

Table 2 : Frequency of occurrence of the more common phytophagous nematodes associated with sugarcane on the four plantation sites of the Ivory Coast.

| | Ferké 1 | Ferké 2 | Borotou | Zuenoula |
|----------------------------------|---------|---------|---------|----------|
| <i>Caloosia</i> | 21.9 | 11.3 | 3.1 | 0 |
| other criconematids ^a | 40.6 | 38.6 | 15.6 | 23.3 |
| <i>Helicotylenchus</i> | 100 | 100 | 96.9 | 93.3 |
| <i>Heterodera</i> | 18.7 | 4.5 | 0 | 0 |
| hoplolaimids ^b | 34.4 | 38.6 | 31.3 | 6.7 |
| longidorids ^c | 40.6 | 15.9 | 3.1 | 16.7 |
| <i>Meloidogyne</i> | 84.4 | 50.0 | 46.9 | 43.3 |
| <i>Paratrichodorus</i> | 3.1 | 2.3 | 0 | 40.0 |
| <i>Paratylenchus</i> | 53.1 | 47.7 | 9.4 | 30.3 |
| <i>Pratylenchus</i> | 96.9 | 93.2 | 93.8 | 93.3 |
| <i>Rotylenchulus</i> | 28.1 | 13.6 | 6.3 | 0 |
| <i>Triversus</i> | 18.75 | 45.5 | 0 | 0 |
| belonolaimids | 71.9 | 72.7 | 100 | 100 |

a : other criconematids = *Criconema*, *Criconemella* and *Hemicriconemoides*.

b : hoplolaimids = *Hoplolaimus* and *Scutellonema*.

c : longidorids = *Xiphinema* and *Longidorus*.

d : belonolaimids = *Paratrophurus*, *Trichotylenchus*, *Trophurus* and *Tylenchorhynchus*.

chus and some tylenchorhynchids were found frequently in the sugarcane plantations in the Ivory Coast.

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ON THE OCCURRENCE OF THE " MEDITERRANEAN BIOTYPE " OF *TYLENCHULUS SEMIPENETRANS* IN SPAIN

Soledad VERDEJO-LUCAS

Departamento Patología Vegetal, IRTA, Crta. de Cabrils s/n, 08348 Cabrils, Barcelona, Spain.

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Tylenchulus semipenetrans Cobb, present in all regions of the world where citrus is grown, also occurs in all citrus growing regions of Spain (Ortuño Martínez *et al.*, 1969; Bello *et al.*, 1986; Martínez Beringola *et al.*, 1987).

Populations of *T. semipenetrans* have been defined as biotypes according to the host status of several indicator plants species (Inserra *et al.*, 1980). Three *T. semipenetrans* biotypes have been identified to date, the " Citrus biotype " infects *Citrus* spp., Carrizo and Troyer citrange, olive, grape and persimmon. The " Mediterr-

anean biotype " is very close to the " Citrus biotype " but does not reproduce on olive. The " Poncirus biotype " reproduces on *Citrus* spp., *Poncirus trifoliata*, their hybrids, and grape but not on olive. The occurrence of biotypes of the nematode is of relevance to rootstock breeding programs, the choice of rootstock to be planted, and other management practices.

In this paper, the results of a differential host test carried out to identify the biotype of four Spanish populations of *T. semipenetrans* are reported.

Materials and methods

The indicator plants included sour orange (*Citrus aurantium*), trifoliolate orange (*P. trifoliata* Rubidoux?), Carrizo citrange, *C. macrophila*, grape (*Vitis rupestris*), and olive (*Olea europea* var "Arvequina").

Soil infested by *T. semipenetrans* was collected from around sour orange rootstock at four locations in the provinces of Barcelona, Tarragona (two locations) and Valencia. The infested soil from each location was screened and mixed with a substrate in such a proportion as to give 4-5 nematodes/cm³ substrate. The substrate consisted of a mixture 1:1 (v/v) of steam sterilized sand and peat moss with the addition of superphosphate at a rate of 1.5 g/dm³ (pH adjusted to 6.5 with CaCO₃). Populations were tested separately and each treatment was replicated five times. Plants were maintained under shading for 7 months.

Fibrous roots were cut into 0.5 cm sections and juvenile and male nematodes were extracted from 3 g by root incubation for 36 h at 24 °C (Tarjan, 1972). Mature females were removed from roots by blender maceration for 30 s and centrifugation-sugar flotation (McSorley *et al.*, 1984). Nematodes were collected on a 45 µm-pore screen.

Data for *T. semipenetrans* females/g root were transformed to $\log(x + 1)$ and subjected to analysis of variance. Means were compared by the LSD Test ($P = 0.05$).

Results and discussion

The four populations of *T. semipenetrans* completed their life cycle (mature females on roots) on the *Citrus* species and the hybrid Carrizo but failed on trifoliolate orange and olive (Table 1). Some juveniles and males

were recovered from *P. Trifoliata* and olive inoculated with the Barcelona and Tarragona populations (Table 1). These nematodes probably remained from the inoculum since they lacked body content and were apparently dead.

All populations tested can be classified as belonging to the "Mediterranean biotype" which is present in all citrus producing countries of the mediterranean region and South Africa (Inserra *et al.*, 1980; Gottlieb *et al.*, 1986; Lamberti *et al.*, 1976). Its occurrence in Spain had not been previously reported. The olive variety "Arvequina" had not been tested before as an indicator plant for the citrus nematode but no variety specification on the host status of olive to *T. semipenetrans* has been found in the literature.

Vitis rupestris was a host of three of the *T. semipenetrans* populations but females of the Barcelona population were only recovered from one replicated plant (Table 1). An Italian nematode population from olive classified as the "Citrus biotype" did not infect *V. rupestris*. *Vitis vinifera* has been reported as a host of the "Poncirus" and "Citrus" biotypes (Baines *et al.*, 1974; Inserra *et al.*, 1980). Italian populations from citrus groves differed in their response to grape Kober 5 BB (*V. berlandieri* + *V. riparia*) (Lamberti *et al.*, 1976). Israeli populations reacted similarly to one another on "Richter 110" but differed on "Paulsen 1103" grape rootstock (*V. berlandieri* × *V. rupestris*) (Gottlieb *et al.*, 1986). *Vitis* species and their hybrids may differ in their reaction to *T. semipenetrans* as suggested by the results reported here and by other workers.

The populations studied originated from sour orange rootstock, the most widespread citrus rootstock used in Spain. The possible occurrence of additional biotypes of *T. semipenetrans* in Spanish citrus groves, however, cannot be discounted due to the limited number of populations tested.

Table 1. Numbers of juvenile + male and of female *Tylenchulus semipenetrans*/g fibrous root recovered 7 months after inoculation.

| Plant host | Populations | | | | | | | |
|---------------------------------|-------------|------|-------------|------|-------------|-------|----------|------|
| | Barcelona | | Tarragona-1 | | Tarragona-2 | | Valencia | |
| | J + ♂♂ | ♀♀ | J + ♂♂ | ♀♀ | J + ♂♂ | ♀♀ | J + ♂♂ | ♀♀ |
| <i>Poncirus trifoliata</i> | 41 | 0 a | 17 | 0 a | 37 | 0 a | 0 | 3 a |
| <i>Citrus aurantium</i> | 36 | 10 b | 16 | 8 ab | 260 | 189 c | 13 | 26 b |
| <i>Citrus macrophila</i> | — | — | — | — | 607 | 413 c | — | — |
| Carrizo Citrange | 64 | 24 c | 14 | 5 ab | — | — | 48 | 38 b |
| <i>Olea europea</i> "Arvequina" | 2 | 0 a | 0 | 0 a | 3 | 0 a | 0 | 0 a |
| <i>Vitis rupestris</i> | 6 | 3 ab | 61 | 8 b | 107 | 31 b | 8 | 16 b |

— : Not tested; Values in the same column sharing the same letter are not statistically significant according to the LSD Test ($P = 0.05$).

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A NEMATODE FEEDING MITE, *TYROPHAGUS PUTRESCENTIAE* (SARCOPTIFORMIS : ACARIDAE)

Anwar L. BILGRAMI * and Qudsia TAHSEEN *

* Section of Nematology, Department of Zoology, Aligarh Muslim University, Aligarh-202002, India.

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There are few reports confirming nematodes as the diet of soil mites. Linford and Oliviera (1938) observed mites feeding on root knot nematodes. Murphy and Doncaster (1957) reported injury of *Heterodera* cysts by a mite. The most definite association came from the work of Rodriguez *et al.* (1962) who observed that when given equal choice, the adult mite *Macrocheles muscaedomesticae* preferred house fly eggs over nematodes while proto- and deutonymph under same conditions preferred nematodes. An oribatid mite *Pergalumna* sp., fed upon *Pelodera lambdiense* and *Tylenchorhynchus martini* in large numbers (Rockett & Woodring, 1965). Muraoka and Ishibishi (1976) described feeding by many species of mites which were identified as nematode predators. Recently, Imbriani and Mankau (1983) observed feeding of a neostigmatid mite, *Lasioseius scapulatus* on *Aphelenchus avenae* and *Cephalobus* sp.

In the present work observations were made on the predatory behaviour of *Tyrophagus putrescentiae* (Sarcoptiformis : Acaridae) using nematodes as prey.

Materials and methods

Prey catching and feeding mechanisms were studied in culture dishes and special observation chambers. A

plastic ring (1 cm high; 2 cm diam.) glued to a coverslip at one end, was fixed in the middle of a metallic slide. The chamber, thus formed, was filled with 1 % water agar. The mites and prey nematodes were then inoculated and the ring was sealed with another coverslip to prevent air drying and escape of mites. Predation was observed on *Rhabditis* sp., *Cephalobus* sp., *Hirschmanniella oryzae* and *Tylenchorhynchus mashhoodi*. The rate of predation by *T. putrescentiae* was determined by using five adult mites against 50 individuals of prey. The effect of prey density on the rate of predation by *T. putrescentiae* was observed by placing 25, 50, 75, 100, 125, 150, 175 and 200 individuals of *H. oryzae* separately with five predators. The number of individuals killed or consumed by the mites was recorded after 24 h. All experiments were carried out at 28 ± 2 °C and replicated five times.

Predatory behaviour

T. putrescentiae feed on nematodes and other microorganisms in culture dishes. During routine observations the cultures of saprophagous species of nematodes viz., *Acrobeloides*, *Cephalobus*, *Rhabditis*, *Panagrellus* and predaceous nematodes viz., *Mononchus*