced by various abiotic and biotic factors (Wallace, 1973; Norton, 1978; Khan, 1981). The root-knot nematode, *Meloidogyne incognita* (Kofoid *et* White) Chitw. and the reniform nematode *Rotylenchulus reniformis*, Linford *et* Oliveira are the most frequently occurring nematode pathogens on tomato grown outdoors in the Aligarh area and can cause severe damage to the crop. In the present study, we examined the effect of the two parasites on each other in cohabitation on tomato and the resultant effect on plant growth.

Materials and methods

Seeds of tomato, *Lycopersicon esculentum* Mill. cv. Marglobe were surface sterilized and sown in wooden trays containing autoclaved soil. Fifteen days after germination seedlings were transplanted to 15 cm clay pots containing autoclaved soil. A day later the pots were inoculated with freshly hatched second stage juveniles of *M. incognita* and immature females of *R. reniformis* (Table I). The experiment was terminated 60 days after inoculation and the numbers of both nematode species from roots and soil were determined and the fresh weights of the plants calculated.

In another experiment, to ascertain the effect of concomitant inoculation on penetration of the two nematode species, fifteen-day-

Table I - *Interaction between* Rotylenchulus reniformis *and* Meloidogyne incognita *on tomato at different inoculum level combinations.*

Initial inoculum (Pi)		Final population (Pf)		Fresh weight of plants (g)
R. reniformis	*M. incognita*	*R. reniformis*	*M. incognita*	
Control				55.9 cd
10		622 c		40.5 bc
100		4206 ac		33.8 ac
1000		28075 bd		31.8 ab
	10		110 a	58.5 aa
	100		5382 d	36.2 ad
	1000		8500 ab	29.2 d
Combination set I				
10	10	675 d	122 a	31.0 ab
100	10	5335 ad	100 a	20.5 b
1000	10	28084 bd	220 a	25.2 c
Combination set II				
10	100	440 b	4172 c	47.3 cb
100	100	5292 ad	2520 b	46.8 cb
1000	100	24538 bc	2544 b	19.4 a
Combination set III				
10	1000	360 a	8835 ac	18.1 a
100	1000	3370 ab	5749 d	20.8 b
1000	1000	13829 ba	2520 b	42.7 bd

Figures in columns followed by the same letter(s) are not significantly different at ($P = 0.05$).

old tomato seedlings were transplanted into small plastic cups containing 1:1 sand:silt mixture. The cups were then inoculated with root-knot or reniform nematodes separately and in combination (Table II). Each treatment was replicated three times. The seedlings were uprooted 6, 12, 48, 72 hrs and one week after inoculation. Roots were thoroughly washed, stained in cotton blue-lactophenol and the nematodes in the roots were counted.

In a third experiment, tomato seedlings inoculated either with root-knot or reniform nematodes were uprooted 72 hrs after inoculation. Roots were washed and fixed in F.A.A., processed in a tertiary-butyl alcohol series, embedded in paraffin-wax and sectioned with a rotary microtome. The sections were stained with safranin and fast green and examined with a light microscope for histopathological details.

Table II - *Penetration of* Rotylenchulus reniformis *and* Meloidogyne incognita *at different intervals in tomato roots in concomitant inoculations.*

Initial inoculum level		*R. reniformis* Intervals (hrs)					*M. incognita* Intervals (hrs)				
R. reniformis	*M. incognita*	6	12	48	72	1 week	6	12	48	72	1 week
10		1	4	5	6	8					
100		4	8	14	20	40					
1000		20	60	88	140	180					
	10						2	6	7	8	9
	100						6	8	16	22	55
	1000						30	69	100	188	220
10	10	2	5	5	8	9	2	4	6	8	10
100	10	3	8	18	22	46	1	5	8	8	9
1000	10	22	58	90	148	175	3	3	5	7	8
10	100	2	3	4	7	9	7	8	18	24	60
100	100	4	7	18	22	45	7	10	19	24	62
1000	100	22	62	84	146	178	4	6	6	15	40
10	1000	—	4	5	7	8	32	68	98	184	230
100	1000	—	4	16	18	36	28	68	98	160	198
1000	1000	10	22	60	100	140	8	70	80	140	160

L.S.D. - In the marginal mean of treatments at (P = 0.05) = 29.42
at (P = 0.01) = 39.37

L.S.D. - In the marginal mean of intervals at (P = 0.05) = 21.72
at (P = 0.01) = 29.35

Results and discussion

Table I shows the rate of increase of both *M. incognita* and *R. reniformis* at three inoculation densities. With both species increase in population densities resulted in decrease in plant weight except at 10M where plant growth was slightly stimulated. The rate of multiplication of *M. incognita* was less than *R. reniformis*. At 100 inoculum density, *R. reniformis* produced a relatively greater decrease in plant growth than *M. incognita*. But at 1000 inoculum density, *M. incognita* caused greater reduction in plant growth than *R. reniformis*.

With concomitant inoculations, when the initial inoculum level of *M. incognita* was constant at 10M and that of *R. reniformis* varied from 10 to 1000 (Table I), each nematode species appeared to multiply independently and was unaffected by the other. At an inoculum level of 10 *M. incognita* and 10 *R. reniformis*, penetration and multiplication were not affected by each other. At 10M+1000R, the population of *R. reniformis* increased and reached the same level as in separate inoculation with 1000R (Table I). However, there was a greater reduction in plant growth than with 1000R alone, indicating an interaction with *M. incognita* (Table II).

The plant weight at 10M+10R combination was less than with either nematode alone. Evidently, both nematodes together reduced the plant weight. The plant weight at 10M increased in comparison with the control (uninoculated) (Table I). It is reported that root-knot nematodes at low populations result in an increase in plant weight. This occurs because of the regeneration and proliferation knot nematodes at low populations result in an increase in plant weight. This occurs beceause of the regeneration and proliferation of lateral roots in response to nematode infection, thereby increasing the absorbing capacity of the plants (Wallace, 1971). *R. reniformis* even at 10R level, reduced plant weight. *R. reniformis* feeds in the endodermis and pericycle region (Heald, 1975; Rebois *et al.*, 1975), which is the generating centre for lateral roots; parasitization of this region might have hampered the regeneration of lateral roots. Additionally, the feeding of *M. incognita* on vascular elements would have impaired the absorption and translocation of water and nutrients. These factors together would have resulted in greater decrease in plant weight with 10M+10R than with 10R alone. At 100R+10M and 1000R+10M, plant weight further decreased and was less than with 100R or 1000R alone (Table I).

In the second set of combinations, with a constant level of 100M, multiplication of *R. reniformis* when compared with 10M constant level further declined at each level of inoculation except at 100R where it was not significantly different. As compared with 100M alone, the rate of multiplication of *M. incognita* also declined. Plant weight increased at 10R+100M and 100R+100M but not when either of the nematodes was inoculated alone. However, at 1000R+100M it decreased considerably (Table I).

In the third set of combinations, with a constant level of 1000M, the multiplication of both *R. reniformis* and *M. incognita* was greatly reduced at all combinations except for *M. incognita* at 10R+1000M. Plant weight was greatly reduced as compared with all other inoculations except at 1000R+1000M where it was relatively high; but it was much less than in the control. As the root-knot and reniform nematodes penetrate the root tip (Linford, 1939; Birchfield, 1962), it is likely that at higher levels of inoculation, overcrowding and clustering might have occurred, thus preventing many of the nematodes from penetrating the roots, which in turn would affect the final population. Penetration of either nematode was unaffected at low concomitant inoculum levels (Table II) and at higher inoculum levels a decline in penetration was observed only a week after inoculations. Singh (1976) also reported that in mixed infections, the penetration of *M. incognita* and *R. reniformis* was reduced significantly only after 20 days from inoculation. At low inoculum levels it seems likely that the nematodes would not restrict the penetration of each other. Although, the penetration of both species declined only at 1000R+1000M, multiplication was, however, affected both at 100 and 1000 inoculum levels of *M. incognita* and varying numbers of *R. reniformis*. So clustering and overcrowding may not be the only factors responsible for such reductions.

Chapman (1959) noticed that in alfalfa and red clover when *Pratylenchus penetrans* and *Tylenchorhynchus martinii* were present together, the population of the latter was significantly reduced whereas *P. penetrans* remained unaffected. He postulated that the root damage caused by *P. penetrans* reduced the food supply available to *T. martinii*. Kinloch and Allen (1972) postulated that reduction in penetration of *M. incognita* and *M. hapla* probably occurred due to destruction of roots before penetration was reduced. A comparable situation occurred for the nematodes in our studies. Both the nematode species feed in the same zone of the root and modify

root tissues into giant cells (Bird, 1971; Sivakumar and Seshadri, 1972; Brathwaite and Duncan, 1974; Heald, 1975; Rebois *et al.*, 1975). We observed in histopathological studies that the infective stage of *R. reniformis* moving intracellularly destroyed cortical cells. As *M. incognita* juveniles move intercellularly through the cortical cells, it is presumed that due to destruction of cortical cells after a large number of immature females of *R. reniformis* have entered the root, the substrate in the cortical region became unsuitable for invasion by *M. incognita*. Also, this may be true for *R. reniformis*. This reduced penetration would be reflected in population reduction.

Clustering and overcrowding, modification and destruction of root tissue and competition for food in short supply are factors that contributed towards reduction in multiplication and penetration. Both the nematodes apparently demonstrated negative interaction particularly at higher inoculum levels in the host. This minimized their adverse effect on plant growth as noticed at 1000R+1000M where an increase in plant growth was observed. As a result of reduced penetration at 1000R+1000M as evident in the growth and multiplication experiment, and also in the penetration experiment (Table II), the plant had to sustain relatively fewer nematodes. Competition between the individuals of both species for nutrients would have affected their pathogenic effects. Further, histopathological changes caused by one nematode species might not have provided suitable nutritional and space requirements for the other species.

SUMMARY

The study examines the interaction of the root-knot, *Meloidogyne incognita* and the reniform, *Rotylenchulus reniformis*, nematodes during cohabitation on tomato roots in artificial inoculations. In single inoculations, populations of both species increased progressively with increase in the inoculum level. In concomitant inoculations, *R. reniformis* penetration and multiplication were unaffected by the presence of low numbers of *M. incognita*. Increase in the inoculum level of *M. incognita* up to 100 juveniles affected multiplication of both species but penetration was unaffected. In the presence of higher numbers of *M. incognita* (1000 juveniles) multiplication of *R. reniformis* declined at all inoculum levels but penetration decreased only at 1000 initial inoculum level. At an initial inoculum level of 1000, multiplication of *M. incognita* was adversely affected by an inoculum of 100 or 1000 *R. reniformis*; but penetration of *M. incognita* declined only when the inoculum level of both nematodes was 1000.

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