Root-knot Nematode Resistance in *Cucumis* Species

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Abstract. The southern root-knot nematode, *Meloidogyne incognita* [(Kofoid & White) Chitwood], causes serious economic losses to melon (*Cucumis melo* L.) production in the United States. The present study was conducted to determine if separable differences in nematode resistance of *Cucumis melo* could be found at some inoculum level. Five *C. melo* lines were compared with *Cucumis metuliferus* Naud. (C701A), a highly resistant species, for root necrosis, galling, egg mass production, and reproduction when inoculated at 0, 500, 1000, 2000, or 5000 nematode eggs per plant. Using these criteria, melon line C880 inoculated with 1000 eggs per plant was highly susceptible, while PI140471, PI 183311, and the cultivars Chilton, Georgia 47, Gulf Coast, Planters Jumbo, and Southland were less susceptible. In greenhouse tests with an inoculum level of 1000 eggs per plant, low levels of resistance were evident. A thorough screening of the available germplasm against *M. incognita* may identify higher levels of root-knot nematode resistance for incorporation into improved melon cultivars.

The Society of Nematologists (Feldmesser 1971) estimated that losses in muskmelons due to nematodes were 20% of their value. The 1980 Agricultural Statistics (U.S. Dept. of Agriculture, 1980) reported the total value in the United States of muskmelons as \$204 million. Therefore, the loss due to nematode injury would be about \$40.8 million per year.

Fassuliotis and Rau (1963) screened 1465 U.S. Plant Introductions (PI) of *Cucumis* species and found no resistance to *Meloidogyne incognita* in the 1152 *Cucumis melo* L. accessions that they screened; one accession of *C. anguria* L. was resistant. Fassuliotis (1967) tested 14 *Cucumis* species and found that *C. ficifolius* A. Rich., *C. anguria* L., and *C. metuliferus* Naud. had high resistance to root-knot nematodes, but *C. melo* had none. Elmstrom and Hopkins (1973) found a significant difference in galling between 21 cultivars and breeding lines of *C. melo* in field studies.

Based on the above information, particularly that of Elmstrom and Hopkins, and the absence of studies involving inoculum level, the current research was designed to determine if, at some inoculum level, resistance to *M. incognita* could be identified in *C. melo*.

Materials and Methods

Preliminary study. A replicated preliminary greenhouse study was conducted to determine the feasibility of evaluating *Cucumis* for root-knot nematode resistance, using culti-

vars and wild species previously reported to have tolerance to root-knot infestation. Seeds of *C. melo* cultivars and lines Chilton, Southland, C880, Georgia 47, Planters Jumbo, and *C. metuliferus* (C701A) were germinated in trays of sand. Seedlings were transplanted 7.6 cm apart in 152-cm rows in sterilized greenhouse benches containing a mix of 3 sand : 1 Jiffy Mix (v/v) (Jiffy Products of America, Batavia, Ill.). All benches received 5N-10P-10K fertilizer and water as necessary. The root-knot nematodes (race 3) used for this experiment were from okra (*Abelmoschus esculentus* L.) and the culture was maintained on pepper (*Capsicum annuum* L., PA-136) roots. The egg inoculum production and the inoculation techniques for this test were those of Fery et al. (1994). The results of the preliminary experiment prompted a study of inoculum levels.

Data for preliminary and inoculum level tests were collected 30 days after inoculation. Egg counts were the actual number of eggs per gram of fresh roots, based on the method of Hussey and Barker (1973). The analysis of variance and the subsequent Duncan's Multiple Range test were accomplished by using the MSTAT-C (Michigan State Univ., East Lansing).

Table 1. Egg count means 30 days after inoculation for five *Cucumis melo* entries and one *Cucumis metuliferus* entry in the first inoculum level nematode resistance study.^z

Entry	Egg counts (1000s)			
	Inoculum levels (nematode eggs/seedling) ^y			
	500	1000	2000	5000
C880	24.1 A	48.6 A	67.2 A	59.7 A
Gulfcoast	9.3 BC	18.8 B	25.1 B	32.2 B
Planters Jumbo	7.7 BC	17.3 B	22.1 B	31.6 B
PI183311	7.6 BC	23.5 B	15.5 BC	19.8 BC
PI140471	11.8 B	13.3 BC	19.3 BC	34.9 B
<i>C. metuliferus</i> (C701A)	1.0 C	1.6 C	2.7 C	2.9 C

^zThe 0 level is not shown due to lack of differences between entries.

^yMeans separation within columns by Duncan's multiple range test ($P \leq 0.05$).

Inoculum levels. Based on the preliminary study and recent information regarding the possible resistant melon lines, two inoculum level tests were conducted. Production conditions similar to the preliminary study were used and inoculation at 0, 500, 1000, 2000, or 5000 eggs per seedling was added. Each inoculum level was confined to a separate bench. There were four completely randomized replications of the following *C. melo* cultivars, lines, PIs, and of 701A *C. metuliferus* at each inoculum level: PI 140471, PI 183311, C880, 'Gulf Coast', and 'Planters Jumbo' melons. C880 was the susceptible control and *C. metuliferus* was the resistant control.

Results and Discussion

Preliminary study. There were significant differences among six *Cucumis* lines for root damage caused by root-knot nematodes as measured by gall, egg mass count, and necrosis indices, and eggs per gram of fresh root (data not shown). The gall and egg mass indices were similar, with *C. metuliferus* having little damage, 'Planters Jumbo' having moderate damage, and the other cultivars/lines having numerous galls and egg masses. Root necrosis was severe for all *C. melo* cultivars and slight for *C. metuliferus*. Egg counts per gram of fresh root resulted in the grouping of lines into three groups; *C. metuliferus* had few eggs, 'Chilton', 'Southland', 'Georgia 47', and 'Planters Jumbo' were intermediate, and the roots of C880 had the highest egg count.

Inoculum level. In inoculum concentration Expt. 1, necrosis was minimal, no differences in the egg mass index were detected, and the gall index gave similar results as the egg counts; thus, only egg counts per gram of fresh root are reported. The egg counts showed *C. metuliferus* to be significantly more resistant than all melon lines and that C880 had less resistance than PI 183311, PI 140471, 'Gulf Coast', or 'Planters Jumbo' ($P \leq 0.05$).

At each inoculum level of the first test, relative damage to each line was the same (Table 1). Egg counts were the most reliable way to separate the six entries. *C. metuliferus* had the fewest eggs and C880 had the most. Although the egg count data for PIs 183311 and 140471 were not significantly different from 'Gulf Coast' and 'Planters Jumbo' with 1000 and 2000 eggs, their roots looked healthier, with less galling and necrosis (Fig. 1). The high egg count of PI183311 at 1000 eggs was highly unusual, indicating possible

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Fig. 1. Roots of *Cucumis* plants inoculated with 1000 eggs per seedling. Note heavy galling and poor root development on F, less galling and better root growth on C and D, few small galls on A and E and no galling on B. A. PI 140471, B. *Cucumis metuliferus* (C701A), C. Planters Jumbo, D. Gulf Coast, E. PI183311, F. C880.

variation in the level of resistance in the PI or of the nematode. Because of this result, a second-level study was conducted; the egg count for this PI was lower than at the 2000 and 5000 levels in test 1, suggesting that the number in the first study was not typical of the overall experiment. Since, to the eye, there was more galling at the 2000-egg level, the 1000-egg level might be desirable for further study of nematode resistance in melons.

The results for the second inoculum level experiment were similar to and confirmed

those of the first test. In the case of PI 183311 that had an unusually high egg count at the 1000-egg level in the first test, the egg count was lower than at 2000 and 5000 eggs in the second test.

These studies demonstrate differences for root-knot nematode resistance in melon as detected by seedling screening tests. The breeding line C880 was highly susceptible to nematode infection and development. In contrast, 'Chilton', 'Gulf Coast', 'Georgia 47', and 'Planters Jumbo' were moderately resistant,

and PI 140471 and PI 183311 were highly resistant and the best of all the melons yet tested. *C. metuliferus* breeding line C701A was the most resistant, but not immune to root-knot nematode infection. An effective root-knot nematode evaluation test can be conducted on melons with an inoculum of 1000 eggs per seedling (Fig. 1). Based on the information from these tests, it is possible to overwhelm resistances if the inoculum levels are too high.

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