

Pathogenicity of Four Species of *Meloidogyne* on Three Varieties of Olive Trees

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Abstract: 'Ascolano' and 'Sevillano' olive trees, *Olea europaea* L., were highly susceptible to *Meloidogyne javanica* (Trueb) Chitwood, and growth of their tops was decreased greatly in tests in a glasshouse. Roots of 'Manzanillo' olive trees were galled moderately by *M. javanica*, and their tops weighed 6% less than those of noninoculated trees. 'Manzanillo' olive is considered highly tolerant to *M. javanica*. 'Ascolano' and 'Manzanillo' olive trees were highly susceptible to *M. incognita* (Kofoid & White) Chitwood. Their roots were galled moderately to severely, and growth of their tops were decreased between 13% and 44%. 'Ascolano' and 'Manzanillo' olive trees were considered to be highly resistant to *M. arenaria* (Neal) Chitwood and *M. hapla* Chitwood since no galls or mature females were found on their roots three and one-half months after inoculation.

In Israel, olive was reported as a host of *M. hapla* Chitwood and *M. incognita* (Kofoid & White) Chitwood by Minz (6), and of *M. javanica* (Trueb) Chitwood by Tarjan (7). Diab and El-Eraki (1) reported that *M. javanica* reproduced on and decreased by 28% the growth of seedling olive trees in Egypt. 'Ascolano' and 'Manzanillo' varieties of olive trees were susceptible to *M. javanica*, however, 'Manzanillo' was more tolerant of this nematode than 'Ascolano' in tests by Lamberti and Lownsbery (3).

Experiments to determine the relative susceptibility of olive trees, varieties 'Ascolano,' 'Manzanillo,' and 'Sevillano' to *Meloidogyne arenaria* (Neal) Chitwood, *M. hapla*, and *M. incognita*, and *M. javanica* in a glasshouse are reported herein.

MATERIALS AND METHODS

Cuttings of 'Ascolano,' 'Manzanillo,' and 'Sevillano' olives were treated with indolebutyric acid (4), rooted in a mist chamber, and planted in a sandy loam in painted metal pots that were 15 cm diameter. After two months trees of uniform size were selected for testing. Ten pots of 'Ascolano' and of 'Manzanillo' and six of 'Sevillano' were in-

oculated with 10,000 second-stage larvae of *M. javanica* obtained from bean roots. Lots of ten 'Ascolano' and 'Manzanillo' olive trees were inoculated with 1,000 or 10,000 second-stage larvae of *M. incognita* obtained from bean roots. The nematodes were disinfested in an aqueous solution of 40 ppm of copper sulfate for one hr, rinsed three times in tap water, and the desired number distributed in five holes 5–6 cm deep in the soil around each of the trees. The same number of noninoculated trees were used for controls. After 8 months, five trees of 'Manzanillo' and of 'Ascolano' that were infected with *M. javanica* and 10 of each variety that were infected with *M. incognita*, were washed free of soil, weighed, and the degree of galling of their roots determined on a scale 0 to 5 (2) with 0 representing no galling and 5 severe galling. After 11 months the remaining pots of 'Ascolano' and of 'Manzanillo' olive and the six of 'Sevillano' that were inoculated with *M. javanica* were examined for nematodes.

In a second test the pathogenicity of *M. arenaria* and *M. hapla* on 'Ascolano' and on 'Manzanillo' olive trees was determined. Lots of 10 one-year-old trees in pots were inoculated with 1,000 second-stage larvae of *M. arenaria* or 4,000 of *M. hapla*. The larvae were obtained from tomato roots and were disinfested as for *M. incognita* above

Received for publication 26 September 1968.

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TABLE 1. Effect of *Meloidogyne javanica* on the growth of 'Ascolano,' 'Manzanillo,' and 'Sevillano' olive trees 11 months after inoculation.

| Variety | Treatment | Fresh weight in grams of the trees | | | Degree of galling |
|------------|--------------------|------------------------------------|------|-------|-------------------|
| | | Roots | Top | Total | |
| Ascolano | none | 28 | 44 | 72 | 0 |
| Ascolano | <i>M. javanica</i> | 35 | 21** | 56 | 5 |
| Manzanillo | none | 14 | 18 | 32 | 0 |
| Manzanillo | <i>M. javanica</i> | 22 | 17 | 39 | 3 |
| Sevillano | none | 23 | 29 | 51 | 0 |
| Sevillano | <i>M. javanica</i> | 27 | 16** | 43 | 4 |

** Difference from the nontreated is significant at the 0.01 level.

before using. The trees were examined for nematode infection three and one-half months after inoculation.

Infected roots from each of the tests were stained with acid fuchsin in lactophenol (5) and the stages of the nematodes were determined.

The treatments were maintained in blocks on a bench in a glasshouse, and precautions were taken to prevent spread of the nematodes to the noninoculated trees. The data were analyzed by Students "t" test.

RESULTS

TEST WITH *M. JAVANICA*: The 'Ascolano' trees that were infected with *M. javanica* were partially defoliated, smaller, and the tops weighed 52% less than the noninfected trees 11 months after inoculation (Table 1 and Fig. 1A). The root systems of the infected trees appeared smaller than those of the noninfected trees 8 months after

inoculation, but after 11 months they weighed 25% more than the noninfected roots. Infected roots were enlarged, distorted and severely galled. The galls were mainly terminal and the roots stopped elongating and branched profusely when galls formed near their apices (Fig. 1B).

The roots of the 'Manzanillo' olive trees were galled moderately by *M. javanica*, and the entire trees weighed 4% less than the noninfected trees after 8 months. After 11 months the infected entire trees weighed 22% more, and the tops 6% less, than those of the noninfected trees (Table 1 and Fig. 1C). Nematode-infected roots were moderately galled and weighed 57% more than the noninfected roots (Fig. 1D). Frequently a root continued to increase in length after a gall had formed and when new galls formed in the region of elongation a chain of galls occurred. Infection and gall formation appeared to stimulate production of lateral roots. 'Manzanillo' olive trees appeared highly tolerant to *M. javanica*.

'Sevillano' olive trees 8 months after inoculation with *M. javanica* were stunted, and at 11 months their tops were severely defoliated and weighed 45% less than the noninfected trees. The roots of inoculated trees were severely galled, stunted, and much branched. Galls occurred at the apices of roots and also as "beads" along the roots. All stages of *M. javanica* occurred in the roots of the three varieties of olive.

TEST WITH *M. INCOGNITA*: The tops

FIG. 1. Symptoms of *M. incognita* and *M. javanica* on 'Ascolano' and 'Manzanillo' varieties of olive (*Olea europaea*). A) Healthy 'Ascolano' olive tree on left, and two trees infected with *M. javanica* at right. B) 'Ascolano' olive roots infected with *M. javanica*. Note large galls and many short stubby roots. C) Healthy 'Manzanillo' olive tree at left, and two trees infected with *M. javanica* at right. D) 'Manzanillo' olive roots infected moderately with *M. javanica*. E) Two noninfected 'Ascolano' olive trees at left. The two trees in the center were inoculated with 1,000 and the two trees at the right with 10,000 larvae of *M. incognita*. F) 'Ascolano' roots infected severely with *M. incognita*. G) Two healthy 'Manzanillo' olive trees at left. The two trees in the center were inoculated with 1,000 and the two trees at the right with 10,000 larvae of *M. incognita*. H) 'Manzanillo' olive roots infected severely with *M. incognita*.

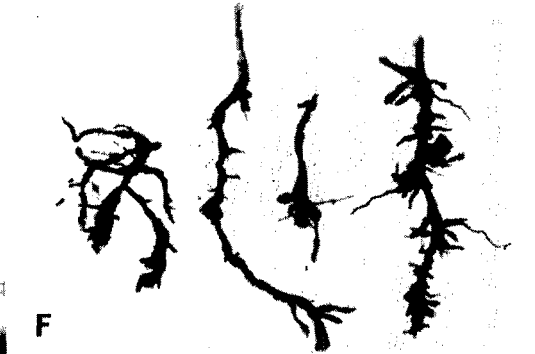


TABLE 2. Effect of *Meloidogyne incognita* on the growth of 'Ascolano' and 'Manzanillo' olive trees 8 months after inoculation.

| Variety | Treatment | Fresh weight in grams of the trees | | | Degree of galling |
|------------|--------------|------------------------------------|------|-------|-------------------|
| | | Roots | Top | Total | |
| Ascolano | none | 9 | 30 | 39 | 0 |
| Ascolano | 1,000 nemas | 15** | 26 | 41 | 3 |
| Ascolano | 10,000 nemas | 17** | 17** | 34 | 4 |
| Manzanillo | none | 17 | 23 | 40 | 0 |
| Manzanillo | 1,000 nemas | 19 | 14* | 32 | 3 |
| Manzanillo | 10,000 nemas | 15 | 13* | 28* | 3 |

* Difference from the nontreated is significant at the 0.05 level.

** Difference from the nontreated is significant at the 0.01 level.

of the 'Ascolano' olive trees inoculated with 1,000 or 10,000 *M. incognita* larvae per pot weighed 13% and 44% less, and the roots weighed 67% and 89% more respectively than those of the noninfested trees (Table 2). The trees inoculated with the high rate, but not with the low rate, were severely defoliated (Fig. 1E). Roots of the trees inoculated with 1,000 larvae were galled moderately, and those that received 10,000 larvae were galled severely. The infected roots were thicker and more profusely branched than those of the noninoculated trees. The galls occurred both terminally and laterally on the roots (Fig. 1F). The increased fresh weight of the roots apparently was due to the numerous galls and to the profuse branching and thickening of the roots.

'Manzanillo' roots 8 months after inoculation with 1,000 or 10,000 *M. incognita* larvae were galled moderately, and the tops weighed 39% and 44% less than those of the noninfested trees (Table 2 and Fig. 1G). Roots of the trees that had been inoculated with 1,000 larvae weighed 12% more and those inoculated with 10,000 larvae weighed 12% less than the noninfested roots. The galls on 'Manzanillo' roots were smaller than those on 'Ascolano' roots and occurred mostly in chains (Fig. 1H).

All stages of *M. incognita* occurred in the 'Ascolano' and 'Manzanillo' roots.

TESTS WITH *M. ARENARIA* AND *M. HAPLA*: The 'Ascolano' and 'Manzanillo' trees that were inoculated with 4,000 *M. arenaria* larvae or 1,000 *M. hapla* larvae per pot were similar in size to the noninoculated trees, three and one-half months after inoculation. Only one second-stage larva and one male of *M. arenaria* was obtained from 'Ascolano' roots after one week in a mist chamber. No *Meloidogyne* nemas were obtained from 'Ascolano' roots that had been inoculated with *M. hapla*, or from 'Manzanillo' roots that had been inoculated with *M. arenaria* or *M. hapla*. No nemas were observed in stained roots of either varieties. 'Ascolano' and 'Manzanillo' olive trees appeared highly resistant to *M. arenaria* and *M. hapla*.

DISCUSSION

The three varieties of olive tested varied in their reaction to *M. cognita* and *M. javanica*. 'Ascolano' and 'Sevillano' olive trees appeared highly susceptible and 'Manzanillo' olive trees tolerant to *M. javanica*. The differences observed in the size and distribution of nematode galls on the roots of these three varieties of olive probably reflect differences in host reaction to this nematode.

'Manzanillo' olive trees were more susceptible to *M. incognita* than were 'Ascolano' olive trees even though its ('Manzanillo') roots were less severely galled. A high (10,000 larvae per pot) level of inoculum was necessary to obtain a significant decrease in the growth of the 'Ascolano' olive trees, while the 'Manzanillo' olive trees were severely stunted by both the low and high levels of inoculum.

'Ascolano' and 'Manzanillo' olive trees appeared highly resistant to *M. arenaria* and *M. hapla*.

LITERATURE CITED

1. DIAB, K. A., and S. EL-ERAKI. 1968. Plant parasitic nematodes associated with olive decline in the United Arab Republic. Pl. Dis. Rep. 52:150-154.
2. HANSEN, C. J., B. F. LOWNSBERY, and C. O. HESSE. 1957. Nematode resistance in plums. Calif. Agric. 11:9, 13.
3. LAMBERTI, F., and B. F. LOWNSBERY. 1968. Olive varieties differ in reaction to the root-knot nematode, *Meloidogyne javanica*. Phytopathologia Mediterranea 7:48-50.
4. LORETI, F., and H. T. HARTMANN. 1964. Propagation of olive trees by rooting leafy cuttings under mist. Proc. Am. Soc. Hort. Sci. 85:257-264.
5. MCBETH, C. W., A. L. TAYLOR, and A. L. SMITH. 1941. Note on staining nematodes in root tissue. Proc. Helminth. Soc. Wash. 8:26.
6. MINZ, G. 1961. Additional hosts of the root-knot nematode, *Meloidogyne* spp. recorded in Israel during 1958-1959. Israel J. Agric. Res. 11:69-70.
7. TARJAN, C. A. 1953. Geographic distribution of some *Meloidogyne* spp. in Israel. Pl. Dis. Rep. 37:315-316.