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RESPONSE OF LINES OF *CAPSICUM* SPP. TO ITALIAN POPULATIONS OF FOUR SPECIES OF *MELOIDOGYNE*

by
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Summary. The reactions of lines of *Capsicum baccatum*, *C. baccatum* var. *pendulum*, *C. chacoense*, *C. chinense* and *C. frutescens* to Italian populations of *Meloidogyne incognita*, *M. javanica*, *M. arenaria* and *M. hapla* were evaluated in glasshouse. Groups of eight plants of each line were transplanted in trays with 12dm^3 of sterilized sandy soil artificially infested with 5,000 eggs and juveniles of each nematode species per plant. Two lines of *C. chinense* and one of *C. frutescens* were resistant to all *Meloidogyne* spp. tested. Seven lines of *C. chinense*, and one of *C. chacoense* were resistant to *M. incognita*, *M. javanica* and *M. arenaria*; one line of *C. chacoense* and two of *C. chinense* were resistant to *M. incognita* and *M. arenaria*. Three lines of *C. chinense* were resistant to *M. incognita* and *M. javanica*. One line of *C. chacoense*, four of *C. chinense* and five of *C. frutescens* were resistant only to *M. incognita*, while three lines of *C. baccatum*, eight of *C. baccatum* var. *pendulum*, nineteen of *C. chacoense*, and ten of *C. frutescens* were susceptible to all four species of the root-knot nematodes.

Among the available cultivars and hybrids of pepper (*Capsicum annuum* L.) only a few are resistant to *Meloidogyne javanica* (Treub) Chitw. A source of resistance to *M. incognita* (Kofoid *et* White) Chitw., *M. javanica* and *M. arenaria* (Neal) Chitw., but not to *M. hapla* Chitw., was found in some lines of *C. frutescens* L. (Di Vito and Saccardo, 1982). Germplasm of pepper from the collection of Dr. Csilléry (Research Institute for Vegetable Crops, Station Budateteny, Budapest, Hungary) was tested in glasshouses to evaluate its reaction to four Italian populations of these root-knot nematode species.

Materials and methods

Lines of *Capsicum baccatum* Wild (3), *C. baccatum* var. *pendulum* (8), *C. chacoense* Hunz. (23), *C. chinense* Jacq. (27), and *C. frutescens* (16), were sown in plastic trays of steam sterilized sandy soil. At the two-leaf stage eight seedlings of each line were transplanted into further trays with the same substrate. Seven days later they were inoculated with 5,000 eggs and juveniles per plant of one of the nematode populations. The nematode populations used as inoculum were *M. incognita* host race 1 (Taylor and Sasser, 1978; Di Vito and Greco, 1982) from Castellaneta (Apulia), *M. javanica* from Ragusa (Sicily), *M. arenaria* host race 2 from Verona (Veneto) and *M. hapla* from Foggia (Apulia). They had been reared on tomato (*Lycopersicon esculentum* Mill.) cv. Rutgers in a glasshouse and the inoculum was extracted from infested roots by using the sodium hypochlorite method (Hussey and Barker, 1973). Pepper cv. Marconi Giallo was used as a susceptible control. All the trays were randomly arranged on benches in a glasshouse maintened at 27 ± 2°C. Forty five days after inoculation the plants were uprooted, the roots were gently washed and the egg masses stained by dipping the roots in a Phloxine B solution (0.15g/l of tap water) for 15 min (Dickson and Ben Struble, 1965). The egg mass index (EI) was then assessed according to a 0-5 scale, where 0 = no egg masses, 1 = 1-2 egg masses, 2 = 3-10, 3 = 11-30, 4 = 31-100, and 5 more than 100 egg masses (Taylor and Sasser, 1978).

A plant was considered resistant when the EI was ≤ 2. The data were than statistically analyzed and LSD's calculated.

Results and discussion

The line 201-21 of *C. chinense* was completely free of *M. incognita* and *M. arenaria* (EI = 0) but a few egg masses were found on the roots of the plants inoculated with *M. javanica* and *M. hapla* (Tab. I). No egg masses were found on the roots of the line 546-6 of the same species of pepper inoculated with *M. incognita* or *M. javanica*, while some egg masses were found on the roots inoculated with *M. arenaria*. Also, there were no egg masses on the roots of the lines 210- 26, 548 and 550-10 inoculated with *M. incog-*

nita, but a few were present on those inoculated with *M. javanica* and *M. arenaria* (Tab. I). The lines 201-16 of *C. chinense* and 589-20 of *C. frutescens* were resistant to all species of root-knot nematodes tested. The line 530-8 of *C. chacoense*, and the lines 201-6, 201-24, 201-26 and 201-27 of *C. chinense* were resistant to *M. incognita*, *M. javanica* and *M. arenaria*, but susceptible to *M. hapla*. One line of *C. chinense* (563-22a) was resistant to *M. incognita* and *M. javanica*, but susceptible to *M. arenaria* and *M. hapla*. Two lines of *C. chacoense* (213 and 528-8) and three of *C. chinense* were resistant to *M. incognita* and *M. arenaria*, but susceptible to *M. javanica* and *M. hapla*. One line of *C. chacoense* (529-8), four of *C. chinense* (544, 511-11, 555-15, and 577-17a) and five of *C. frutescens* (579-4, 580/2-5, 585-10, 586-12 and 591-30) were resitant only to *M. incognita* (Fig. 1) and susceptible ot the remainder three species of root-knot nematodes (Tab. I). The remaining 19 lines of *C. chacoense*, *C. chinense*, 10 of *C. frutescens*, and all lines of *C. baccatum* and *C. baccatum* var. *pendulum* were susceptible to the four Italian populations of *Meloidogyne* spp. tested (Fig. 1). The roots of the control cv. Marconi Giallo were heavily infested by the nematodes with an EI of about 5 (Tab. I).

Fig. 1 - Pepper roots of a resistant line of *Capsicum frutescens* (left) and of susceptible lines of *C. baccatum* (center) and *C. baccatum* var. *pendulum* (right) inoculated with *Meloidogyne incognita*.

TABLE I - *Reaction of lines of* Capsicum spp. *to Italian populations of* Meloidogyne incognita, M. javanica, M. arenaria *and* M. hapla.

Line	*M. incognita*		*M. javanica*		*M. arenaria*		*M. hapla*	
	EI*	HR**	EI	HR	EI	HR	EI	HR
Capsicum baccatum								
109-1	3.4	S	4.0	S	4.2	S	4.8	S
208-4	3.0	S	5.0	S	4.6	S	4.2	S
501-1	3.7	S	4.4	S	5.0	S	5.0	S
C. baccatum var. *pendulum*								
599-2	3.1	S	3.4	S	3.1	S	4.4	S
601-4	3.2	S	4.0	S	3.7	S	4.1	S
602-5	3.2	S	4.0	S	4.0	S	4.9	S

Table I continued

Line	*M. incognita*		*M. javanica*		*M. arenaria*		*M. hapla*	
	EI*	HR**	EI	HR	EI	HR	EI	HR
603-6	3.2	S	4.0	S	3.4	S	3.7	S
604-7	2.6	S	3.4	S	3.2	S	4.0	S
611-14	3.2	S	3.4	S	2.9	S	4.3	S
612-15	3.1	S	4.7	S	3.6	S	3.4	S
613-7	3.6	S	4.4	S	3.6	S	4.1	S
C. chacoense								
102	4.3	S	3.7	S	4.0	S	4.3	S
102-1	3.8	S	3.4	S	3.6	S	3.4	S
205-4	3.2	S	3.0	S	4.0	S	3.4	S
211-2	3.1	S	4.6	S	5.0	S	4.0	S
213-8	1.7	R	2.6	S	1.0	R	4.0	S
516-1	4.0	S	4.4	S	5.0	S	4.9	S
519-3	2.6	S	5.0	S	5.0	S	5.0	S
520-3	3.2	S	5.0	S	4.8	S	5.0	S
521-3	2.6	S	5.0	S	5.0	S	5.0	S
522-3	3.6	S	5.0	S	5.0	S	5.0	S
524-4	2.8	S	4.2	S	5.0	S	4.9	S
525-6	3.6	S	4.0	S	3.0	S	3.4	S
526-6	3.3	S	4.6	S	4.9	S	5.0	S
527-6	3.3	S	3.6	S	3.9	S	5.0	S
528-8	2.0	R	2.7	S	1.9	R	2.9	S
529-8	1.9	R	3.7	S	3.7	S	3.1	S
530-8	0.6	R	0.5	R	0.6	R	3.7	S
533-9	2.6	S	4.2	S	2.8	S	3.4	S
534-10	3.2	S	5.0	S	4.9	S	5.0	S
536-12	2.9	S	3.8	S	4.0	S	4.6	S
538-13	3.9	S	4.7	S	5.0	S	4.0	S
539	3.5	S	3.7	S	5.0	S	4.7	S
540	3.0	S	3.2	S	3.0	S	4.4	S
C. chinense								
201-8	1.0	R	1.6	R	1.2	R	3.0	S
201-15	3.0	S	3.2	S	4.1	S	4.7	S
201-16	1.0	R	2.0	R	0.0	R	2.0	R
201-21	0.0	R	0.2	R	0.0	R	2.0	R
201-24	1.4	R	1.0	R	0.0	R	2.2	S
201-25	2.7	S	4.0	S	4.3	S	4.3	S
201-26	0.0	R	0.7	R	0.1	R	2.8	S
201-27	1.6	R	0.3	R	2.0	R	2.8	S
542-2	3.5	S	4.1	S	3.7	S	4.7	S
543-3	2.7	S	3.6	S	3.4	S	4.4	S
544	1.9	R	3.5	S	2.8	S	2.8	S
544-4	3.5	S	3.2	S	4.7	S	4.2	S
546-6	0.0	R	0.0	R	0.3	R	3.4	S
547-7	1.2	R	2.1	S	1.8	R	3.2	S
548	0.0	R	0.3	R	0.2	R	2.4	S
548-8	3.1	S	4.7	S	3.6	S	3.4	S
550-10	0.0	R	1.4	R	1.2	R	3.6	S
551-11	0.8	R	2.3	S	3.4	S	3.5	S
554-14	3.5	S	2.9	S	4.7	S	4.5	S
555-15	1.9	R	4.5	S	2.5	S	3.1	S
577-17a	2.0	R	2.3	S	2.6	S	3.6	S
558-17e	1.2	R	2.7	S	1.6	R	3.4	S
559-18	1.6	R	2.2	S	1.9	R	3.2	S
562-21	3.0	S	2.9	S	2.9	S	3.3	S
563-22a	1.6	R	1.9	R	2.9	S	3.4	S
564-22	2.5	S	2.5	S	2.9	S	3.0	S
565-23	3.4	S	4.0	S	4.6	S	3.7	S
C. frutescens								
577/2-2	2.1	S	3.4	S	3.6	S	3.6	S
577/3-2	2.6	S	3.5	S	4.7	S	4.3	S
577/4-2	3.1	S	4.0	S	4.1	S	4.0	S
577/5-2	2.9	S	3.4	S	3.5	S	3.5	S
577/6-2x	2.5	S	4.1	S	3.0	S	3.2	S
579-4	2.0	R	2.4	S	3.0	S	2.9	S
580/1-5	3.6	S	4.7	S	2.7	S	3.3	S
580/2-5	0.5	R	2.3	S	3.7	S	3.8	S
580/3-5	2.5	S	4.1	S	4.2	S	3.9	S
585-10	1.6	R	4.1	S	2.9	S	3.8	S
586-12	0.9	R	2.4	S	2.5	S	4.0	S
587-14	3.1	S	4.6	S	3.9	S	3.4	S
589-20	0,7	R	1.7	R	0.9	R	1.8	R
589-20-81	2.9	S	2.7	S	3.5	S	3.7	S
590-21	3.0	S	4.5	S	3.7	S	3.0	S
591-30	1.0	R	3.5	S	2.7	S	4.2	S
C. annuum Marconi Giallo (check)	5.0	S	4.8	S	5.0	S	5.0	S
L.S.D. P≤0.05	0.65		0.66		0.73		0.48	
P≤0.01	0.86		0.87		0.96		0.63	

* 0 = no egg masses, 1 = 1-2 egg masses, 2 = 3-10, 3 = 11-30, 4 = 31-100, 5 = more than 100 egg masses.
** Host reaction; S = susceptible, egg masses index (EI) > 2; R = resistant, egg masses index (EI) ≤ 2.

Thus, in conclusion three lines of pepper were resistant to *M. incognita*, *M. javanica*, *M. arenaria* and *M. hapla*, eight lines to *M. incognita*, *M. javanica* and *M. arenaria*, one to *M. incognita* and *M. javanica*, five to *M. incognita* and *M. arenaria* and 13 only to *M. incognita* (Tab. II).

These results would indicate that the resistance of pepper to root-knot nematodes is controlled by several different genes, probably at least five (Tab. II). Hare (1957) stated that resistance of pepper to root-knot nematodes was controlled by a single dominant gene (*N*). However, he suspected that several other genes might be involved in the resistance process. Later, Di Vito and Saccardo (1978) found a new source of resistance in *C. frutescens* and *C. chinense*. These findings were confirmed more recently by Hendy *et al.* (1985) who reported several genes are involved in the lines of *C. annum* that are resistant to *M. incognita*, *M. javanica*, *M. arenaria* and *M. hispanica* Hirschmann (the Siville root-knot nematode). However, more investigations are required to identify these different types of resistance in pepper to *Meloidogyne* spp., in terms of the number of genes and their inheritance.

The discovery of the resistance to *M. hapla* in addition to *M. incognita*, *M. javanica* and *M. arenaria*, in two lines of *C. chinense* and in one of *C. frutescens* could be profitably used in plant breeding programmes to obtain cultivars and hybrids F1 of pepper with resistance to these important species of root-knot nematodes.

TABLE II - *Reaction type of lines of* Capsicum *spp. to* Meloidogyne incognita, M. javanica, M. arenaria *and* M. hapla *and genotype categories proposed.*

Species of *Capsicum* and N° of lines tested		Reaction type [1]				N° of lines resistant	Genotypes resistant to
		Mi	Mj	Ma	Mh		
C. annuum (check)	1	S[2]	S	S	S	0	
C. baccatum	3	S	S	S	S	0	
C. baccatum var. *pendulum*	8	S	S	S	S	0	
C. chacoense	23	R	R	R	S	1	Mi, Mj, Ma
		R	S	R	S	2	Mi, Ma
		R	S	S	S	1	Mi
		S	S	S	S	0	
C. chinense	27	R	R	R	R	2	Mi, Mj, Ma, Mh
		R	R	R	S	7	Mi, Mj, Ma
		R	R	S	S	1	Mi, Mj
		R	S	R	S	3	Mi, Ma
		R	S	S	S	4	Mi
		S	S	S	S	0	
C. frutescens	16	R	R	R	R	1	Mj, Mi, Ma, Mh
		R	S	S	S	5	Mi
		S	S	S	S	0	

[1] Mi = *Meloidogyne incognita*, Mj = *M. javanica*, Ma = *M. arenaria*, and Mh = *M. hapla*.
[2] Susceptible, egg masses index (EI) > 2; R = Resistant, (EI) ≤ 2.

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