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Plant Parasitic Nematodes Associated with Olive in Algeria

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Surveys were conducted during 2010–2013 in olive growing areas of south and north of Algeria to identify plant parasitic nematodes associated with this crop. Sixteen genera of plant-parasitic nematodes were identified. Among them four are considered as having economic importance for olive. Among these the endoparasites *Pratylenchus* spp. were detected in the majority of the sampled areas and were the most frequent. *Meloidogyne* spp. were also present in some areas. *Helicotylenchus* spp. were present with a high frequency in almost all surveyed sites. Among the ectoparasites, only *Xiphinema* spp. have potential to damage olive. Other nematodes of less importance were poorly represented. Nematode densities varied according to taxa identified and areas surveyed. Excepted *Pratylenchus* spp. and *Helicotylenchus* spp., the others taxa are reported for the first time on olive in Algeria.

Keywords: olive, plant parasitic nematodes, nursery, orchard.

In Algeria, olive crop is one of the most important revenue for the economy of the rural population. The crop covers an area of 312,000 hectares planted with 34 million trees, resulting in an annual production of about 193,000 tons of table olives and 400,000 tons of oil olive in 2011 (MADR, 2011). Revitalized by the National Plan for Agricultural and Rural Development (PNDAR) in 2000, the Algerian olive cultivation has increased from 165,000 ha in 1999 to 312,000 ha in 2011, with the eastern regions and centre of the country being the most important olive-growing areas, representing 23% and 49%, respectively, of the national olive orchard. Cultivation of olive has gained particular interest in recent years nationwide. Besides, the crops have socio-economic and environmental value and olives, especially olive oil, have peculiar nutritional qualities (COI, 2009). According to preliminary surveys carried out by staff of the Plant Protection Institute and farmers complaints, olive plants are prone to diseases and pests (Bennai and Hamadache, 2012). Nico et al. (2002) and Castillo et al., (1999, 2010) reported that plant-parasitic nematodes can be very damaging to olive crop. Among these nematodes *Pratylenchus* spp. (root lesion nematodes) and *Meloidogyne* spp. (root-knot nematodes) must be mentioned. Other nematodes having potential to damage olive are *Heterodera mediterranea*

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(cyst nematodes), *Rotylenchulus* spp. (reniform nematodes) and *Helicotylenchus* spp. (spiral nematodes).

Unfortunately, data on nematodes associated with olive trees are not available in Algeria, except the report on *Pratylenchus* spp. by Troccoli et al. (1992). Information on plant parasitic nematodes of olive in Algeria is necessary to limit yield losses. Therefore, our objective was to identify plant-parasitic nematodes associated with olive threes in some olive production areas.

Materials and Methods

The survey was conducted in the main olive-growing regions of western (Mascara), central (Boumerdes, Blida) and eastern (Bejaia), in the north and south (Biskra, El Oued and Laghouat) regions of Algeria during 2010–2013 (Fig. 1). The characteristics of the surveyed areas are reported in Table 1. The soil samples were collected with an auger from the rhizosphere of both olive orchards and nurseries, between 20 and 30 cm deep. Each soil sample was composite of several soil cores for a total of 1.5 kg. To extract vermiform nematodes, the soil samples were processed according to the Baermann's funnel method as modified by Dalmasso (1966). The identification of the nematodes to genus level was based on the morphological characters as observed after fixation according to De Grisse (1969). Nematodes were counted using Petri dishes divided in different sectors, under a binocular stereoscope. The frequency was determined according the formula:

Frequency = Number of samples containing a species / number of samples collected.

Table 1

Geo-ecological description of the study sites

Criteria Localities	Bioclimatic	Average annual rainfall (mm)	Average tempe-ratures °C	Longitude	Latitude	Soil texture
North of country						
Blida	Subhumid	791	17.9	2°50'00" East	36°29'00" North	Clay-loam
Boumerdes	Humid	739	18	3°28'0" East	36°46'0" North	Clay-loam
Bejaia	Subhumid to humid	839	17.6	5°04'00" East	36°45'00" North	Clay-loam
Mascara	Semi-arid	486	16.7	0°08'24" East	35°23'47" North	Sandy
South of country						
Biskra	Hot, dry desert	141	21.8	5°0'0" East	34°0'0" North	Sandy-loam
El Oued	Desert	74	21.8	6°52'03" East	33°22'06" North	Sandy
Laghouat	Desert	176	17.4	2°51'54" East	33°47'59" North	Loam-sandy

Results and Discussion

The sites selected for sampling (Table 1) belong to very different bioclimatic zones ranging from desert floor (El Oued, Biskra, Laghouat) to semi-arid (Mascara) and humid and subhumid (Boumerdes and Blida). In the north, average temperatures and rainfall were 16.7 °C and 18 °C and 400–839 mm, respectively; in the south of the country (El Oued, Biskra and Laghouat), they are 17.4 °C and 21.8 °C and from 74 to 176 mm, respectively. The soil texture of the study sites vary greatly: at Biskra, El Oued and Laghouat it is sandy-loam to loam-sandy; in the north, it is clay except in Mascara where it is sandy.

The results showed a significant diversity of several genera of nematodes (Tables 2 and 3). Indeed, the survey revealed the presence of 16 genera of nematodes belonging to the two main order (Dorylaimida and Tylenchida): *Xiphinema (Longidoridae), Meloidogyne* (*Meloidogynidae), Pratylenchus (Pratylenchidae), Helicotylenchus (Hoplolaimidae), Paratylenchus, Tylenchulus semipenetrans, Gracilacus (Tylenchulidae), Tylenchorhynchus (Telotylenchidae), Aphelenchoides (Aphelenchidae), Criconema, Criconemoides and Hemicriconemoides (Criconematidae), Boleodorus, Coslenchus, Tylenchus (Tylenchidae), Telotylenchus (Belonolaimidae).*

Among these lists, *Pratylenchus* spp. are the most dangerous, frequent and dominant both in nurseries and orchards with a frequency ranging from 34.22 to 36.92%, respectively, and population densities ranging from 12–60 to 2–485 individuals/100 cm^3 of soil. These migratory endoparasites are considered as quarantine pests for Algeria. Also, these nematodes have potential to cause considerable damage both to olive orchards and nurseries all over the world (Abrantes et al., 1992; Nico et al., 2002; Castillo and Vovlas, 2002).

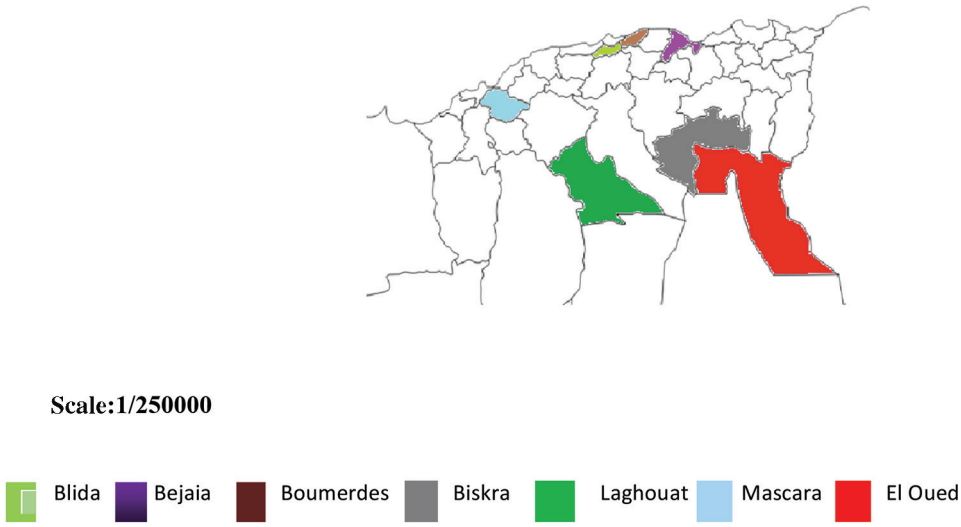

Fig. 1. Study sites where soil samples were collected during 2010–2013

Table 2

Density and frequency of plant parasitic nematodes associated with olive orchards in Algeria

Nematode genus	Density /100 cm^3	Frequency (%)
Aphelenchoides	3–25	1.5
Gracilacus	2–14	3.07
Criconema	1–13	1.5
Helicotylenchus	2–441	58.46
Hemicriconemoides	1–5	1.5
Meloidogyne	10–102	27.69
Paratylenchus	2–6	7.69
Pratylenchus	2–485	36.92
Telotylenchus	2–5	6.11
Tylenchus	2–5	9.20
Tylenchorynchus	20–110	10.52
Xiphinema	1–25	24.62

Table 3

Density and frequency of plant parasitic nematodes associated with olive nurseries in three regions of Algeria

Nematodes genus	Density /100 cm^3	Frequency (%)
Boleodorus	1–24	2.63
Coslenchus	2–38	2.63
Criconemoides	1–3	2.63
Helicotylenchus	2–75	23.6
Meloidogyne	33–98	31.57
Paratylenchus	10–15	7.89
Pratylenchus	12–60	34.22
Tylenchulus	12–46	13.15
Tylenchorynchus	1–13	7.89
Xiphinema	1–10	23.68

Of the genus *Pratylenchus* the most common and severe species to olive are *P. penetrans* and *P. vulnus* (Nico et al., 2002; Sasanelli and D'Abbado, 2002) causing severe defoliation, leaf chlorosis, shortening of internodes, lesions and necrosis on roots (Lamberti and Baines, 1969; Nico et al., 2003).

Recently, a new species, *P. olea* was reported from olive roots in Tunisia and Spain (Palomares-Rius et al., 2014). In Algeria, the species *P. thornei* was reported in the soil rhizosphere and roots of olive tree in the Boufarik region (Blida) (Troccoli et al., 1992).

The root-knot nematodes, *Meloidogyne* spp. are also considered dangerous to olive and are listed in plant quarantine organisms for Algeria. They are present in the regions of Mascara and Boumerdes, both in olive nurseries and orchards with frequencies of 31.57% and 27.69% and soil population densities of 33–98 and 10–102 juveniles/100 cm^3 soil, respectively. Outside Algeria, several species are reported associated to olive orchards and nurseries (Nico et al., 2002). The main species most frequently encountered are *Meloid-*

ogyne arenaria, *M. hapla*, *M. incognita*, *M. javanica*, *M. lusitanica* and *M. baetica* (Castilllo et al., 2003; Nico et al., 2003). The symptoms caused by these nematodes are more severe when due to infections by *M. javanica* and *M. arenaria* followed by infections by *M. incognita* (Sasanelli et al., 2002; Nico et al., 2003).

Therefore, it is necessary to identify these nematodes at species level and extend the survey in other olive growing areas of Algeria, especially in the Saharan region where environmental conditions (soil texture and temperatures) are conducive to their infections.

Helicotylenchus spp. were detected in all samples of the surveyed sites with a frequency of 58.46% and soil population density in the range 2–441 nematodes /100 cm^3 soil. In nurseries, they were present with a frequency of 23.6% and soil population densities of 2–75 nematodes/100 cm^3. Species of this genus can behave both as ectoparasites or endoparasites; they are cosmopolitan and common in cultivated and uncultivated soils (Schrec-Reis et al., 2010).

They include several species found associated with olive trees on which they cause necrosis on the roots and affect tree growth (Inserra et al., 1979). The species *Helicotylenchus dihystera*, reported in Egypt and Italy, reduces root growth. *Helicotylenchus erythrinae*, *H. digonicus* and *H. oleae* cause root necrosis, chlorosis and desiccation of the leaves have been reported from Greece and Cyprus (Philis and Siddiqui, 1976) and Jordan (Bridge, 1978 in Sasanelli, 2009; Hashim, 1979).

The genera *Pratylenchus* and *Helicotylenchus* were the most dominant and present in high soil population densities in almost all areas sampled. However, *Meloidogyne* sp. was only noted in the Mascara and Boumerdes regions.

Among the ectoparasites, *Xiphinema* sp. was also detected in the olive rhizosphere; despite it occurred at low densities, it can be damaging. It was found with frequencies of 23.68% and 24.62% and soil population densities of 1–25 and 1–10 nematodes per 100 cm^3 in nurseries and orchards, respectively, in the Laghouat and Blida regions on the cultivar Chemlel (the olive cultivar mostly cultivated in Algeria).

According to Castillo et al. (2010), these nematodes cause severe damage to olive. The species *Xiphinema diversicaudatum, X. elongatum* and *X. index* were reported in association with root necrosis on olive whose damage were observed especially in nurseries (Ciancio and Mukerji, 2009), they also affect plant growth in Egypt (Diab and El-Eraki, 1968).

Tylenchulus sp. was detected only in the nurseries of the Blida region with a frequency of 13.15% and soil population densities of 12–46 individual/100 cm^3 soil. The species was identified as *T. semipenetrans*; its presence is probably related to the citrus vocation of this area and therefore, it would be interesting to determine the biotype, because the "citrus biotype" can reproduce on olive (Baines et al., 1974), and ascertain the pathogenicity of the nematode to olive. The variation in frequency and soil population density in different sites can be explained by differences in soil type (McSorley and Frederick, 2002) and weather conditions (Tzortzakakis and Trudgill, 2005).

The other ectoparasites encountered, *Paratylenchus* spp., *Telotylenchus* spp., *Criconema* spp., *Criconemoides* spp., *Hemicriconemoide* spp., *Aphelenchoides* spp., *Gracilacus* spp., *Tylenchorynchus* spp., *Boleodorus* spp., *Coslenchus* spp. and *Tylenchus* spp. were poorly represented, with frequencies lower than 10% and low soil population

densities, and are not supposed to cause problems as their pathogenesis top olive has not been ascertained. However, the method used to extract nematodes is not the best to extract poorly motile nematodes.

The genus *Criconema* was detected in the rhizosphere of olive trees in Greece (Mani et al., 2014). In Portugal, only the species *C. princeps* was detected in olive (Castillo et al., 2010). *Gracilacus* spp. are ectoparasites with a low economic importance but have large host ranges. The species *G. peratica*, *G. teres* are reported on olive in Italy with a density of 280–360 nematodes per gram of roots (Nico et al., 2002) and Spain (Castillo et al., 2010).

These two genera of nematodes were detected in the Mascara region; they are known to be very damaging if present at high densities. However, they are poorly represented in our samples.

Tylenchorynchus spp. are very common polyphagous ectoparasites. They were reported in the majority of olive-growing countries, such as Spain, Greece, Cyprus, Turkey and Jordan (Castillo et al., 2010), but their economic importance has not been assessed. In Algeria, they were detected in all surveyed regions but at low frequencies (7.89–10.52%). However, evidence of their pathogenicity is still lacking.

Conclusion

Finally, we feel that surveys must be extended to the other olive-growing areas of Algeria not yet explored. The extraction of the endoparasitic nematodes from the roots and the observation of them on the roots are suggested to ascertain their parasitism to olive. Also, the identification of the nematodes to species level is necessary to adopt proper control measures to limit damages caused by nematodes and their spread from nurseries to farmers' fields.

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