Interaction of the cyst and root-knot nematodes in roots of rice

Y. Seshagiri Rao, J. Satyanarayana Prasad and A.V. Surya Rao

Central Rice Research Institute, Cuttack-753006, Inde.

Summary

Interspecific interaction between the endoparasitic stages of the cyst nematode (*Heterodera oryzicola*, Rao & Jayaprakash, 1978), and the root-knot nematode (*Meloidogyne graminicola*, Golden & Birchfield, 1968) in roots of rice cv. Sattari was investigated under artificial inoculations. With the increase in initial density of each nematode in the inoculum, there was corresponding significant increase in final density at 35 days. When inoculated in combination to the same plant, at the same time or the cyst nematode first and root-knot nematode a week later or vice versa, the root-knot nematode was found to multiply more rapidly and was better adapted. The buildup of the cyst nematode was partly inhibited in the competition for food and space in roots.

Résumé

Interaction entre un Heterodera *et un* Meloidogyne *dans les racines du riz*

L'interaction entre les stades endoparasites d'*Heterodera oryzicola* Rao & Jayaprakash, 1978 et de *Meloidogyne graminicola* Golden & Birchfield, 1968 dans les racines du riz cv. Sattari a été étudiée par inoculation artificielle. A l'augmentation de la population initiale (inoculum) de chaque nématode a correspondu une augmentation de sa population finale après 35 jours. Quand les deux parasites étaient inoculés à la même plante au même moment où l'un d'entre eux une semaine avant l'autre, *Meloidogyne graminicola* se multipliait plus rapidement et apparaît donc mieux adapté. Le développement d'*Heterodera oryzicola* apparaissait partiellement inhibé dans la compétition pour l'espace et la nourriture à l'intérieur des racines.

The root-knot nematode *Meloidogyne graminicola* (Mg) is established as a pest of rice in upland and well drained soils causing losses of up to 17% in grain yield (Biswas & Rao, 1971) due to ill-filling of kernels (Rao & Biswas, 1973). The cyst nematode *Heterodera oryzicola* (Ho) is restricted to a few areas in Kerala, Orissa but inflicts yield losses of up to 41.9% (Usha & Kuriyan, 1981). Juveniles of both pests penetrate through cortex to the vascular tissue of roots and invade phloem. With Mg, phloem parenchymatous cells form multinucleate coenocytes on the 4th day of invasion (Jena & Rao, 1977) while with Ho, coalescence of cells to form syncytium occurs but without hyperplasia of xylem as in Mg infestation (Jayaprakash & Rao, 1981). Mg completes its life cycle in 24 (male) to 27 days (female) while Ho takes 14 to 20 days respectively. As reported above, both the pests compete for phloem and hence it was designed to investigate the influence of one over the other in inoculated conditions during 1980-81.

Material and methods

Pure cultures of both nematodes were maintained on susceptible rice cv. *Sattari*. Egg masses of root-knot nematode and cysts with egg sacs of the cyst nematode were drawn from cultures for tests. Inoculations were given to ten days old plants of cv. Sattari growing individually in sterilised soil (1 kg) filled in pots by placing the inocula in soil near the root zone. Seven inoculum levels viz. 6 Ho — 5 Ho + 1 Mg — 4 Ho + 2 Mg — 3 Ho + 3 Mg — 2 Ho + 4 Mg — 1 Ho + 5 Mg and 6 Mg were given in four combinations viz. (*i*) Ho alone, (*ii*) Ho and Mg together, (*iii*) Ho first and Mg a week later and (*iv*) Mg first and Ho a week later. All treatments were replicated three times. At 35 days after inoculation the total number of the nematodes in the root tissue was enumerated after staining in cotton blue lactophenol and soil population was estimated by wet sieving and extraction of the entire soil from each pot (Rao & Israel, 1972). The log values of the populations in the three replicates were analysed as randomised block design for comparing the buildup in the inoculations.

Results and discussion

Final populations

With the increase in the density of Ho cysts from one to six in the inoculum, there was an increase in the total number of nematodes in the root tissue

irrespective of the inoculum combinations (Tab. 1). However, the invading larvae of Ho were significantly more numerous when Ho alone was inoculated followed by inoculations given along with Mg. There was increase in final populations of Mg also due to the increase in the number of egg masses in the inoculum. But, at levels of three to five egg masses alone in the inoculum, the final populations were on par. Inoculation of Mg to plants inoculated earlier with Ho did not affect the endoparasitic populations though inoculations with Mg in combination with Ho showed a slight reduction.

TABLE 1

Influence of concomitant inoculation of *Heterodera oryzicola* (Ho) and *Meloidogyne graminicola* (Mg) in rice

	Inoculum combination						*C.D. 0.05%*		
Inoculum levels Ho-Mg	*Ho alone*	*Ho and Mg together*	*Ho first and Mg a week later*	*Mg first and Ho a week later*	*Mg alone*	*Mean*	*Inoculum levels*	*Inoculum combinations*	*Interaction*
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*
Heterodera oryzicola			a) Final population						
1-5	39	40	62	32		43			
2-4	95	77	99	57		81			
3-3	145	122	158	90		126			
4-2	192	166	235	147		183			
5-1	255	194	376	233		257			
Mean	122	105	153	89			0.15	0.49	0.23
6-0	478								
Mean	416						0.40	NS	NS
			b) Cysts and eggmasses						
1-5	18	12	2	2		6			
2-4	27	12	9	4		10			
3-3	48	40	21	9		25			
4-2	55	57	21	13		31			
5-1	66	55	49	20		44			
Mean	39	28	13	6			0.29	0.33	0.67
6-0	78								
Mean	43						0.31	NS	NS
Meloidogyne graminicola			a) Final population						
5-1		78	124	108	134	109			
4-2		158	189	164	324	198			
3-3		252	308	6 836	358	311			
2-4		399	488	503	596	493			
1-5		518	633	685	765	645			
Mean		230	296	290	372		0.12	0.06	0.27
0-6					821				
Mean					424		0.40	NS	NS
			b) Eggmasses						
5-1		19	7	14	17	13			
4-2		20	12	26	19	11			
3-3		59	19	56	49	42			
2-4		136	79	89	107	100			
1-5		108	90	143	143	118			
Mean		51	26	40	47		0.61	NS	0.26
0-6					185				
Mean					59		0.52		

ADULTS IN THE FINAL POPULATION

H. oryzicola : Significant reduction in the final population of Ho was observed in inoculations made along with Mg either concurrently or a week later at all levels of Ho and Mg (Tab. 1) over the individual inoculations of Ho.

M. graminicola : Inoculations with Mg alone or along with Ho were at par and significantly superior to those given with Ho first and Mg a week later or Mg first and Ho a week later indicating a certain amount of competition between both (Tab. 1).

BUILDUP INDEX

H. oryzicola : Inoculation with Ho alone showed significantly higher buildup at all levels than when inoculated in combination (Fig. 1). Inoculations with Mg first followed by Ho showed least buildup which was due to the ill-effects of competition between both. At low inoculum densities, *H. schachtii* and *H. oryzae* were reported to produce higher per cent females. Increase in inoculum size resulted in non-availability of "living space" and destruction of the immature stages (Kerstan, 1969). Such behaviour of *H. oryzicola* in roots of rice at levels of 120 eggs /g soil were identified earlier (Jayaprakash, 1979).

M. graminicola : With the increase in the number of egg masses in the inocula, there was a corresponding increase in the buildup of the final population in all combinations (Fig. 1). Irrespective of whether inoculations were given with Mg alone or in combination with Ho, the increasing trend of final population was same confirming earlier reports of Mg development in roots at graded levels of 1 to 32 egg masses in inoculum (Rao & Israel, 1972). *H. oryzae* does not cause true giant cells (Berdon- B. & Merny, 1964) but areas of disintegration of cell wall within stele were found. In the barnyard grass (*Echinochloa colonum*) affected by *H. graminophila* neither giant cells nor galls were found, but only slight enlargment of phloem occurred (Birchfield, 1973). *H. oryzicola* appears to depend on the syncytial development for nutrition and hence the competition with Mg. The root-knot seemed to be the aggressive pest since the final populations and the buildup of Ho were reduced when inoculation were given with both the pests. Even at an equal level of 3 Ho + 3 Mg inoculum, the buildup of Mg was higher.

In an earlier trial, it was observed that larvae of Mg hatched and established earlier in rice roots than Ho larvae (Rao & Prasad, 1982) when inoculated together. These observations confirm the earlier reports on *M. incognita* and *H. zeae* inoculations simultaneously in maize where the former did not interfere with the penetration of the later. Also it was stated that in general prior establishment of any of the species, significantly reduced the invasion of the other species (Kaul & Sethi, 1982). This differential behaviour may be due to the dominance of Mg over Ho in rice in the present investigation.

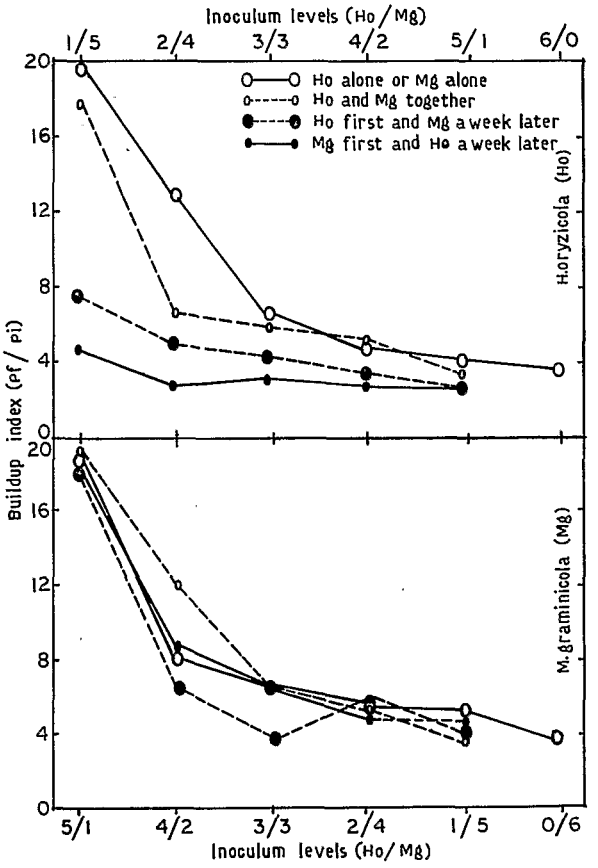

Fig. 1. Interaction of cyst and root-knot nematodes in rice roots.

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