Nematol. medit. (1983), 11: 125-131.

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VARIATION IN DEVELOPMENT AND INFECTIVITY AMONG POPULATIONS OF *MELOIDOGYNE HAPLA* ON FOUR TOMATO CULTIVARS AND OTHER HOST PLANTS

by
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In many areas of the world root-knot nematodes *Meloidogyne* spp., are important pests of crops. The different species of *Meloidogyne* are known to differ in their host range, and non-host crops are often used to reduce populations before a susceptible crop is grown. Resistant cultivars have also been bred in some crop species and can be used to reduce *Meloidogyne* populations. In tomato (*Lycopersicon esculentum* Mill.) more than 120 cultivars have been produced with resistance to *Meloidogyne* spp. and some (*e.g.* Nemared, Rossol, Small Fry) combine resistance to three *Meloidogyne* spp. (*M. javanica*, *M. incognita*, and *M. arenaria*) (Fassuliotis, 1979; Hadisoeganda and Sasser, 1982). However, it is known that this resistance is often less effective against some populations or races than against others (Sasser, 1963).

This paper describes the use of 4 tomato cultivars (1 susceptible, 3 resistant), and 5 other crop plants to measure the variation in infectivity and development of 5 populations of *M. hapla*.

Materials and Methods

Five populations of *Meloidogyne hapla* Chitw. were tested: one from Canada (with 15 chromosomes), two from USA (with 17 and 45 chromosomes respectively), and two from England (with 17 and 45 chromosomes respectively). Egg-masses of all five populations were obtained from roots of a non-resistant tomato (cv. Rutgers) grown in nematode-infested soil for 6 wks in a greenhouse at 22°C. The eggs were separated from the gelatinous matrix as described previously (Stephan and Trudgill, 1982).

In the first experiment, which tested the host status of four tomato cultivars to four populations of *M. hapla*, three-week-old Rutgers tomato plants (non-resistant) and Nemared, Rossol and Small Fry (resistant to *M. javanica*, *M. incognita* and *M. arenaria*) were transferred to 10 cm pots filled with 500g of peat soil (3 parts peat: 1 part sand) and immediately inoculated with 2000 eggs. The experiment was conducted in a greenhouse maintained at 22°C and with 16h daylight and was completely randomized with six replicates. After 60 days the plant roots were washed free of soil and the numbers of galls, eggs and egg per egg-mass counted. Duncan's Multiple Range test was applied to the data. A second series of experiments, conducted under similar conditions, tested the development of five populations of *M. hapla* on six plant species. Thirty, 3-week-old plants each of tomato (cv. Rutgers); watermelon (cv. Charleston Grey); tobacco (cv. Clevlandii); peanut (cv. Florrunner); cotton (cv. Delta pine 16) and carrot (cv. Gold Pak) were transplanted to 10 cm pots filled with the peat soil and immediately inoculated with 2000 eggs. Each experiment tested one population. At 2-day intervals, starting from 24 days after inoculation, the roots of 2 plants were washed free of soil and the time of first egg production noted. The number of root galls was determined 60 days after inoculation.

Results

The non-resistant tomato, Rutgers, was heavily galled by the four populations of *M. hapla* and supported large numbers of egg-bearing females. On the three resistant cultivars, only the Canadian population reproduced well, Rossol and Nemared showing no resistance and Small Fry being only partially resistant (Table I). The reproduction of the populations of *M. hapla* from USA and England was markedly reduced on all three resistant cultivars. However, there were some differences in the degree of resistance. Nemared was more resistant to one of the English ($n = 17$) populations than Rossol and Small Fry, the numbers of galls, eggs and eggs/egg-mass as formed being significantly ($P = 0.05$) fewer than on the other two cultivars.

Table I - *Numbers of galls, eggs and eggs/egg mass produced by four populations of* M. hapla *on four tomato cultivars 60 days after inoculation.*

Cultivar	NUMBER OF GALLS AND EGGS OF *M. HAPLA*											
	Canadian			English (n=17)			USA (n=17)			English (n=45)		
	galls	eggs 10^3	eggs/egg mass	galls	eggs 10^3	eggs/egg mass	galls	eggs 10^3	eggs/egg mass	galls	eggs 10^3	eggs/egg mass
Rutgers	121 e*	42 g	374 f	102 d	36 fg	355 f	106 d	32 fg	297 e	117 de	56 g	475 g
Nemared	144 f	51 g	354 f	0.5 a	0.009 a	18 a	1 a	0 a	0 a	18 c	3 de	172 d
Rossol	113 de	34 fg	307 e	8 b	0.1 cd	119 c	2 a	0 a	0 a	7 b	0.9 cd	172 c
Small Fry	109 d	11 ef	101 b	1 a	0.128 b	128 c	2 a	0 a	0 a	4 b	0.4 c	89 b

* Values of galls, eggs, or eggs/egg mass followed by the same letter are not significant at ($P<0.05$) according to Duncan's multiple range test.

Table II - *Development of five populations of* Meloidogyne hapla *on various host plants at 22°C.*

	M. hapla Population	Host					
		tomato	carrot	peanut	tobacco	watermelon	cotton
No. of galls	Canadian	126 bc*	106 ab	108 c	102 c	0 a	0
	n = 17 USA	113 ab	111 ab	23 b	6 b	0 a	0
	n = 17 UK	107 a	104 a	24 b	3 b	0 a	0
	n = 45 USA	154 d	143 c	136 d	138 d	13 b	1**
	n = 45 UK	115 ab	107 ab	8 a	0 a	0 a	0
First egg mass (Days)	Canadian	28	31	33	30	—	—
	n = 17 USA	35	35	33	31	—	—
	n = 17 UK	38	39	38	42	—	—
	n = 45 USA	30	32	35	31	35	—
	n = 45 UK	32	34	35	—	—	—

* Results within column values followed by the same letter are not significant at (P=0.05) according to Duncan's multiple range test.

** This population produced males only inside root galls.

However, Small Fry was more resistant than the other two cultivars to the other English (n = 45) population.

Among the six plant species tested, tomato and carrot were the best hosts for all populations of *M. hapla*, as assessed by time of egg production and numbers of galls. Cotton was resistant and only juveniles of one of the American (n = 45) populations showed any development. Watermelon was also resistant, except for the American (n = 45) population. Peanut and tobacco were good hosts for the Canadian and the American (n = 45) populations but poor or resistant hosts for the other three populations. Over all, the American population produced significantly ($P = 0.05$) more galls than the other populations on the roots of the host plants tested (Table II).

The length of the life cycle (egg to egg) for the American (n = 17) population was shorter on tobacco and peanut (31 and 33 days respectively) than on tomato (35). In contrast, the other four populations of *M. hapla* took less time to develop and produce eggs on tomato than on any of the other plant species tested.

Discussion

The three resistant tomato cultivars had different reactions to the four populations of *M. hapla*, and the nematode populations differed in their reactions to the same cultivar. The Canadian population reproduced well on all three cultivars whereas the American (n = 17) population did not. All three cultivars were partially resistant to the English populations. These results contrast with earlier reports (Dropkin *et al.*, 1967; Fassuliotis, 1976; Hadisoeganda and Sasser, 1982; Sasser and Kirby, 1979; Singh *et al.*, 1974) which found no resistance to *M. hapla* in tomato. These results, therefore, show how the degree of resistance of a cultivar is determined by the interaction between both plant species and nematode factors.

Similar differences in reproduction were observed in the experiment with different plant species. On the good hosts (tomato cv. Rutgers and carrot) all populations reproduced well, but on peanut and tobacco the populations differed and only the American (n = 45) population reproduced on watermelon. Differences in pathogenicity among different populations and existence of different races in the same *Meloidogyne* species have been observed (Colbran, 1958; Gillard, 1961; Riggs and Winstead, 1959; Sasser, 1963 and 1979).

The differences in virulence between the *M. hapla* populations tested in these experiments appeared to be greater than previously recognised. In particular, the American (n = 45) population appears to be distinct and more virulent than the others. Stephan and Trudgill (1982) reported that this population was also distinct in its temperature requirement, needing higher temperature for invasion and development than other populations of *M. hapla*. Whether it belongs to a separate race is uncertain, but these results show that it differs considerably from the other populations.

I wish to thank Drs. A. C. Triantaphyllou and J. D. Eisenbak for confirming, with cytological and biochemical techniques, that the population of *M. hapla* tested in the study was free from contaminants.

SUMMARY

The reproduction of four populations of *Meloidogyne hapla* was compared on three cultivars of tomato resistant to *M. javanica, M. incognita* and *M. arenaria.* On a non-resistant tomato cv. Rutgers, all populations reproduced well. *M. hapla* from Canada reproduced well on Rossol and Nemared, but cv. Small Fry was partially resistant. All three cultivars were very resistant to two *M. hapla* populations from England and were totally resistant to a population from USA. Differences in pathogenicity among five populations of *M. hapla* on six plant species were also compared. On tomato (cv. Rutgers) and carrot all populations reproduced well, but on peanut and tobacco the populations differed. On watermelon only the population from USA with 45 chromosomes reproduced, and this was the only population to show any development on cotton.

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Accepted for publication on 23 April 1983.