OCCURRENCE, POPULATION DENSITY, AND DISTRIBUTION OF ROOT-LESION NEMATODES, *PRATYLENCHUS* SPP., IN THE SULTANATE OF OMAN

A. Mani,[1] Muzna S. Al Hinai,[1] and Z. A. Handoo[2]

Ministry of Agriculture and Fisheries, Directorate of Agricultural Research, P.O. Box 50, Postal Code-121 (Al Seeb), Sultanate of Oman,[1] and Nematology Laboratory, USDA-ARS, 10300 Baltimore Avenue, Beltsville, MD-20705-2350, U.S.A.[2] Current address of senior author: 31 St. Dennis Drive, #606, North York, M3C 1G8, Canada.

ABSTRACT

Mani, A., Muzna S. Al Hinai, and Z. A. Handoo. 1997. Occurrence, population density, and distribution of root-lesion nematodes, *Pratylenchus* spp., in the Sultanate of Oman. Nematropica. 27:209-219.

Surveys were conducted in Batinah, Dhahira, Interior, Jabal Akhdar, and Sharqia regions and Dhofar and Musandam governorates of the Sultanate of Oman during cropping seasons from 1990-97, to study the occurrence, population density, and distribution of root-lesion nematodes. Twelve species of *Pratylenchus* were recorded in association with 31 plant families that included 21 vegetable crops, 19 tree fruit crops, 16 field crops, two ornamentals and 14 weeds. Eleven known species of *Pratylenchus* are reported in the country for the first time. Among them *P. jordanensis* was the most frequently observed nematode species occurring in association with 37 crops and 14 weed species and found widely distributed in all the regions. *Pratylenchus neglectus* was the second most frequently recorded species in association with 24 plant species. *Pratylenchus brachyurus, P. coffeae, P. scribneri,* and *P. zeae* were the other economically important nematode species observed in the country.

Key words: distribution, Oman, *Pratylenchus jordanensis, P. neglectus,* root-lesion nematodes, survey.

RESUMEN

Mani, A., M. S. Al Hinai y Z. A. Handoo. 1997. Presencia, densidad poblacional, y distribución de los nematodos lesionadores de la raíz, *Pratylenchus spp.*, en el Sultanato de Oman. Nematropica. 27:209-219.

Se realizaron muestreos en las regiones de Batinah, Dhahira, Interior, Jabal Akhdar, y Sharqia, y en las gobernaciones de Dhofar y Musandam del Sultanato de Oman, en epoca de cosecha desde 1990-97, para estudiar la presencia, densidad de población y distribución de los nematodos lesionadores de la raíz. Doce especies de *Pratylenchus* fueron registradas, en asociación con 31 familias de plantas, las que incluyeron 21 cultivos de hortalizas, 19 cultivos de árboles frutales, 16 cultivos agrónomicos, 2 ornamentales y 14 malezas. Once especies conocidas de *Pratylenchus* se reportan por primera vez en el país. Entre estas, *P. jordanensis* fue la especie de nematodo más frecuentemente encontrada, presente en asociación con 37 cultivos y 14 especies de malezas y estando ampliamente distribuida en todas las regiones. *P. neglectus* fue la segunda especie reportada con más frecuencia en asociación con 24 especies de plantas. *Pratylenchus brachyurus, P. coffeae, P. scribneri,* y *P. zeae* fueron las otras especies de nematodos económicamente importantes observadas en el país.

Palabras claves: distribución, lesionadores de la raíz, muestreo de nematodos, Oman, *Pratylenchus jordanensis, P. neglectus.*

INTRODUCTION

The Sultanate of Oman is situated between 16°40' and 26°20' north latitudes and 51°50' and 59°40' east longitudes and occupies the south eastern corner of the Arabian Peninsula. Its borders, administrative divisions, climate and cropping sys-

tems were described in an earlier report (Mani and Muzna Al Hinai, 1996). Alfalfa, banana, cowpea, cucumber, date palm, eggplant, garlic, lime, mango, melons, okra, onion, pomegranate, red pepper, rhodesgrass, sweet lime, sweet orange and tomato are the important crops grown in all regions of the Sultanate. The major crops grown on more than 80% of a total cultivated area of 41,024 ha are: Alfalfa 9.0%, banana 4.9%, date palm 49.2%, lime 5.0%, mango 7.2%, and vegetable crops 5.2% (Anonymous, 1989).

Waller and Bridge (1978) reported the presence of the root-lesion nematode, *Pratylenchus brachyurus* (Godfrey) Filipjev and Schuurmans Stekhoven on lucerne and potato at Salalah in south Oman. Mani (1993) considered *Pratylenchus* species, next to root-knot nematodes, as the second most important group of plant-parasitic nematodes and reported the distribution of four species of *Pratylenchus* in Batinah region. However, detailed studies have not yet been carried out to identify the species of *Pratylenchus* in association with major crops in all the regions. Hence, we studied and report herein the occurrence, population density, and distribution of *Pratylenchus* spp. present in Oman.

MATERIALS AND METHODS

Surveys were carried out in all regions of the country from 1990-97. A total of 12 wilayats (divisions) in Batinah, 9 in Interior, 7 in Dhahira, 6 in Sharqia, 4 in Musandam and 5 in Dhofar Governorate were visited during the survey. Five farms in each wilayat were randomly selected with the help of extension personnel. Samples were obtained at least two months after planting of annual crops. One or two samples, depending on the cropped area, each consisting of three to five sub-samples were collected from each crop using a garden trowel or an auger. Soil and root samples were collected from the rhizosphere region up to 15 cm from the base of the plants and at a depth to 15 cm in vegetable and field crops. In tree fruit crops, samples were collected 20-50 cm away from the base of the plants and up to 20-25 cm depth, depending on the crop and its age (Mani, 1993). A total of 1757 soil samples along with feeder roots were collected. A composite sample of 250 cm^3 soil was drawn and processed following Cobb's sieving and decanting technique, followed by a modified Baermann funnel method. Roots were washed free of soil, cut into pieces and incubated for 36-48 hr in Baermann funnels filled with water containing 0.5% hydrogen peroxide. Nematodes in suspensions were fixed in 2.0% hot formaldehyde, and identified and counted using a stereo binocular microscope. Specimens of each species were fixed in 5% formaldehyde solution, processed to anhydrous glycerine by the modified Seinhorst method (Seinhorst, 1959) and mounted on Cobb's slides with double cover slips (Cobb, 1917). The nematodes were examined under a compound microscope and their identities confirmed with recent taxonomic keys (Handoo and Golden, 1989; Nickle, 1991; Siddiqi, 1986). Literature was consulted for proper identification of plant specimens (Ghazanfar, 1992).

RESULTS AND DISCUSSION

The occurrence of a nematode species in samples is expressed as frequency. Absolute frequency is the percentage of times a nematode species occurs in a known number of samples, while relative frequency, also expressed as a percentage, is the ratio between absolute frequency of a species and absolute frequency of all *Pratylenchus* species. The genus *Pratylenchus* had absolute frequencies ranging from 20-30% in each region with an overall mean fre-

quency of 21.2%. Twelve species of *Pratylenchus* were found in association with 21 vegetables, 19 tree fruit crops, 16 field crops, two ornamentals and 14 weeds belonging to 31 families (Table 1). All of the species, except *P. brachyurus* (Godfrey) Filipjev and Schuurmans Stekhoven are reported in Oman for the first time. Alfalfa, cucurbits, date palm, eggplant, garlic, lime, onion, pistachio, rhodesgrass and sweet potato were often found in association with two or more species of root-lesion nematodes.

Pratylenchus coffeae (Zimmermann) Filipjev and Schuurmans Stekhoven was recorded in soil and root samples of banana, date palm, *Ixora coccinea* L., lime, mandarin, mango, sweet lime and sweet orange. Its mean population density of 432 nematodes per 250 cm^3 soil was the highest of all species (Table 2). The morphology of the *P. coffeae* populations obtained from date palm and sweet lime varied from other populations by the absence of indentation on the tail terminus and they were identified based on the morphology of head, stylet and tail. A nematode most resembling *P. gutierrezi* Golden *et al.* was observed in two soil samples collected from banana in Dhahira region, although scanning electron microscopy of lip morphology was not used to confirm its identity (Golden *et al.*, 1992). The *P. coffeae* population densities in roots of different *Citrus* species ranged from 75-350 nematodes per 5 g. They produced typical brown necrotic lesions on fibrous roots of lime (Fig. 1B) and severe infection resulted in fibrous root rot. In advanced stages, infected trees often exhibited symptoms of decline and even death of trees (Fig. 1A). Weeds like *Cynodon dactylon* (L.) Pers. and *Setaria verticillata* (L.) P. Beauv., growing in basins of infected-trees, were found infected by the nematode. *P. coffeae* is known to be an important parasite of many other crops, and can cause heavy damage to coffee, banana and citrus (Loof, 1991; Siddiqi, 1964).

Pratylenchus brachyurus, P. delattrei Luc, *P. jordanensis* Hashim, *P. pseudopratensis* Seinhorst, *P. neglectus* (Rensch) Filipjev and Schuurmans Stekhoven and *P. scribneri* Steiner were recorded in association with alfalfa in the Sultanate. *P. jordanensis* was the most widespread and frequently encountered species and was also observed in association with 36 other crops and 14 weeds in Oman. The nematode was encountered at high population levels in soil and root samples of alfalfa, cucurbits, rhodesgrass and several tree fruit crops and was detected at a mean population density of 157 nematodes per 250 cm^3 soil. Data collected from Batinah region, in farms having a history of *P. jordanensis* infestation on alfalfa, revealed that apparently healthy crops harbored higher nematode population densities than did declining crops, apparently due to the availability of more fibrous roots in healthy crops. A positive correlation ($P \leq 0.05$) existed between health of the crop and nematode population density. It appeared that decline symptoms first became evident at high population levels, wherein the crop exhibited slowly expanding patches of poor growth and reduced yield. In advanced stages, plant and nematode population densities were reduced due to death of plants (Figs. 2A and 2B). Severe plant injury may also involve nematode aggravated soil-borne fungal diseases. The root-injury caused by lesion nematodes is often aggravated by the secondary infection of the feeding sites by other micro organisms. Several species of *Pratylenchus* and *Meloidogyne* are known to interact with pathogenic fungi causing greater damage than by nematodes or fungi alone on many crops, including alfalfa (Evans and Haydock, 1993; Mani and Sethi, 1987). The

Table 1. Occurrence, population density and distribution of *Pratylenchus* spp. in association with major crops in different regions of Oman.

Scientific name of associated plant	Family	Common name	Nematodes recorded[x] mean population[w] density	Distribution[x]
Abelmoschus esculentus Moen.	Malvaceae	Bhendi	Pj-40	DG
Abutilon muticum (Del. ex DC) Sweet	Malvaceae	Weed	Pj-15[y]	B
Allium cepa (L.) Willd.	Liliaceae	Onion	Pj-250′, Pn-220′, Pz-100′	I, M, S
Allium sativum L.	Liliaceae	Garlic	Pb-20, Pj-35′, Pn-57, Pz-58′	I, J, S
Amaranthus graecizans L.	Amaranthaceae	Pigweed	Pj-10[y]	B
Annona reticulata L.	Annonaceae	Custard-apple	Psc-20	DG
Beta vulgaris L.	Chenopodiaceae	Beet root	Pb-32, Pj-32	B
Brassica oleracea L. var. *botrytis*	Cruciferae	Cauliflower	Pj-106	B, DG
Brassica oleracea L. var. *capitata*	Cruciferae	Cabbage	Pj-94, Pn-25	B, I
Camellia sinensis (L.) O. Kuntze	Theaceae	Tea	Pn-90	J
Capsicum annuum L.	Solanaceae	Pepper	Pj-70, Pn-20, P-40	B, I
Carica papaya L.	Caricaceae	Papaya	Pb-15, Pj-47	B, D, I, M, S
Carthamus tinctorius L.	Compositae	Safflower	Pj-270, Pn-270	I
Chenopodium murale L.	Chenopodiaceae	Nettle Leaved-goosefoot	Pj-10[y]	B
Chloris barbata Sw.	Poaceae	Weed	Pj-40[y]	B
Chloris gayana Kunth.	Poaceae	Rhodes-grass	Pd-55, Pj-545′, Pn-330′, Psc-60′	B, D, DG, I, M, S
Cicer arietinum L.	Fabaceae	Chickpea	P-55	B
Citrullus lanatus (Thunb.) Mansf.	Cucurbitaceae	Watermelon	Pj-51, P-10	B, D, S
Citrus aurantifolia (Christm.) Swing.	Rutaceae	Lime	Pb-20, Pc-280[y], Pn-47, P-63	B, D, M, S
Citrus limettoides Tanaka	Rutaceae	Sweet lime	Pc-105[y], Pj-63, Pn-40	B, I, M, S
Citrus reticulata Blanco.	Rutaceae	Mandarin	Pc-90[y]	B
Citrus sinensis (L.) Osbeck	Rutaceae	Sweet-orange	Pc-25[y], Pj-58	B, S
Cocos nucifera L.	Arecaceae	Coconut	Pj-40, Psc-55	B, DG
Crocus sativus L.	Iridaceae	Saffron	Pn-2160′	J
Cucumis melo L.	Cucurbitaceae	Sweet-melon	Pj-20	S
Cucumis sativus L.	Cucurbitaceae	Cucumber	Pj-120, Psc-120	DG
Cucurbita maxima Duch.	Cucurbitaceae	Pumpkin	Pj-60, P-50	B, DG
Cucurbita pepo L.	Cucurbitaceae	Squash	Pj-20, P-20	DG, I

Table 1. (Continued) Occurrence, population density and distribution of *Pratylenchus* spp. in association with major crops in different regions of Oman.

Scientific name of associated plant	Family	Common name	Nematodes recorded[v] mean population[w] density	Distribution[x]
Cynodon dactylon (L.) Pers.	Poaceae	Weed	Pc-20[y], Pj-90[y]	B
Cyperus conglomeratus Rottb.	Cyperaceae	Weed	Pj-51[y]	B
Dactyloctenium aegyptium (L.) Beauv.	Poaceae	Weed	Pj-50[y]	B
Daucus carota L. var.*sativa* DC.	Umbelliferae	Carrot	Pj-20	I, M
Euphorbia granulata Forssk.	Euphorbiaceae	Weed	Pj-12[y]	B
Ficus carica L.	Moraceae	Fig	Pj-230	B, I
Helianthus annuus L.	Compositae	Sunflower	Pn-225	I
Heliotropium europaeum L.	Boraginaceae	Weed	Pj-14[y]	B
Hordeum vulgare L.	Poaceae	Barley	Pn-75	I
Ipomea batatas (L.) Poir.	Convolvulaceae	Sweet-potato	Pb-462, Pj-101, Pn-80, Pz-85	B, DG, I, S
Ixora coccinea L.	Rubiaceae	Forest flame	Pc-155′	DG
Lactuca sativa L.	Compositae	Lettuce	Pj-105, Pn-80	I, S
Launaea procumbens (Roxb.) Dandy, Ram. & Raj.	Compositae	Weed	Pj-12[y]	B
Lycopersicon esculentum Mill.	Solanaceae	Tomato	Pj-84, P-40	B, I, M
Malus pumila Mill.	Rosaceae	Apple	Pp-70′, Pv-105′	J
Mangifera indica L.	Anacardiaceae	Mango	Pc-75[y], Pd-45, Pn-60	B, S
Manihot esculenta Crantz.	Euphorbiaceae	Cassava	Pj-68, Pn-200	B, S
Manilkara zapota (L.) Roven.	Sapotaceae	Sapodilla	P-20	D
Medicago sativa L.	Fabaceae	Alfalfa	Pb-106′, Pd-134′, Pj-147′, Pn-62′, Pps-90′, Psc-168′, P-40	B, D, DG, I, J, M, S
Mentha longifolia Opiz ex Steud.	Labiatae	Mint	P-20	S
Momordica carantia L.	Cucurbitaceae	Bittergourd	Pj-200, Psc-160	DG
Musa spp.	Musaceae	Banana	Pb-95, Pc-653′, Pg-200′, Pj-130, P-45	B, D, DG, M, S
Paspalidium geminatum (Forsskal) Stapf in Prain	Poaceae	Weed	Pj-64[y]	B
Pennisetum purpureum K. Schum.	Poaceae	Elephantgrass	Pj-84	B, D
Phoenix dactylifera L.	Araceae	Date-palm	Pb-77, Pc-140, Pd-145, Pj-168, Pn-157	B, D, I, M, S
Phyllanthus maderaspatensis L.	Euphorbiaceae	Weed	Pj-12[y]	B
Pistacia vera L.	Anacardiaceae	Pistachio	Pj-60, Pn-75′	J
Portulaca oleracea L.	Portulacaceae	Common purslane	Pj-25[y]	B

Table 1. (Continued) Occurrence, population density and distribution of *Pratylenchus* spp. in association with major crops in different regions of Oman.

Scientific name of associated plant	Family	Common name	Nematodes recorded[v] mean population[w] density	Distribution[x]
Prunus domestica L.	Rosaceae	Plum	Pp-50[z]	J
Prunus persica (L.) Batsch.	Rosaceae	Peach	Pv-125[z]	J
Punica granatum L.	Punicaceae	Pomegranate	Pj-58, Psc-40	B, DG, I
Pyrus communis L.	Rosaceae	Pear	Pp-70[z]	J
Raphanus sativus L.	Cruciferae	Radish	Pj-150	M
Rosa sp.	Rosaceae	Rose	Pj-50[y], Pn-40	J
Saccharum officinarum L.	Poaceae	Sugarcane	Psc-220[z]	DG
Setaria verticillata (L.) P. Beauv.	Poaceae	Weed	Pc-10[y], Pj 40[y]	B
Solanum melongena L.	Solanaceae	Eggplant	Pb-35, Pj-162	B, D, I, M, S
Solanum tuberosum L.	Solanaceae	Potato	Pb-53, Pj-60	B. I
Sporobolus nervosus Hochst.	Poaceae	Grass	Psc-180	DG
Trigonella foenum-graecum L.	Fabaceae	Fenugreek	Pn 400[z]	S
Triticum aestivum L.	Poaceae	Wheat	Pn-280, Pz-70	B, D, I, S
Vigna unguiculata (L.) Walp.	Fabaceae	Cowpea	Pj-68	B
Vitis vinifera L.	Vitaceae	Grapevine	Pj-112, Pn-120	B, D, DG, S
Zea mays L.	Poaceae	Corn	Pn-20, Pse-212	B, D, I, S

[v]Nematodes recorded:
Pb - *Pratylenchus brachyurus* (Godfrey) Filipjev and Schuurmans Stekhoven
Pc - *P.-coffeae* (Zimmermann) Filipjev and Schuurmans Stekhoven
Pd - *P. delattrei* Luc
Pg - *P. gutierrezi* Golden, Lopez and Vilchez
Pj - *P. jordanensis* Hashim
Pn - *P. neglectus* (Rensch) Filipjev and Schuurmans Stekhoven
Pp - *P. penetrans* (Cobb) Filipjev and Schuurmans Stekhoven
Pps - *P. pseudopratensis* Seinhorst
Psc - *P. scribneri* Steiner
Pse - *P. sefaensis* Fortuner
Pv - *P. vulnus* Allen and Jensen
Pz - *P. zeae* Graham
P - *Pratylenchus* sp.
[w]Mean nematode population in 250 cm^3 soil, unless followed by superscript y.
[x]Distribution: B - Batinah; D - Dhahira; DG - Dhofar Governorate; I - Interior; J - Jabal Akhdar; M - Musandarn Governorate; S - Sharqia.
[y]Numbers represent nematode populations in 1.0 g root.
[z]Nematodes were also detected in roots of corresponding plant species.

Table 2. Frequency, population density and distribution of *Pratylenchus* spp. in different regions of Oman.

Nematode species	Absolute frequency (%)	Relative frequency (%)	Mean Population/ 250 cm^3 soil	Distribution[z]
Pratylenchus brachyurus	2.1	9.9	91	B, D, I, M, S
P. coffeae	0.3	1.6	432	B, D, M, S
P. delattrei	1.9	9.1	124	B, D, I, S
P. gutierrezi	0.1	0.5	200	D
P. jordanensis	10.6	50.0	157	B, D, DG, I, J, M, S
P. neglectus	2.3	11.0	202	D, I, J, M, S
P. pseudopratensis	0.6	2.7	85	I, D, S
P. penetrans	0.2	1.1	65	J
P. sefaensis	0.3	1.6	212	D, I, S
P. scribneri	1.0	4.6	113	DG, M
P. vulnus	0.1	0.5	115	J
P. zeae	1.5	7.3	85	B, D, DG, I, M, S

[z]Distribution: B - Batinah; D - Dhahira; DG - Dhofar Governorate; I - Interior; J - Jabal Akhdar; M - Musandam Governorate; S - Sharqia.

nematode was previously recognized as one of the agents responsible for the decline of alfalfa in Oman (Mani and Al Hinai, 1997) and apple trees in Queensland, Australia (Stirling *et al.*, 1995). Townshend and Willis (1990) observed that *P. penetrans* (Cobb) Filipjev and Schuurmans Stekhoven was the most important species on alfalfa in addition to *P. coffeae*, *P. crenatus* Loof, *P. neglectus*, *P. pratensis* (de Man) Filipjev, and *P. vulnus* Allen and Jensen. Although *P. penetrans* was observed on temperate fruit crops during the present survey, it was not recorded on alfalfa. *P. crenatus* and *P. pratensis* were not observed on alfalfa nor on other crops in Oman.

Pratylenchus jordanensis was recovered from the roots of fourteen weed species growing in alfalfa fields (Table 1). Monocot weeds such as *Chloris barbata* Sw., *Cynodon dactylon* (L.) Pers., *Cyperus conglomeratus* Rottb., *Dactyloctenium aegyptium* (L.) Beauv., *Paspalidium geminatum* (Forsskal) P. Stapf in Prain and *Setaria verticillata* (L.) P. Beauv. were found to be favorable hosts with nematode population densities ranging from 40-90 per g of root. Thus, it is evident that monocot weeds play an important role in increasing populations of *P. jordanensis* in fields, and may contribute to more rapid decline of the crop. Therefore, weed management in alfalfa fields should be emphasized.

Pratylenchus brachyurus was encountered in association with alfalfa, beet root, date palm, garlic, lime, and papaya, and at high numbers on sweet potato. *P. brachyurus* often inflicts severe damage to peanut in southern USA and Australia. It also infects other crops like potato (tuber attack in South Africa), pineapple (Hawaii, Brazil, western Africa), citrus, cotton, peach, soy-

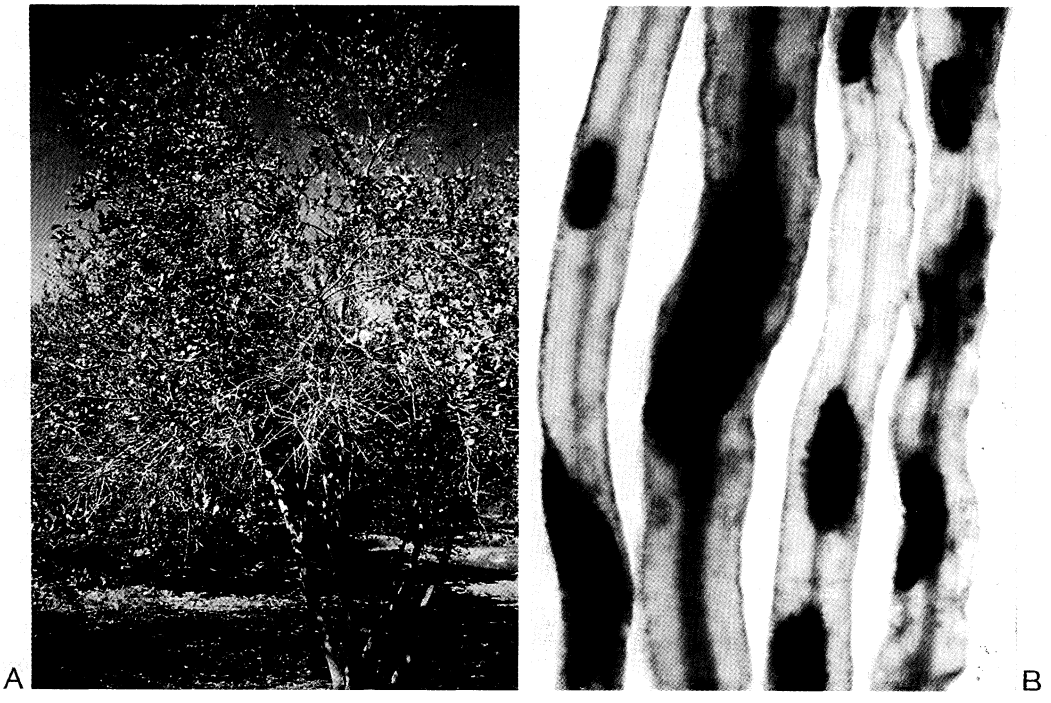

Fig. 1. Lime tree exhibiting symptoms of decline caused by *Pratylenchus coffeae* (A), and brown necrotic lesions on fibrous roots of lime produced by *P. coffeae* (B).

bean, tobacco, coffee, rubber and several members of Poaceae (Loof, 1991) including sugarcane (Williams, 1969).

P. neglectus, *P. scribneri* and *P. zeae* Graham were observed in many regions with relative frequencies ranging from 4.6-11.0%. *P. neglectus* was the second most frequently encountered species in association with 24 plant species and the populations were high on cassava, date palm, fenugreek, garlic, lettuce, lime, pistachio, rhodesgrass, rose, safflower, saffron, sunflower, sweet lime and sweet potato. It appears that all the crops, except rhodesgrass, represent new crop associations for the nematode. Its usual host range includes bean, cereals, crucifers, grasses, legumes, peppermint, strawberry and tobacco (Loof, 1991). *P. scribneri* was observed in the rhizosphere soil of alfalfa, bittergourd, cucumber, coconut, pomegranate, rhodesgrass and sugarcane during the present survey. It is a common parasite of soybean in mid-western USA (Siddiqi, 1986) and sugarcane in many countries (Williams, 1969). It has other important hosts like corn, onion, potato, snap bean, sugarbeet, tomato etc. *P. zeae* was found associated with garlic, onion and sweet potato in Oman; whereas, it was noted as a major parasite of cereals, peanut, sugarcane, tobacco and several grasses in other countries. Corn, rice, sugarcane, and tobacco often suffer heavy damage (Fortuner, 1976; Loof, 1991).

Pratylenchus sefaensis Fortuner was rarely found in association with corn in Oman, and an earlier report confirmed the present observation (Swarup and Sosa-Moss, 1990). Although, *P. goodeyi* Sher and Allen is an important parasite of banana in east Africa (Gowen and Queneherve, 1990;

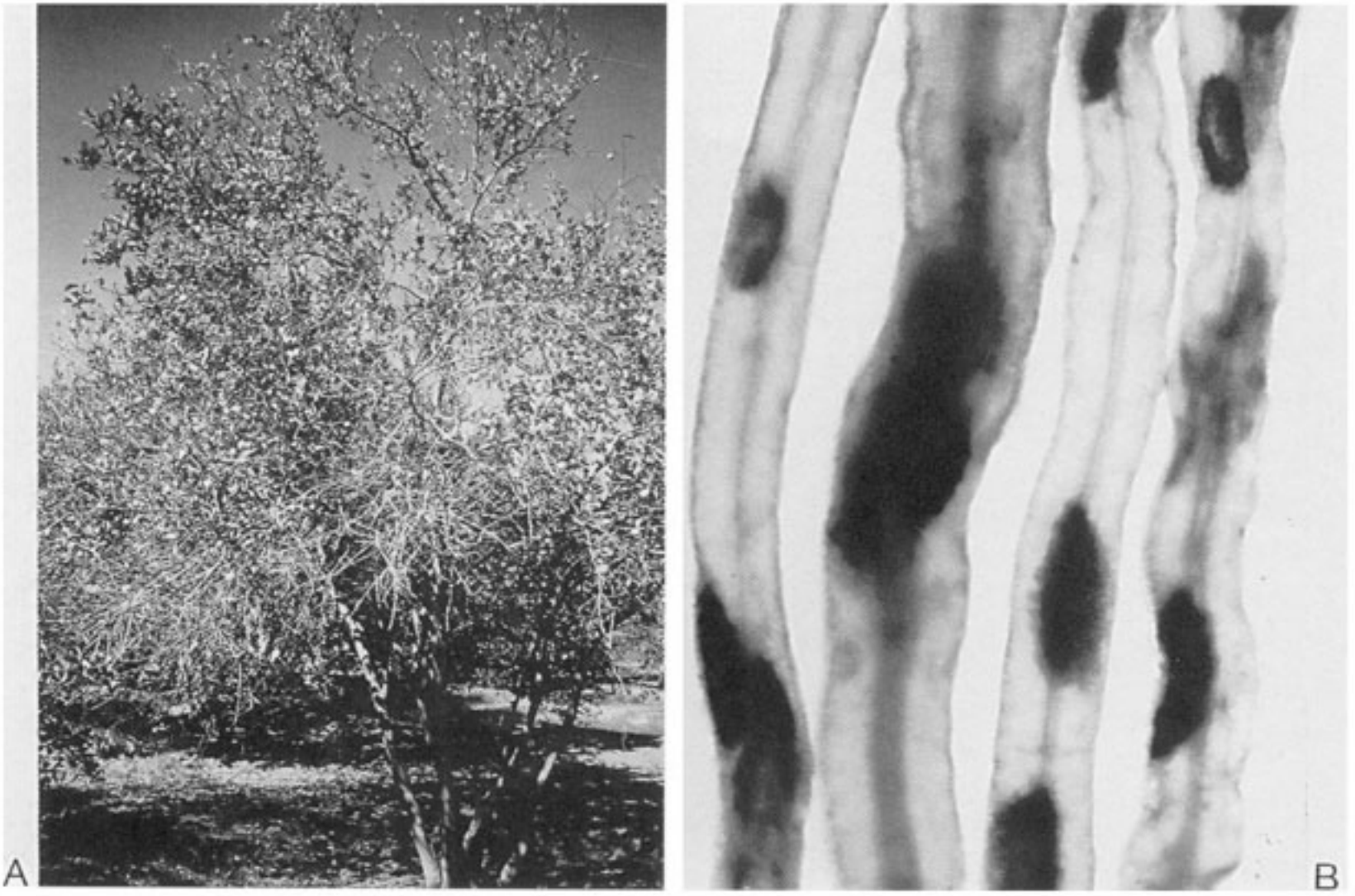

Fig. 1. Lime tree exhibiting symptoms of decline caused by *Pratylenchus coffeae* (A), and brown necrotic lesions on fibrous roots of lime produced by *P. coffeae* (B).

Table 2. Frequency, population density and distribution of *Pratylenchus* spp. in different regions of Oman.

Nematode species	Absolute frequency (%)	Relative frequency (%)	Mean Population/ 250 cm^3 soil	Distribution[z]
Pratylenchus brachyurus	2.1	9.9	91	B, D, I, M, S
P. coffeae	0.3	1.6	432	B, D, M, S
P. delattrei	1.9	9.1	124	B, D, I, S
P. gutierrezi	0.1	0.5	200	D
P. jordanensis	10.6	50.0	157	B, D, DG, I, J, M, S
P. neglectus	2.3	11.0	202	D, I, J, M, S
P. pseudopratensis	0.6	2.7	85	I, D, S
P. penetrans	0.2	1.1	65	J
P. sefaensis	0.3	1.6	212	D, I, S
P. scribneri	1.0	4.6	113	DG, M
P. vulnus	0.1	0.5	115	J
P. zeae	1.5	7.3	85	B, D, DG, I, M, S

[z]Distribution: B - Batinah; D - Dhahira; DG - Dhofar Governorate; I - Interior; J - Jabal Akhdar; M - Musandam Governorate; S - Sharqia.

nematode was previously recognized as one of the agents responsible for the decline of alfalfa in Oman (Mani and Al Hinai, 1997) and apple trees in Queensland, Australia (Stirling *et al.*, 1995). Townshend and Willis (1990) observed that *P. penetrans* (Cobb) Filipjev and Schuurmans Stekhoven was the most important species on alfalfa in addition to *P. coffeae*, *P. crenatus* Loof, *P. neglectus*, *P. pratensis* (de Man) Filipjev, and *P. vulnus* Allen and Jensen. Although *P. penetrans* was observed on temperate fruit crops during the present survey, it was not recorded on alfalfa. *P. crenatus* and *P. pratensis* were not observed on alfalfa nor on other crops in Oman.

Pratylenchus jordanensis was recovered from the roots of fourteen weed species growing in alfalfa fields (Table 1). Monocot weeds such as *Chloris barbata* Sw., *Cynodon dactylon* (L.) Pers., *Cyperus conglomeratus* Rottb., *Dactyloctenium aegyptium* (L.) Beauv., *Paspalidium geminatum* (Forsskal) P. Stapf in Prain and *Setaria verticillata* (L.) P. Beauv. were found to be favorable hosts with nematode population densities ranging from 40-90 per g of root. Thus, it is evident that monocot weeds play an important role in increasing populations of *P. jordanensis* in fields, and may contribute to more rapid decline of the crop. Therefore, weed management in alfalfa fields should be emphasized.

Pratylenchus brachyurus was encountered in association with alfalfa, beet root, date palm, garlic, lime, and papaya, and at high numbers on sweet potato. *P. brachyurus* often inflicts severe damage to peanut in southern USA and Australia. It also infects other crops like potato (tuber attack in South Africa), pineapple (Hawaii, Brazil, western Africa), citrus, cotton, peach, soy-

Fig. 2. One year-old and apparently healthy alfalfa crop growing in a field heavily infested with *Pratylenchus jordanensis* (A), and an adjoining plot with a two year-old alfalfa crop exhibiting patchy symptoms of decline, primarily due to severe infection of *P. jordanensis* (B).

nematode problems, planning further studies to assess their economic importance, and developing effective management strategies.

ACKNOWLEDGMENTS

The authors are thankful to Mr. Ali Abdulla Al-Jabri, Director General and Mr. Abdulla Dawood Al-Zidgali, Director of Plant Protection, Directorate of Agricultural Research, Rumais for providing necessary facilities. Thanks are due to Mr. Saeed Abdul Haleem and Mr. Masoud Rahbani, for their technical assistance during the survey.

LITERATURE CITED

ANONYMOUS, 1989. Statistical Yearbook. Development Council, Technical Secretariat, Directorate General of National Statistics, Sultanate of Oman.

COBB, N. A. 1917. Notes on Nemas. Contributions to a Science of Nematology. Williams & Wilkin Co., Baltimore, MD, U.S.A.

EVANS, K., and P. P. J. HAYDOCK. 1993. Interactions of nematodes with root-rot fungi. Pp. 104-133 *in* M. Wajid Khan, ed. Nematode Interactions. Chapman & Hall, London, U.K.

FORTUNER, R. 1976. *Pratylenchus zeae.* C. I. H. Descriptions of Plant-Parasitic Nematodes, 6, No. 77. Commonwealth Institute of Helminthology, Albans, Herts., U.K.

FORTUNER, R. 1977. *Pratylenchus thornei* C. I. H. Descriptions of Plant-Parasitic Nematodes, 7, No. 93. Commonwealth Institute of Helminthology, Albans, Herts., U.K.

GHAZANFAR, S. A. 1992. An Annotated Catalogue of the Vascular Plants of Oman and their Vernacular Names. National Botanic Garden of Belgium, Meise, Belgium.

GOLDEN, A. M., R. LÓPEZ CH., and H. VÍLCHEZ R. 1992. Description of *Pratylenchus gutierrezi* n.sp. (Nematoda:Pratylenchidae) from coffee in Costa Rica. Journal of Nematology 24:298-304.

GOWEN, S., and P. QUENEHERVE. 1990. Nematode parasites of bananas, plantains and abaca. Pp. 431-460 *in* M. Luc, R. A. Sikora, and J. Bridge, eds. Plant Parasitic Nematodes in Subtropical and Tropical Agriculture. CAB International, Wallingford, Oxon, U.K.

HANDOO, Z. A., and A. M. GOLDEN. 1989. A key and compendium to the species of the genus *Pratylenchus* Filipjev, 1936 (lesion nematodes). Journal of Nematology 21:202-218.

KHAIR, G. T. 1986. List of plant parasitic nematodes of Australia. Department of Primary Industry, Canberra, Australia.

LOOF, P. A. A. 1991. The family Pratylenchidae Thorne, 1949. Pp.363-421 *in* W. R. Nickle, ed. Manual of Agricultural Nematology. Marcel Dekker, New York, U.S.A.

MANI, A. 1993. Nematode diseases. Pp. 75-98 *in* Tariq Al Zidgali, ed. Status of Pests and Diseases in Oman. Series. 1. Plant diseases in the Batinah. Document no. 6/93/22, Agricultural Research Centre, Rumais, Sultanate of Oman.

MANI, A., and M. S. AL HINAI. 1996. Host range and distribution of *Meloidogyne incognita* and *M. javanica* in the Sultanate of Oman. Nematropica 26:73-79.

MANI, A., and M. S. Al HINAI. 1997. Plant-parasitic nematodes associated with alfalfa and fluctuations of *Pratylenchus jordanensis* populations in the Sultanate of Oman. Fundamental and Applied Nematology 20:443-447.

MANI, A., and C. L. SETHI. 1987. Interaction of root-knot nematode, *Meloidogyne incognita* with *Fusarium oxysporum* f. sp. *ciceri* and *F. solani* on chickpea. Indian Journal of Nematology. 17:1-6.

NETSCHER, C., and R. A. SIKORA. 1990. Nematode parasites of vegetables. Pp. 237-283 *in* M. Luc, R. A. Sikora, and J. Bridge, eds. Plant Parasitic Nematodes in Subtropical and Tropical Agriculture. C.A.B. International, Wallingford, Oxon, U.K.

NICKLE, W. R. 1991. Manual of Agricultural Nematology. Marcel Dekker, New York, U.S.A.

SEINHORST, J. W. 1959. A rapid method for the transfer of nematodes from fixative to anhydrous glycerine. Nematologica 4:67-69.

SIDDIQI, M. R. 1964. Studies on nematode root-rot of citrus in Uttar Pradesh, India. Proceedings of Zoological Society, Calcutta 17:67-75.

SIDDIQI, M. R. 1986. Tylenchida: Parasites of Plants and Insects. CAB International, Farnham Royal, Slough, U.K.

STIRLING, G., R., S. R. DULLAHIDE, and A. NIKULIN. 1995. Management of lesion nematode (*Pratylenchus jordanensis*) on replanted apple trees. Australian Journal of Experimental Agriculture 35:247-258.

SWARUP, G., and C. SOSA-MOSS. 1990. Nematode parasites of cereals. Pp. 109-136 *in* M. Luc, R. A. Sikora, and J. Bridge, eds. Plant Parasitic

Nematodes in Subtropical and Tropical Agriculture. CAB International, Wallingford, Oxon, U.K.

TOWNSHEND, J. L., and C. B. WILLIS. 1990. Root-lesion nematodes. Pp. 50-51 *in* D. L. Stuteville, and D. C. Erwin, eds. Compendium of Alfalfa Diseases. APS Press, The American Phytopathological Society, St. Paul, MN, U.S.A.

WALLER, J. M., and J. BRIDGE. 1978. Plant diseases and nematodes in the Sultanate of Oman. PANS 24:313-326.

WILLIAMS, J. R. 1969. Nematodes attacking sugar cane. Pp. 184-203 *in* J. E. Peachey, ed. Nematodes of Tropical Crops. Technical Communication No. 40, Commonwealth Agriculture Bureaux, Albans, Herts., U.K.

Received: *11.VII.1997*

Recibido:

Accepted for publication: *14.XI.1997*

Aceptado para publicacion: