PLANT-PARASITIC NEMATODES ASSOCIATED WITH DATE PALM TREES (*PHOENIX DACTYLIFERA* L.) IN THE SULTANATE OF OMAN

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ABSTRACT

Mani, A., Z. A. Handoo, and S. Livingston. 2005. Plant-parasitic nematodes associated with date palm trees (*Phoenix dactylifera* L.) in the Sultanate of Oman. Nematropica 35:135-143.

Surveys were conducted in the Batinah, Interior, Sharqia and Dhahira regions and in the Musandam governorate in the Sultanate of Oman to study the occurrence, population density and geographical distribution of phytoparasitic nematodes associated with date palm. Surveys were conducted during two successive cropping seasons from October to April from 1990 to 1997. A total of 165 soil samples were collected and plant parasitic nematodes were identified from the rhizosphere of date palm. Mixed populations of 32 economically important plant-parasitic nematode species belonging to 17 genera were identified, with fifteen identified to species. *Rotylenchulus anamictus* was reported for the first time in the Arabian Peninsula, and *Helicotylenchus digonicus* represents a new record for the Sultanate of Oman. The important parasitic nematodes found in date palm rhizosphere included populations of *Helicotylenchus multicinctus*, which ranged from 22-3960 nematodes/250 cm^3 soil with high numbers at Seeb, Barka, and Rustaq; *Meloidogyne incognita*, ranged from 156-7560 juveniles/250 cm^3 soil with high numbers at Quriyat and Buraimi; *M. javanica*, with 20-4000 juveniles/250 cm^3 soil with high numbers at Wadi-Quriyat and Dhank; and *Rotylenchulus anamictus* with 400-12,600 nematodes/250 cm^3 soil with high populations at Adam, Samail, Nizwa, Bahla, Al Hamra, Wadi-Quriyat, Ibri, Buraimi and Wadi Al Tayyin. Additionally, *Helicotylenchus* sp., *Pratylenchus* sp., and *Rotylenchulus* sp. were often observed at varying population levels. Other nematode genera identified were insignificant in most instances, usually occurring in low population densities. The effects of nematode damage on growth, vigor and yield of date palm need to be investigated.

Key words: date palm, distribution, *Helicotylenchus digonicus*, *H. multicinctus*, *Helicotylenchus* sp., *Meloidogyne javanica*, nematode survey, population density, *Pratylenchus* sp., *Rotylenchulus anamictus*, *Rotylenchulus* sp.

RESUMEN

Mani, A., Z. A. Handoo, and S. Livingston. 2005. Nematodos fitoparásitos asociados con la palma datilera (*Phoenix dactylifera* L.) en el Sultanato de Omán. Nematropica 35:135-143.

Se realizaron censos en las regiones de Batinah, Interior, Sharqia y Dhahira y en la gobernación de Musandam en el Sultanato de Omán para estudiar la presencia, densidad de población y distribución geográfica de nematodos fitoparásitos asociados con la palma datilera. Los censos se hicieron durante dos temporadas de cultivo sucesivas, de octubre a abril de 1990 a 1997. Se colectó un total de 165 muestras de suelo, y se identificaron los nematodos fitoparásitos de la rizosfera de las palmas datileras. Se identificaron poblaciones mixtas de 32 especies de nematodos fitoparásitos, pertenecientes a 17 géneros, incluyendo 15 identificaciones hasta especie. Se reporta *Rotylenchulus anamictus* por primera vez en la península arábica, y se hace el primer registro de *Helicotylenchus digonicus* en el Sultanato de Omán. Los nematodos fitoparásitos importantes encontrados en la rizos-

fera de palmas datileras incluyen poblaciones de *Helicotylenchus multicinctus*, que oscilaron entre 22 y 3960 nematodos/250 cm^3 de suelo con altas poblaciones en Seeb, Barka y Rustaq; *Meloidogyne incognita*, con poblaciones entre 156 y 7560 juveniles/250 cm^3 de suelo y altas densidades en Quriyat y Buraimi; *M. javanica*, con 20 a 4000 juveniles/250 cm^3 de suelo, y altas densidades en Wadi-Quriyat y Dhank; y *Rotylenchulus anamictus* con 400-12,600 nematodos/250 cm^3 de suelo, con altas poblaciones en Adam, Samail, Nizwa, Bahla, Al Hamra, Wadi-Quriyat, Ibri, Buraimi y Wadi Al Tayyin. Se observaron, además, con frecuencia *Helicotylenchus* sp., *Pratylenchus* sp. y *Rotylenchulus* sp. en diversas densidades de población. Los demás géneros identificados no fueron de significancia en la mayoría de los casos y se encontraron normalmente en bajas densidades de población. Es necesario investigar los efectos del daño causado por nematodos en el crecimiento, vigor y producción de las palmas.

Palabras clave: densidad de población, distribución, *Helicotylenchus digonicus*, *H. multicinctus*, *Helicotylenchus* sp., *Meloidogyne javanica*, palma datilera *Pratylenchus* sp., *Rotylenchulus anamictus*, *Rotylenchulus* sp.

INTRODUCTION

Date palm (*Phoenix dactylifera* L.) is the most important fruit crop grown in the Sultanate of Oman, and the crop occupies about 78% of the cultivated area (Kindy and Sharji, 1996). Since ancient times, date palm cultivation has been an important source of income in Oman. A hectare of date palm plantation can yield a total of approximately 50 tonnes of fruit/year (Figs. 1 and 2) with gross revenue of approximately US $125,000/ha/year. Date fruits are a part of Omanis' every-day diet and the fruits are offered to all visitors as a gesture of goodwill. Date fruits are very nutritious, a good source of sucrose, calcium, potassium, iron and vitamins. The dates are mostly eaten fresh and processed dates are exported to other countries (Anonymous, 2002; Kinawy, 2005). Thus, date palm occupies a prominent role in the economic, social and cultural life of the Omani people.

Summer temperatures in Oman from April to August range from 40-50°C, and date palm is the only crop which can survive this harsh climate. The crop needs high temperature with low humidity during fruit maturity and ripening stages. Date palm is well adapted to a hot and dry climate, and saline soil conditions, as well as the quality of water available in many parts of Oman. Date palm is grown commonly in all northern regions of Oman (Fig. 3) but not in southern Oman because it has a more moderate climate throughout the year which does not favor its cultivation.

Date palm suffers from the damage of many insect pests and fungal diseases (Kinawy, 2005). The common insect pests found attacking date palm trees include Dubas bug, *Ommatissus lybicus* Bergevin; Parlatoria date scale, *Parlatoria blanchardi* (Targioni-Tozeti); date palm mealy bug, *Pseudaspidioproctus hyphaeniacus* Hall; red palm weevil, *Rhynchophorus ferrugineus* (Oliver); long-horn date palm stem borer, *Jebusea hammerschmidti* Reiche; fruit stalk borer, *Oryctes* spp.; and rhinoceros beetle, *Oryctes rhinoceros* (Linnaeus). The common fungal diseases that affect date palms include inflorescence rot, *Mauginiella scaettae* Cavara; black scorch/bud rot, *Ceratocystis paradoxa* (Dade); false smut, *Graphiola phoenicis* (Moug.) Poit.; brown leaf spot, *Mycosphaerella tassiana* (de Not.) Johanson; rachis or diplodia wilt, *Diplodia phoenicum* (Sacc.) H. Fawe. & Klotz; Pestalotiopsis leaf spot, *Pestalotiopsis palmarum* (Cooke) Steyaert.; Belâat disease, *Phytophthora palmivora* (E. J. Butler) and Fusarium wilt, *Fusarium oxysporum* Schlechtendahl.

Fig. 1. A date palm plantation at fruiting stage located in the Interior region of Oman.

Mani *et al.* (1997) reported the presence of five root-lesion nematodes, *Pratylenchus brachyurus*, *P. coffeae*, *P. delattrei*, *P. jordanensis*, and *P. neglectus* from the rhizosphere soil of date palm in Batinah, Dhahira, Interior, Musandam, and Sharqia regions of Oman respectively. A nematological survey of date palms and other major crops in Algeria conducted by Lamberti *et al.* (1975) found three nematode species (*Pratylenchus penetrans*, *Xiphinema elongatum* and *Longidorus congoensis*) causing damage to date palm with the most common being *X. elongatum*, which was observed in all the oases studied. Greco *et al.* (1980) investigated the possible interaction between *Fusarium oxysporum* Schl. f. sp. *albedinis*, causal agent of bayoud disease of the date palm, and the root-knot nematode *Meloidogyne incognita* (Kofoid *et* White) Chitwood in a glasshouse experiment. They reported that although all the plants growing in soil inoculated with either or both the pathogens showed initial symptoms of decline three months after inoculation, the concomitant presence of nematode and fungus did not aggravate the disease situation. Although plant-parasitic nematodes have been generally recognized as one of the important groups of pathogens, only very meager information is available on the occurrence, distribution, biology, and population dynamics of major parasitic nematodes and their influence on the growth and yield of date palm. Hence, an attempt was made during the present investigation to survey and document the occurrence, population density and distribution of the plant-parasitic nematodes recorded in association with date palm trees.

Fig. 2. Date palm tree with fruit bunches at peak production.

MATERIALS AND METHODS

Surveys were carried out in the Batinah, Dakhliya (Interior), Sharqia and Dhahira regions (provinces) and Musandam governorate during 1990-97 (Table 1, Fig. 3). Each region was surveyed during the main cropping season from October to April for two consecutive years. Four to five farms were randomly selected in each wilayat (district), with the assistance of extension personnel from Agricultural Development Centre located in each wilayat, and at least one sample was collected from each farm. A total of 165 soil samples were collected close to the drip lines from the rhizosphere region of date palm trees up to 25-cm depth with an auger following a random pattern of sampling. A total of four to six sub-samples, each having about 150 cm^3 soil, were collected from 2-3 trees in each field and pooled. A composite sample of 250 cm^3 soil was drawn and processed employing Cobb's sieving and decanting technique followed by modified Baermann funnel technique (Hooper, 1986). Nematodes were fixed in hot 3% formaldehyde solution, with some fixed specimens processed to anhydrous glycerine (Seinhorst, 1959) and examined under a compound microscope for species identification. In addition, soil samples from certain important intercrops were occasionally collected and processed following the above procedures. Some plant-parasitic nematodes were identified using the temporary and semi-permanent mounts of nematode specimens (Jepson, 1987; Siddiqi, 1986). Nematodes were identified to genus level from all samples and to species level when found in high numbers. Nematode identi-

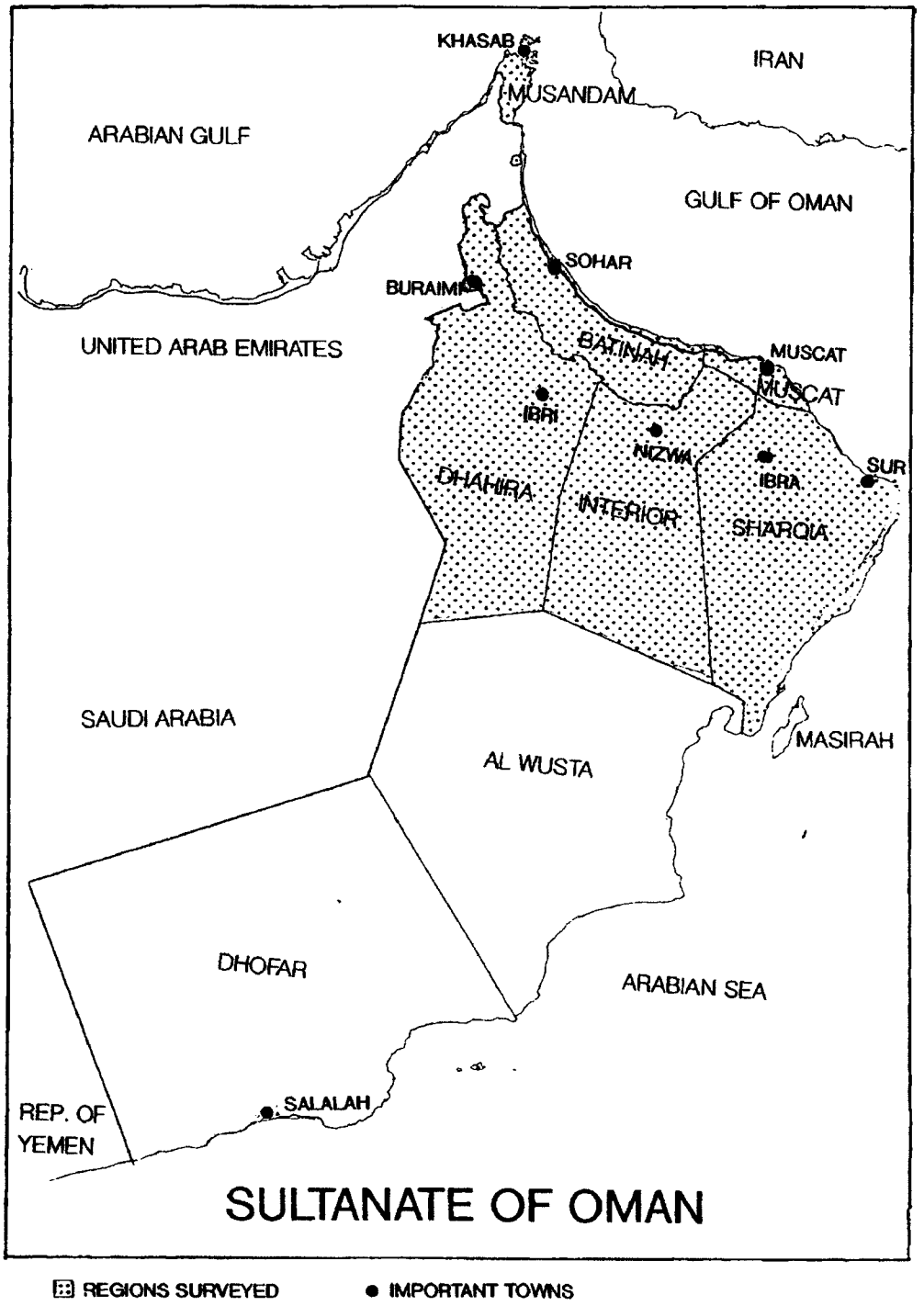

Fig. 3. Map of Sultanate of Oman showing areas in which samples were taken.

Table 1. Regions and wilayats surveyed during 1990-97.

Name of region	No. of wilayats	Name of wilayats
Batinah	12	Quriyat, Seeb, Barka, Rustaq, Musanah, Suweiq, Khabourah, Saham, Sohar, Liwa, Shinas, Murair
Dakhliya or Interior	9	Bid Bid, Samail, Izki, Manah, Adam, Nizwa, Bahla, Al Hamra, Wadi Quriyat
Sharqia	4	Ibra, Mudhaibi, Sinaw, Sur
Dhahira	7	Ibri, Dhank, Yanqul, Buraimi, Mahda, Sinainah, Wadi Al Tayyin
Musandam	4	Bukha, Diba, Khasab, Mad'ha

fications were based on the morphology of adult and larval forms and their identifications were confirmed with recent taxonomic keys (Dasgupta *et al.*, 1969; Handoo, 2000; Handoo and Golden, 1989; Loof and Luc, 1990; Mai *et al.*, 1996; Robinson *et al.*, 1997; Sher, 1966). Nematode populations in soil were classified into low, medium and high following the scale given in Table 2 and the scale was used for discussing the results.

RESULTS AND DISCUSSION

Date palm was found to be grown as a main crop and also as a border crop around sections of farms. Alfalfa (*Medicago sativa* L.) was often grown as an intercrop in date palm plantations. In addition, banana, lime, eggplant, pepper, okra, onion, and garlic were also grown as intercrops. The common weed species recorded in date palm plantations included *Abutilon multicum* (Del. ex DC) Sweet, *Calotropis* sp., *Chenopodium murale* L., *Ixora coccinea* L., *Phyllanthus maderaspatensis* L., *Portulaca oleracea* L., *Setaria verticillata* (L.) P. Beauv., *Solanum nigrum* L. and *Vernonia cineria* (L.).

Nematodes in 17 genera and 32 species were found in association with date palm (Table 2). *Helicotylenchus*, *Meloidogyne*, *Pratylenchus* and *Rotylenchulus* were the major plant parasitic nematode genera most frequently recovered. Multiple genera of plant-parasitic nematodes were found often and species of *Helicotylenchus*, *Pratylenchus*, and *Tylenchorhynchus* occurred in combinations at low population levels irrespective of the region. However, if a nematode species was present in high numbers in a sample, multiple genera did not occur in such samples. In most instances, *Rotylenchulus anamictus* Dasgupta, Raski and Sher occurred at a very high population level (>1000 nematodes per 250 cm^3 soil) and in such samples, other plant-parasitic nematode species were not observed, even at low numbers. Certain patterns on the occurrence of some nematode species were observed in relation to the geographical region. For instance, in both years of survey, *Helicotylenchus multicinctus* (Cobb) Golden was commonly found only in Batinah region and it was of rare occurrence or completely absent in other regions. *Helicotylenchus microcephalus* Sher was common in Interior region. *Rotylenchulus anamictus* was recorded only in Interior and Dhahira regions and was absent in other regions.

Meloidogyne incognita was detected in the Batinah and Interior regions at low to medium (up to 500 juveniles [J_2] per 250 cm^3 soil) population levels. *Meloidogyne javanica* was found widely distributed in the

Table 2. Occurrence, population density and distribution of plant-parasitic nematodes associated with date palm in Oman.

Nematode genera/species	Occurrence (%)	Population range[y]	Mean popn.[y, z]	Distribution
Criconemoides sp.	2.0	40-50	45	Buraimi, Liwa, Yanqul, Mad'ha, Khasab
Criconemella sp.	1.5	30-45	33	Bahla
Ditylenchus sp. juveniles	8.1	20-100	40	Seeb, Shinas, Bid bid, Adam, Nizwa, Ibri, Dhank
Dolichodorus sp.	3.0	10-40	28	Bahla, Buraimi, Mahda
Filenchus sp.	2.2	15-45	25	Dhank, Yanqul
Helicotylenchus digonicus	1.4	70-110	82	Sinaw
H. dihystera	2.0	56-120	88	Liwa
H. indicus	1.1	100-150	74	Sur
H. microcephalus	8.1	20-575	263	Bid Bid, Izki, Adam, Bahla, Al Hamra, Yanqul
H. multicinctus	6.1	22-3960	128	Seeb, Barka, Rustaq, Musanah, Khabourah, Saham, Liwa, Shinas, Murair, Adam, Dhank
Helicotylenchus sp.	36.4	20-2700	285	Common in all wilayats
Hemicriconemoides mangiferae	8.1	22-680	125	Barka, Saham, Adam, Manah, Sur, Mahda,
Hemicriconemoides sp.	3.0	10-748	45	Shinas, Manah, Nizwa, Dhank, Mahda,
Longidorus sp.	8.1	20-35	27	Musanah, Suweiq, Murair, Bid Bid,
Macroposthonia sp.	2.0	20-30	23	Manah, Wadi-Quriyat
Meloidogyne incognita	6.1	156-7560	510	Quriyat, Seeb, Yanqul, Buraimi,
M. javanica	14.1	20-4000	620	Kabourah, Manah, Wadi-Quriyat, Ibri, Dhank, Sinainah, Mahda, Buraimi
Meloidogyne sp.	16.2	20-1500	280	Saham, Shinas, Bid Bid, Izki, Nizwa, Bahla,Al Hamra, Ibri, Yanqul, Buraimi, Mahda, Mad'ha
Paralongidorus sp.	1.0	15-20	17	Saham
Paratylenchus sp.	3.0	15-50	43	Seeb, Saham, Samail, Mahda, Mad'ha
Pratylenchus brachyurus	2.0	95-420	257	Liwa
P. coffeae	1.0	120	120	Dhank

[y]Nematode population per 250 cm^3 soil.
[z]Population density of ecto-parasitic nematodes: Low (1-50), medium (51-100) and high (>250); population density of endo- and semi-endo parasitic nematodes: Low (1-250), medium (251-500) and high (>500)

Table 2. (Continued) Occurrence, population density and distribution of plant-parasitic nematodes associated with date palm in Oman.

Nematode genera/species	Occurrence (%)	Population range[y]	Mean popn.[y, z]	Distribution
P. delattrei	1.5	20-50	25	Dhank
P. jordanensis	1.5	15-650	115	Diba, Mad'ha
Pratylenchus sp.	25.3	20-340	77	Common in all wilayats
Psilenchus sp.	1.5	15-60	30	Mahda
Rotylenchulus anamictus	13.1	400-12,600	2623	Adam, Samail, Nizwa, Bahla, Al Hamra, Wadi-Quriyat, Ibri, Buraimi, Wadi Al Tayyin
Rotylenchulus sp. juveniles	15.2	40-960	245	Seeb, Rustaq, Samail, Al Hamra, Sinainah,
Tylenchorhynchus nudus	1.5	10-50	32	Khasab, Mad'ha
Tylenchorhynchus sp.	17.2	10-130	80	Common in all wilayats
Xiphinema americanum	3.0	10-40	28	Barka, Musanah, Suwaiq, Saham,
Xiphinema sp.	5.1	10-60	30	Seeb, Bid Bid, Samail

[y]Nematode population per 250 cm^3 soil.
[z]Population density of ecto-parasitic nematodes: Low (1-50), medium (51-100) and high (>250); population density of endo- and semi-endo parasitic nematodes: Low (1-250), medium (251-500) and high (>500)

Interior and Dhahira regions, and its population was the highest (4000 J_2/250 cm^3 soil) in the Dhank wilayat. In the Batinah region, date palm seedlings were found infected with *M. javanica*, and small galls were seen on fibrous roots. However, root-knot nematode galls were not observed on roots of young (1-9 years) or old (<10 years) date palm trees on any farm, although high J_2 populations were observed in soil. The population in soil could be due to the presence of infected weed hosts like *S. nigrum* and *V. cineria* in date palm plantations which served as the source of nematode inoculum for the field as observed on earlier occasions in Oman (Mani and Al Hinai, 1996). Jensen (1961) found *M. incognita* on roots of date palm in Western nurseries. In greenhouse studies, Carpenter (1964) reported that root-knot nematodes, principally *M. javanica*, can severely damage or kill date palm seedlings and that date palms also showed a remarkable capacity for quick and abundant root regeneration, even from roots that were extensively galled and rotted. In addition, seedling infection of 50 varieties of date palms revealed that most were severely damaged by root-knot nematodes. However, the survival of 10 to 20% of the seedlings in 8 varieties suggested that some populations might be useful in selecting and breeding date palms that combine tolerance to root-knot nematode injury with good horticultural traits. High populations of *Meloidogyne* species were also recorded in association with diseased date palm trees in Saudi Arabia (Al-Khoury, 1989).

Rotylenchulus anamictus Dasgupta, Raski and Sher was recorded in 13.1% of the samples, and populations ranged from 400 to 12,600 per 250 cm^3 soil at Adam, Samail, Nizwa, Bahla, Hamra, Wadi-Quriyat, Ibri, Buraimi and Wadi Al Tayyin. This species

was also encountered at high population levels of 1300 to 2750 per 250 cm^3 soil on lime and onion in Interior region, (Anonymous, 1993 and 1994), and the nematode was observed for the first time in the Arabian Peninsula. This nematode has not been reported in Asia or the Pacific region (Maqbool, 1991). The type host and locality of *R. anamictus* was from soil around *Acacia* sp. about 2 miles south of Merca, Somalia.

Helicotylenchus multicinctus was commonly recorded in all wilayats in Batinah region during the survey, and the populations were high at Seeb, Barka and Rustaq. *Helicotylenchus digonicus* Perry, Darling and Thorne is a new record for the country. In addition, a high population (650 nematodes per 250 cm^3 soil) of *Pratylenchus jordanensis* Hashim was recorded in association with date palm at Mad'ha. *Helicotylenchus microcephalus* and *Pratylenchus* sp. were also frequently recorded in the rhizosphere of date palm trees. The observation of *P. coffeae* (Zimmerman) Filipjev and Schuurmans Stekhoven in the date palm rhizosphere in Dhank wilayat may be due to the inter-cultivation of banana, where the nematode was collected from the rhizosphere soil in the same field.

The present survey revealed the occurrence of many plant-parasitic nematodes in date palm rhizosphere that could be of potential importance. Although *H. multicinctus*, *M. incognita*, *M. javanica*, and *R. anamictus* were the nematodes often recorded at high population levels during the survey, their biology, host-parasite relationships and population dynamics in relation to date palm, as well as the effect of their damage on growth, vigor and yield of date palm, need to be studied in detail.

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