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OCCURRENCE AND DISTRIBUTION OF THE CITRUS NEMATODE (*TYLENCHULUS SEMIPENETRANS*) IN JORDAN

by
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Summary. One–hundred and sixty–two composite soil samples were taken during October 1990 and March 1991 from citrus groves in the Northern Jordan Valley, Central Jordan Valley, Southern Jordan Valley, Southern Ghors, Jerash and Wadi Shueib. Field sampling revealed that the citrus nematode (*Tylenchulus semipenetrans*) was widely distributed in citrus groves in Jordan. Slow decline disease of citrus, caused by the citrus nematode, appeared to be of large magnitude in the older plantations in the Northern Jordan Valley. Second stage juvenile population densities at Deir Alla Station were found to increase in the autumn and spring seasons, but fell down to minimum levels in mid summer. Nematode numbers were high in sandy–loam soils (30.8% - 69.8% sand, 11.2% - 33.2% clay and 19.0% - 36.0% silt). Moreover, soils containing lower organic matter (0.77% - 1.43%), sustained higher numbers of the citrus nematode.

Annual fruit production of all citrus species in Jordan is about 119,000 tonnes which represents about 66% of the total fruit production (Anon, 1990). About 94% of the 5,289 hectares planted to citrus is concentrated in the Jordan Rift Valley.

The citrus nematode, *Tylenchulus semipenetrans Cobb*, is a pathogen of citrus causing a disease called "slow decline" which adversely affects tree vigour and results in lowered fruit production with up to 50% reduction in yield (Van Gundy, 1986; Philis, 1989). There is little information on the distribution of *T. semipenetrans* in Jordan and therefore surveys were undertaken to determine its occurrence and distribution, together with the influence of some soil factors on population dynamics, and seasonal fluctuations in population densities in the Central Jordan Valley.

Materials and methods

A total of 162 soil samples were taken from five locations in the citrus growing areas, the number of samples related to the area planted to citrus species in each locality (Fig. 1, Table I). Sampled groves were 15 years or more of age grafted on sour orange (*Citrus aurantium* L.) rootstock. Sampling was undertaken in October and March when juvenile populations of *T. semipenetrans* are considered to be at their highest (Yousef, 1988). Each sample was a composite of five sub-samples taken at a depth of 5-20 cm from within the drip - line of each tree. Nematodes were extracted from 250 cc aliquots of soil by wet sieving and a modified Baermann funnel technique (Ayoub, 1977). Nematodes were killed by gentle heat and preserved in 3% formaldehyde solution.

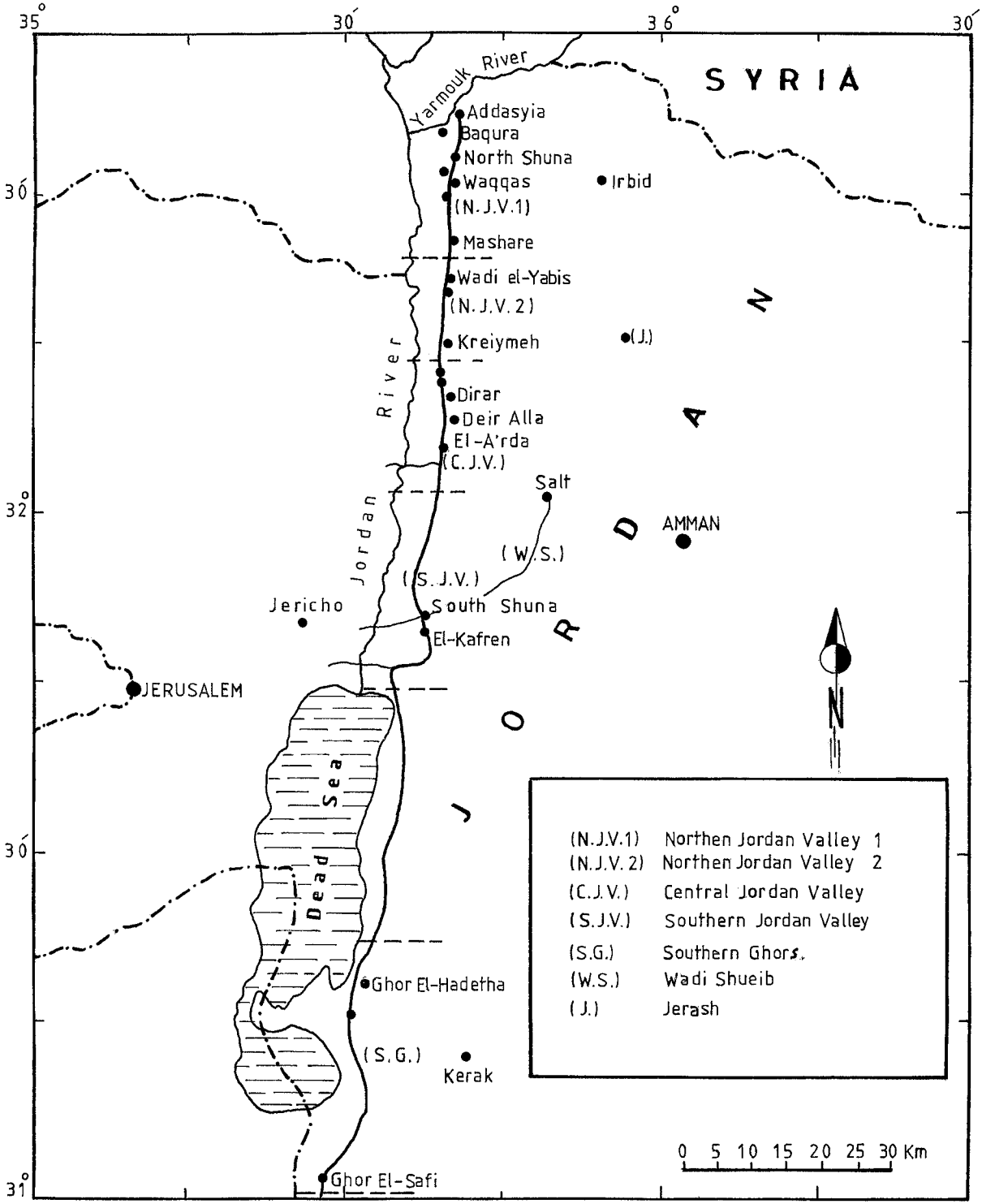

Fig. 1 - Areas and locations of citrus growing in Jordan included in the study.

TABLE I - *Number of soil samples taken from the citrus groves* (Citrus spp.) *grafted on sour orange rootstock from the different locations under study.*

Location	Lemon (*C. lemon* L.)	Orange (*C. sinensis* L.)	Mandarin (*C. reticulata*) Blanco)	Tangerine (*C. mitis* Blanco)	Grapefruit (*C. paradisi* Macfad)	Pomelo (*C. grandis* L.)	Total
Northern Jordan Valley 1	11	9	10	14	5	5	54
Northern Jordan Valley 2	8	7	8	10	5	7	45
Central Jordan Valley	5	6	4	5	2	3	25
Southern Jordan Valley	2	2	2	2	2	2	12
Southern Ghors	4	2	2	2	2	–	12
Jerash	2	2	2	2	–	2	10
Wadi Shueib	2	2	–	–	–	–	4
Total	34	30	28	35	16	19	162

From the survey soil samples, those collected from lemon groves (*C. lemon*) grafted on sour orange rootstock, were analyzed for texture, soil reaction (pH) and electrical conductivity (EC) (Black *et al.*, 1965). Soil soluble Na^+ and K^+ were determined with a flame photometer and Ca^{++} and Mg^{++} with an atomic absorption spectrophotometer. Soil organic matter was calculated according to the Walkley-Black method (Black *et al.*, 1965).

A further investigation, to determine seasonal fluctuation in population densities, was carried out in a 15-year old citrus grove at Deir Alla Agricultural Experiment Station in the Central Jordan Valley. Four soil cores, 5-20 cm depth, were taken from within the drip line of each of 24 citrus trees (grafted on sour orange rootstock) in November, February, May and August. The number of second stage juveniles was determined for 500 cc of each composite sample using the Cobb sieving method followed by a centrifugal - flotation technique (Ayoub, 1977).

Results

The citrus nematode was present in almost all of the citrus groves sampled, but there were different population densities of the second stage juveniles in the soil samples (Table II).

Numbers of second stage juveniles (J2) in Northern Jordan Valley 2 were significantly higher than in Northern Jordan Valley 1, Central Jordan Valley and Jerash ($P = 0.01$), with an average of 3381 and 3288 per 250 cc soil during October 1990 and March 1991, respectively (Table II). The infestation was intermediate in Wadi Shueib, Southern Jordan Valley and Southern Ghors.

There was a significantly higher nematode population build-up during March 1991 than

TABLE II - *Average number of citrus nematode second stage juveniles isolated from 250 cc soil from all locations of citrus growing in Jordan grafted on sour orange rootstock.*

Locations	October, 1990	March, 1991
Northern Jordan Valley 1	1596	1219
Northern Jordan Valley 2	3381	3288
Central Jordan Valley	1494	2002
Southern Jordan Valley	2470	3260
Southern Ghors	2510	3283
Jerash	1540	1488
Wadi Shueib	2680	2600

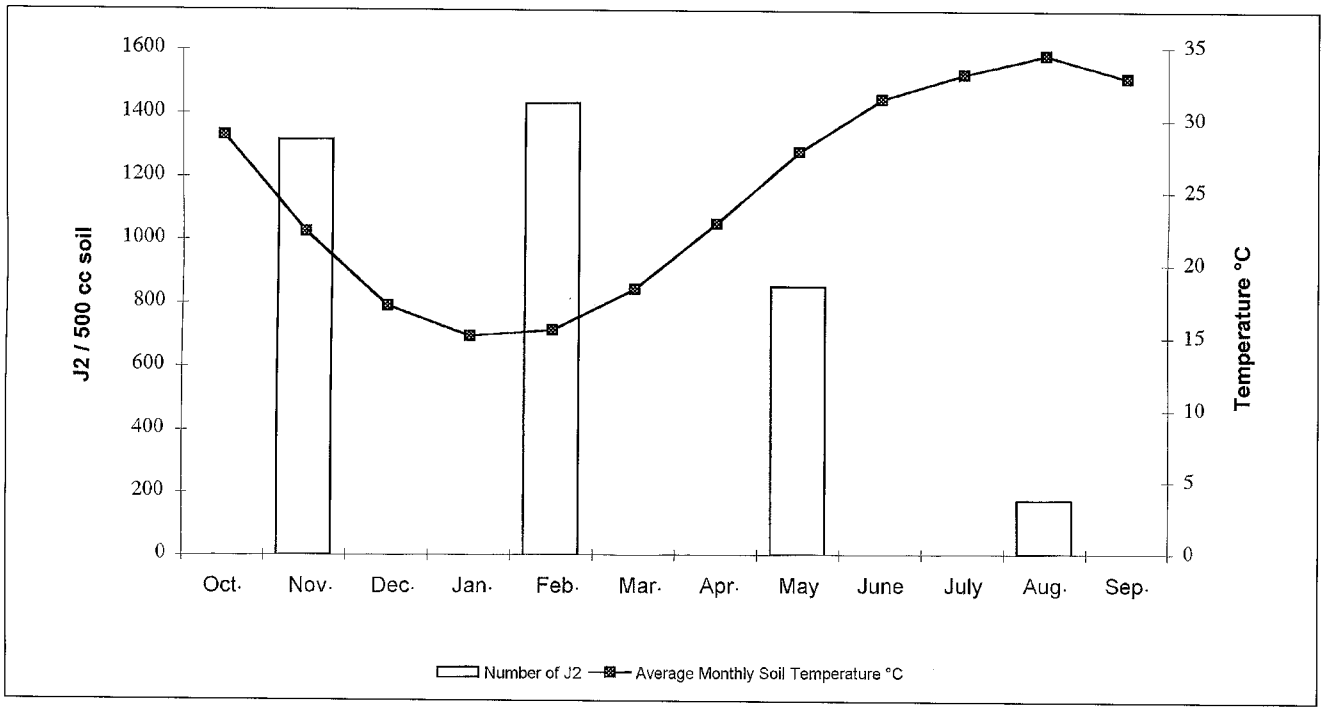

Fig. 2 - Population trends of the citrus nematode second stage juvenile (J2) at Deir Alla on sour orange rootstock, as affected by average monthly soil temperature taken at 20 cm depth.

October 1990 in Central Jordan Valley, Southern Jordan Valley, and Southern Ghors with an average numbers of 2002, 3260 and 3283 per 250 cc soil, respectively (Table II). Nematode populations in Northern Jordan Valley 1 were higher in October 1990 with an average of 1596 per 250 cc soil. There were no significant differences in J2 populations between the two dates at Northern Jordan Valley 2, Wadi Shueib and Jerash.

There was a significant relationship between soil texture and J2 population densities in the lemon groves, larger populations being associated with increasing sand content. There was a negative relationship between soil organic matter content and J2 populations. Other soil factors had no significant influence on nematode numbers in the soil.

Seasonal soil sampling from Deir Alla Station (Central Jordan Valley) indicated that J2 were present in greatest numbers in November and February with an average of 1316 and 1430 J2 per 500 cc soil, respectively. J2 populations decreased significantly to 850 J2 in May and were present at their lowest numbers (only 172 J2) in August (Table III, Fig. 2).

TABLE III - *Population densities of the citrus nematode second stage juveniles in 500 cc soil of sour orange rootstock as affected by soil temperature recorded at 20 cm depth.*

Date of sampling	Number of nematode juveniles	Average monthly soil temperature (°C)
November, 1990	1316	22.4
February, 1991	1430	15.6
May, 1991	850	27.9
August, 1991	172	34.5

Discussion

The survey showed that the citrus nematode is distributed in all regions of citrus growing in Jordan showing "slow decline" symptoms on older trees. The widespread distribution of the citrus nematode is believed to be due to the distribution of seedlings from infested nurseries such as Wadi Shueib, Deir Alla and Baqura.

There were different levels of nematode populations in the various geographical areas of citrus growing. Soil temperature and presumably other soil factors, as well as plant age, are important in this situation. Mean soil temperatures increase southwards, ranging between 17.4 °C in Northern Jordan Valley 1 to 21.6 °C in Southern Ghors during March. Kirkpatric *et al.* (1965) stated that the favourable soil temperature of the citrus nematode is between 25 and 30 °C.

The high numbers of nematode populations in Northern Jordan Valley 2 could be due to the old age of citrus plantations in this area. The long period of infestation is expected to enable the nematode to build-up high population levels.

The citrus nematode has been found in soils differing widely in texture (11.2 - 57.6% clay) (Kirkpatric *et al.*, 1965; Van Gundy and Martin, 1962). In the Jordan Valley, however, high population densities of second stage juveniles were found in soil containing a relatively low clay content, i.e., sandy to sandy loam soils. Such soils increase availability of oxygen, facilitate nematode movement and provide better citrus root distribution.

Soil organic matter showed a negative effect on population levels of the citrus nematode; probably through reduction of soil pH or providing several species of parasitic and predator micro - organisms with the required nourishment.

Other soil characteristics tested (pH, EC and major soil soluble cations) did not appear to significantly influence population of the citrus nematode; possibly because of the narrow range of values obtained in the various areas of citrus growing. Elsewhere it has been reported that the citrus nematode is favoured by pH 6-7 (Van Gundy and Martin, 1962) and low soil salinity (Sweelam and El-Gindi, 1989).

Population trends of the second stage juveniles illustrated in this study, indicate tendency of the citrus nematode to be affected by soil temperature, which also affects root growth (Kirkpatric *et al.*, 1965). High numbers of juveniles occurred during the autumn and spring in the Central Jordan Valley, where soil temperature (17.3 and 22.9 °C; as lowest autumn and highest spring temperatures respectively) are quite suitable for nematode reproduction and new flush of citrus root growth (Reuther, 1973).

Literature cited

ANON., 1990. Annual Statistical Report of Fruit Trees in Jordan. Ministry of Agriculture, Amman, Jordan. pp. 164.

AYOUB S. M., 1977. *Plant Nematology, An Agricultural Training Aid*, Department of Food and Agriculture, State of California (USA), pp. 157.

BLACK C. A., EANS D. D., ENSMINGER L. E., WHITE J. L., CLARK F. E., and DINQUER R. C., 1965. *Methods of Soil Analysis*, American Society of Agronomy, Inc., Pub., pp. 247-310.

KIRKPATRICK J. D., VAN GUNDY S. D. and TOSO P. H., 1965. Soil pH, temperature, and citrus nematode reproduction. *Phytopathology, 55*: 1064. (Abst.).

PHILIS J., 1989. Yield loss assessment caused by the citrus nematode (*Tylenchulus semipenetrans*) on Valencia orange in Cyprus, *Nematol. medit., 17*: 5-6.

REUTHER W., 1973. Climate and citrus behavior, pp. 280-337. In: Citrus industry, Vol. III, Ed. Reuther W., 1973, Univ. of California (USA).

SWEELAM M. E. and EL-GINDI A. Y., 1989. Influence of salinity levels on *Tylenchulus semipenetrans* activity and growth of sour orange seedlings in sandy soil. *Bull. Fac. of Agric. Cairo Univ., 40*: 481-486.

VAN GUNDY S. D., 1986. Plant parasitic nematodes of Banana, Citrus, Coffee, Grapes and Tobacco. Union Carbide Agricultural Product Company, Inc. (USA), pp. 174.

VAN GUNDY S. D. and MARTIN G. P., 1962. Soil texture, pH, and moisture effects on the development of citrus nematode (*Tylenchulus semipenetrans*). *Phytopathology, 52*: 31 (Abst.).

YOUSEF D. M., 1988. A study on the citrus nematode (*Tylenchulus semipenetrans*) in the Jordan Valley. Ministry of Agric. Ann. Reptr. 88/89, pp. 116-133. (Jordan).

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