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SEASONAL POPULATION CHANGES AND MANAGEMENT OF *TYLENCHULUS SEMIPENETRANS* USING ORGANIC AMENDMENTS AND FENAMIPHOS

by

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Summary. Seasonal population variations of the citrus nematode, *Tylenchulus semipenetrans* in association with grapefruit was studied from September 1995 to August 1997 at Tanuf in Al Dhakhliya (Interior) region of Oman. Nematode populations in soil and roots steadily increased from September and reached high levels during January-March, then sharply declined during summer from May to August. Significant negative correlations were observed between maximum air and soil temperatures and nematode populations in soil and roots. The effect of three organic amendments and fenamiphos on the management of *T. semipenetrans* was tested on sweet lime. There was no reduction in nematode populations due to application of clandosan at 2.5 t/ha, chopped leaves of harmal (*Rhazya stricta*) at 7 t/ha and fenamiphos at 8 kg a.i./ha. Application of sawdust at 20 t/ha reduced populations of *T. semipenetrans* compared to controls during both seasons.

Sweet lime (*Citrus limettioides* Tanaka), sweet orange [*C. sinensis* (L.) Osbeck] and grapefruit (*C. paradisi* Macfady) are commonly grown in Al Dhakhliya and Al Sharqia regions in the Sultanate of Oman. Surveys carried out in the regions revealed the occurrence of more than 22 species of phytonematodes in association with many *Citrus* spp. with the citrus nematode, *Tylenchulus semipenetrans* Cobb and the lesion nematode, *Pratylenchus coffeae* (Zimmerman) Filipjev *et* Schuurmans Stekhoven as the only known pathogenic species. *T. semipenetrans* was found widely distributed at high population levels (Anonymous, 1993, 1994 and 1995) in all regions, except Batinah. It is recognized as the causal agent of 'slow-decline' of citrus in all citrus-growing countries (Siddiqi, 1974; Nickle, 1991). In this study we investigated the seasonal population variations of *T. semipenetrans* and evaluated the efficacy of certain organic amendments and fenamiphos for its management.

Materials and methods

The study on population dynamics was carried out in government orchard of grapefruit trees (>10 yr) planted (5x5 m) near Tanuf in Al Dhakhliya region from September 1995 to August 1997. The experimental field soil consisted of 1.1% coarse sand, 34.3% fine sand, 34.3% silt and 30.3% clay with 36.0% calcium carbonate. Soil pH was 7.3 and electrical conductivity (EC) was 0.3 dsm/m (1:5). Irrigation water recorded a pH of 7.2 and EC of 5.2 dsm/m. The trees were irrigated twice a week by low-volume bubbler irrigation system located in tree basins. Weeds were manually managed in rows and disked between rows. Nematicides had not been used in the orchard in the previous seven years. Soil and root samples were collected from ten randomly selected trees during the first week of every month. Samples were collected from each tree, from two opposite sites, up to 25 cm depth using a garden trowel. Sampling sites were changed every month to cover the basin area in a circular fashion (Mukherjee and Dasgupta, 1993). Soil temperature was recorded in the rhizosphere region at 15 cm depth using a Kane-May digital thermometer. Second-stage juveniles (J_2) were extracted from 250 cm^3 soil by Cobb's sieving and decanting technique followed by a modified Baermann funnel method. Five g of roots were washed free of soil, cut into small pieces and incubated in modified Baermann funnels filled with water, containing 0.5% hydrogen peroxide. J_2 were collected after 48 hours of incubation using a 38 μm sieve. Nematode populations were counted in one ml aliquot under a stereo binocular microscope. Moisture content of soil samples was estimated on oven-dry samples. Maximum and minimum temperatures and rainfall were recorded. The data were subjected to correlation and regression analysis. Mean values of two years data on maximum, minimum and soil temperatures, soil moisture and nematode populations in soil and roots were employed for graphical representation.

Clandosan (Igene Biotechnology Inc.) at 2.5 t/ha, chopped leaves of harmal (*Rhazya stricta* Decne.) at 7 t/ha and sawdust at 20 t/ha and fenamiphos at 8 kg a.i./ha were applied to seven year-old sweet lime trees on 7.1.1996 and 14.7.1996 and 7.10.1996 and 6.4.1997 respectively during the first and second season of the experiment. The products were applied in two equal split doses and incorporated in top layer of soil in tree basins while sawdust was applied as mulch. The treatments, including an untreated control, were laid out randomly as single-tree plots, replicated five times. Nematode populations in soil and roots were estimated before and at 2, 4, 6 and 8 months after treatment. Moisture content of soil samples was estimated on oven-dry samples. Weed growth in various treatments was scored on 0-4 scale at the time of each sampling. The experimental field soil and irrigation water characteristics were similar to the conditions described earlier.

Results and discussion

Ambient and soil temperatures steadily declined from September and reached the lowest levels in January (Fig. 1). The temperatures increased from February and reached the peak during July and declined thereafter. Rainfall of 140 mm was received in March, 1997. Moisture content of soil samples ranged from 12 to 22 per cent.

Nematode densities increased from September and reached high levels during December-April (Fig. 2). There was a marked decrease in populations both in soil and roots from April onwards when maximum air and soil temperatures increased. The populations in soil and roots were very low during May-July coinciding with high air temperature of 40.4-42.1 °C and soil temperature of 24.9-26.4 °C. Significant negative correlations were observed between maximum air temperature and soil temperature and nematode populations in soil and roots (Table I). The moisture content of soil samples varied from 12-18.6% and 14.3-22% during May-August in 1996 and 1997, respectively, and it indicated that desiccation was not a factor responsible for decreased nematode populations in soil and roots. However, high soil temperature could be a major abiotic factor affecting the penetration and/or multiplication of *T. semipenetrans* during summer months. Population dynamics of *Helicotylenchus multicinctus* and *Meloidogyne incognita* infecting banana in Batinah region also revealed a similar trend and the populations in soil and roots were at negligible levels during June-July indicating the adverse effect of high soil temperature (Mani and Al Hinai, 1996). Similarly O'Bannon *et al.*, (1966) explained the role of temperature on penetration, development and reproduction of *T. semipenetrans*. Population size of *T. semipenetrans* was also affected by soil texture and organic-matter content (Van Gundy and Martin, 1962; O'Bannon, 1968), soil moisture (Van Gundy *et al.*, 1962, 1964), acidity (Van Gundy and Martin, 1962), oxygen content (Van Gundy *et al.*, 1962), salin-

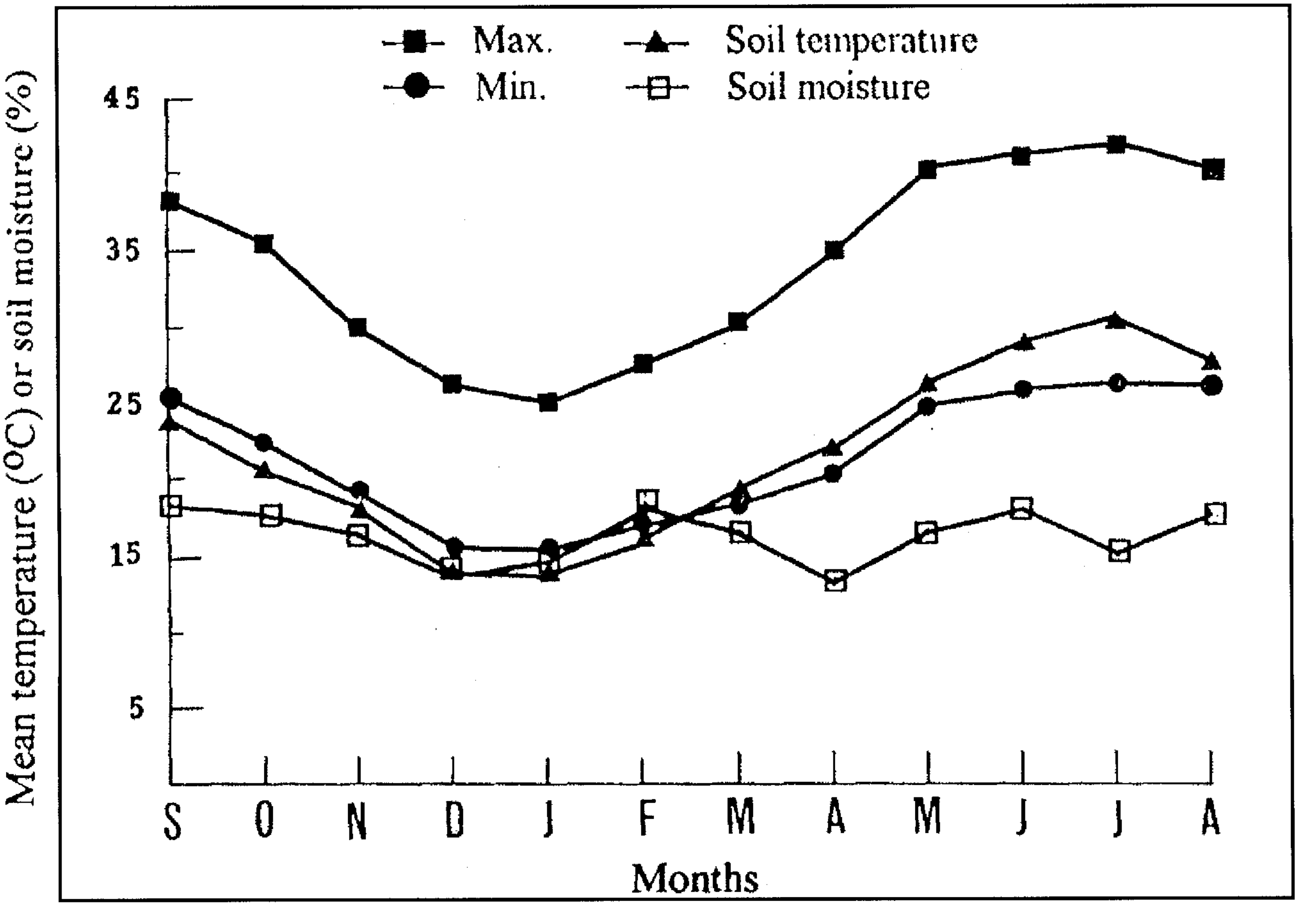

Fig. 1 - Monthly maximum and minimum air temperature, soil temperature and soil moisture recorded during 1995-97.

ity (Mashela *et al.*, 1992), host genotype (Kaplan and O'Bannon, 1981) and chemical composition (Cohn, 1965) of citrus fibrous roots. Recently Duncan and Eissenstat (1993) suggested that carbohydrate competition between developing citrus fruit and *T. semipenetrans* influenced the seasonal fluctuations in nematode population densities. Duncan *et al.*, (1993) further observed seasonal differences in the attractiveness to *T. semipenetrans* of citrus root extracts. Numbers of citrus nematode females on roots and juveniles and males in soil were related positively to root mass density and root concentrations of reducing sugars, starch, and total nonstructural carbohydrates and inversely related to soil moisture and lignin content.

Populations of *T. semipenetrans* in soil and roots were not affected by clandosan, leaves of harmal or fenamiphos. Instead, nematode populations both in soil (Fig. 3) and roots increased markedly from October to April, indicating the inefficacy of the treatments. Nematode populations decreased in all treatments during June which might be due to high soil temperature as observed with population dynamics of the nematode. Application of clandosan to kiwifruit trees at 2.5 t/ha was found effective in reducing populations of *M. incognita* and *Pratylenchus* sp. in Chile (Gonzalez, 1993) and fenamiphos at 10 kg a.i./ha, either single dose or multiple applications at low rates was effective in controlling *M. incognita* and *T. semipenetrans* on grapevine in

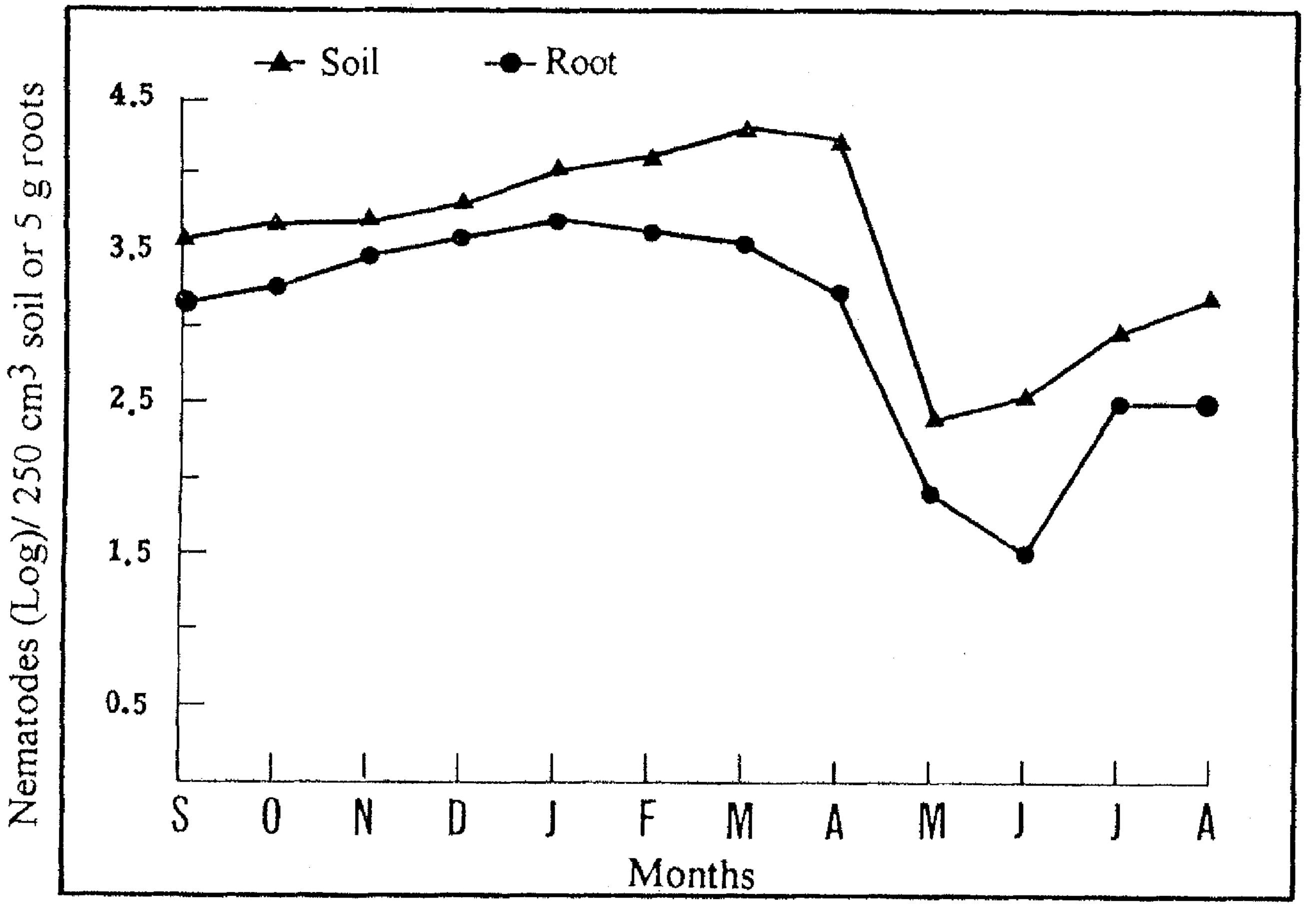

Fig. 2 - Seasonal variations in population levels of *Tylenchulus semipenetrans* in rhizosphere soil and roots of grapefruit during 1995-97.

TABLE I - *Correlation coefficients between ambient and soil temperatures and populations of* Tylenchulus semipenetrans.

Parameters	'r' values	Regression equations
Max. air temperature * population in soil	-0.462*	Y=33829.6-780.5X
Max. air temperature * population in roots	-0.761**	Y=11624.8-278.3X
Soil temperature * population in soil	-0.467*	Y=31754.2-1151.7X
Soil temperature * population in roots	-0.756**	Y=10727.9-403.3X

*, ** Correlation coefficients significant at 5% and 1% level respectively.

Australia (Edwards, 1991). Fenamiphos, which was effective against ecto and endo-parasitic nematodes infecting banana in sandy loam (Mani and Al Hinai, 1996) in Batinah region of Oman, was ineffective in controlling citrus nematode in clay loam. Meher and Sethi (1993) reported that adsorption of fenamiphos was of high order in clay soil. It was noticed that elution of fenamiphos into soil water was found to decrease markedly with increasing proportions of clay content in soil. Schneider *et al.* (1990) suggested that as fenamiphos sulfoxide was more available to the soil water and more mobile in the soil than fenamiphos, fenamiphos sulfoxide would leach deeper into the soil. Davis *et al.* (1993) indicated that the accelerated degradation of fenamiphos sulfoxide in field plots treated previously with fenamiphos could account for the reduction of nematicidal efficacy. Hence, the inefficacy of fenamiphos observed in the present study could be either due to high clay content in soil which might have adsorbed the compound or degradation or leaching of the compound into deeper layer of soil. The results indicate the need for further studies on the persistence of fenamiphos under local conditions and the ways to improve its availability in soil water phase.

Sawdust was the only treatment in which nematode population was maintained almost at the same level both in soil (Fig. 3) and roots throughout the experimental period whereas it increased two to three folds in other treatments. These results indicated the nematode-suppressive effect of sawdust. Stirling (1989) reported that sawdust plus urea was effective in reducing the population of *M. incognita* on ginger. Stirling *et al.* (1995) further reported that replanted apple trees mulched with sawdust or sawdust and manure recorded the lowest population of *P. jordanensis*. These results are consistent with the findings of Stirling. Besides, it was observed that soil moisture was 2-4% higher in tree basins mulched with sawdust than other treatments. Weed growth in plots mulched with sawdust was a maximum of one when compared with 3-4 (on 0-4 scale) in other treatments at the time of each sampling

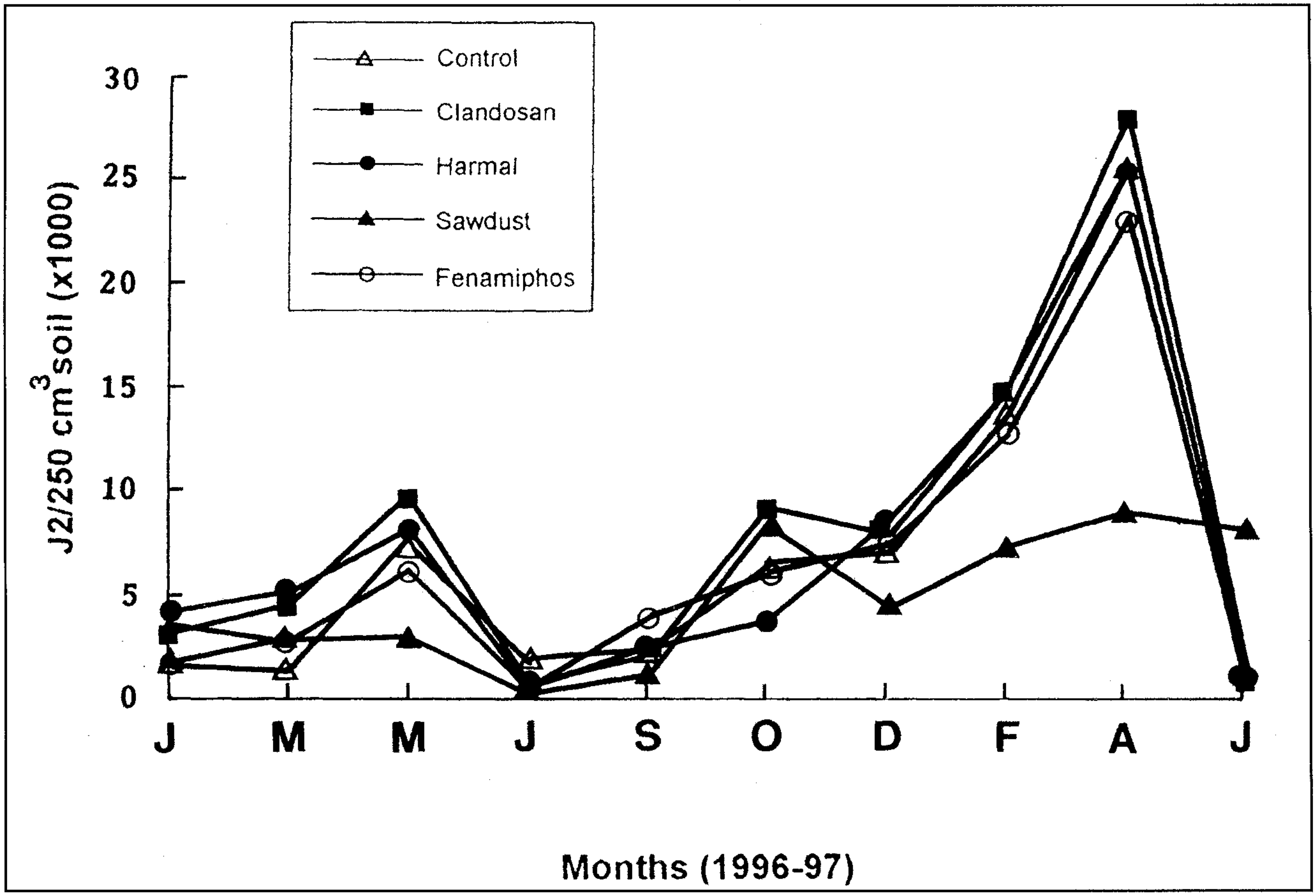

Fig. 3 - Effect of organic and nematicidal treatments on population levels of *Tylenchulus semipenetrans* in soil during 1996-97.

and similar results were obtained in alfalfa field in Batinah region of Oman (Anonymous, 1996). Thus, sawdust was effective in reducing the populations of citrus nematode, conserving soil moisture and managing weeds in citrus orchards.

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