Bölüm 1

Plant-Parasitic Nematodes Associated with Olive Trees and Management Strategies

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Abstract

Olive (*Olea europaea* L.) is a crop of significant economic and cultural importance, particularly in the Mediterranean region. Its cultivation, however, is frequently challenged by various stress factors, among which plant-parasitic nematodes (PPNs) are recognized as major threats to root health, plant growth, and overall yield. This study reviews the plant-parasitic nematode species reported on olive trees worldwide, highlighting their distribution, biology, and the types of damage they cause. Furthermore, it examines current management strategies, including chemical, biological, and cultural control measures, as well as integrated approaches aimed at sustainable nematode management. By synthesizing global findings, the study underscores the necessity of effective nematode monitoring and control in olive orchards and provides recommendations for future research to support sustainable olive production systems.

1. INTRODUCTION

The olive tree (*Olea europaea* L.) is a long-cultivated species in the Mediterranean basin, with a history spanning several millennia, and has held considerable cultural, economic, and nutritional significance throughout human civilization (Zohary and Spiegel, 1975). Well-suited to the Mediterranean climate, this durable and long-living tree has become emblematic of prosperity

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and vitality, forming a fundamental component of the regional diet through the production of both table olives and olive oil.

The genus *Olea* includes roughly 27 species and approximately 600 cultivars globally. Olive cultivation occurs in nearly 40 countries across five continents; however, only around 30 of these engage in commercial-scale production (Efe et al., 2011). Among the leading producers are Tunisia, Türkiye, Italy, Greece, Spain, Morocco, Portugal and Syria.

The origin of the olive remains a debated topic; however, the most widely accepted hypothesis proposes that cultivation began with wild olives (*Olea europaea* L.) naturally occurring in the forests of Anatolia, from which the species subsequently spread throughout the Mediterranean basin (Liphschitz et al., 1991). *Olea europaea* L., belonging to the Oleaceae family, is thought to have originated in Southeastern Anatolia, Upper Mesopotamia, and Southwestern Asia (Owen et al., 2000). Other studies suggest that olives first appeared in South Asia, were later introduced to the Mediterranean via the Middle East and represent one of the earliest domesticated fruit tree species (Somova et al., 2003).

Historically, olive oil, leaves, and fruits have been widely utilized for nutritional, medicinal, and ritual purposes (Soni et al., 2006). Currently, nearly 97% of global olive production is concentrated within the Mediterranean basin (COI, 1991). The olive tree is considered the second most significant oil-producing fruit tree worldwide, following the palm (Baldoni and Belaj, 2010).

Evidence indicates that olives have been part of the Mediterranean flora for approximately 10,000 years, with some fossil records suggesting up to 12,000 years of history (Ünsal, 2023). Today, olive cultivation extends over more than 10 million hectares globally, primarily between latitudes 30° and 45°. According to FAO (2022), total production amounts to 21.4 million tons, with Spain producing 3.9 million tons, Türkiye 2.9 million tons, and Italy 2.1 million tons. Approximately 93% of the world's olive trees are found within Mediterranean countries (FAO, 2022).

In recent years, global olive production has risen substantially, rendering both productivity and product quality critical factors for sustainable cultivation. However, the presence of various diseases, pests, and weeds in olive orchards adversely affects production, leading to notable reductions in yield and quality.

Among the principal species causing damage within the olive ecosystem are the olive fruit fly (*Bactrocera oleae* Rossi) (Diptera: Tephritidae), the olive leafroller (*Palpita unionalis* (Hübner)) (Lepidoptera: Pyralidae), the olive scale

insect (*Parlatoria oleae* (Colvée)) (Hemiptera: Diaspididae), and the olive moth (*Prays oleae* (Bernard)) (Lepidoptera: Yponomeutidae). These pests inflict both direct and indirect economic losses, primarily through feeding fruit and leaf tissues.

Among the major biotic constraints on olive production, plant-parasitic nematodes (PPN) are particularly important. These nematodes are estimated to account for approximately 12.6% of crop losses in cultivated plants worldwide (Lopes-Caitar et al., 2019). Specifically, over 70 species from 33 different plant-parasitic nematode genera have been reported in association with olive trees (Lamberti and Vovlas, 1993).

These nematode species impair water and nutrient uptake by causing structural damage to the root system, disrupting the plant's physiological balance and thereby leading to significant losses in both yield and quality. Additionally, the feeding injuries in root tissues facilitate the entry of pathogens such as fungi and bacteria, increasing the host plant's susceptibility to secondary infections (Özdemir, 2022). This further exacerbates the detrimental effect of plant-parasitic nematodes on olive trees and negatively affects overall olive productivity.

2. PLANT-PARASITIC NEMATODES: GENERAL OVERVIEW

Nematodes are microscopic, cylindrical organisms belonging to the subphylum Nematoda, exhibiting remarkable adaptability in both terrestrial and aquatic environments. Approximately 25% of nematodes are free-living, 1% are plant-parasitic, 6% are aquatic, and 15% are animal-parasitic (Ayyoub, 1980). Free-living nematodes contribute significantly to the decomposition and cycling of organic matter, whereas plant-parasitic nematodes (PPNs) feed on roots, stems, leaves, and tubers, causing substantial economic losses across a wide variety of products (Djian-Caporalino et al., 2009; Ecevit and Akyazı, 2010; Kepenekci, 2012).

Plant-parasitic nematodes utilize needle-like mouthparts called stylets to withdraw sap from plant cells. In the process, they secrete toxic compounds that induce symptoms such as galls, wilting, chlorosis, stunted growth, and root deformities (Gaugler and Anwar, 2004; Decraemer and Hunt, 2006; Kepenekci, 2012). Furthermore, the feeding injuries created by these nematodes facilitate the penetration of pathogens, including fungi, bacteria, and viruses, resulting in indirect damage to the host plant (Gaugler and Anwar, 2004).

The majority of economically important plant-parasitic nematode species belong to the order Tylenchida, with roughly 4,305 species identified to date (Maggenti, 1991; Nicol et al., 2011). Globally, the annual economic losses

attributed to these nematodes are estimated to range from 78 to 157 billion US dollars (Barker et al., 1981; Sasser and Carter, 1985; Sasser and Freckman, 1987; Nicol et al., 2011).

Nematodes exhibit a remarkable tolerance to environmental stress. In the absence of a suitable host, the eggs of certain species can enter a dormant state, remaining viable in the soil for prolonged periods. This adaptive capability facilitates the persistence of plant-parasitic nematode populations in agricultural ecosystems and constitutes a critical biological characteristic that significantly complicates their management.

3. PLANT-PARASITIC NEMATODES in OLIVE TREES

Olive trees host numerous widely distributed plant-parasitic nematodes, including spiral nematodes (*Helicotylenchus* spp.), root lesion nematodes (*Pratylenchus* spp.), root-knot nematodes (*Meloidogyne* spp.), and *Mesocriconema xenoplax* (Raski) Loof & De Grisse, 1989 (Lamberti and Vovlas, 1993; McLeod et al., 1994; Nejad et al., 1997; Kepenekci, 2001; Nico et al., 2002; Nico et al., 2003b; Peña Santiago et al., 2004; Castillo et al., 2010; Sanei and Okhovvat, 2011; Ali et al., 2014). In contrast, the cyst-forming nematodes (*Heterodera mediterranea* Vovlas, Inserra & Stone, 1981) and citrus nematode (*Tylenchulus semipenetrans* Cobb, 1913) exhibit a more confined distribution in olive trees (Vlachopoulos, 1991; McKenry, 1994; Castillo et al., 1999; Castillo and Vovlas, 2002).

To date, more than 150 nematode taxa reported to infest or be linked with olive cultivation have been documented (McKenry, 1994; Nico et al., 2002; Nico et al., 2003a; Ali et al., 2014). In addition to the previously mentioned species, other genera reported in association with olive trees include *Amplimerlinius* spp., *Paratrichodorus* spp., *Aorolaimus* spp., *Paratylenchus* spp., *Trichodorus* spp., *Pratylenchoides* spp., *Xiphinema* spp., and *Tylenchorhynchus* spp. (Hashim, 1982; Roca and Lamberti, 1988; Lamberti and Vovlas, 1993; Decraemer, 1994; Nico et al., 2002).

Most endoparasitic nematodes, including *Pratylenchus, Tylenchulus*, *Heterodera*, and *Meloidogyne,* are considered infecting olive tree roots (Castillo et al., 2010; Sanei and Okhovvat, 2011; Ali et al., 2014). These nematodes interfere with the normal formation and functioning of roots, ultimately leading to diminished plant growth and lower yields (Karssen and Moens, 2006).

For instance, in Argentina, *Meloidogyne javanica* (Treub, 1885) Chitwood, 1949, has been reported as a major pathogen, causing widespread wilting problems in young, recently planted olive groves (Pérez et al., 2001). Similarly,

in the USA, olive losses attributed to *Tylenchulus semipenetrans* and *Meloidogyne* spp. are estimated to range between 5% and 10% (Koenning et al., 1999).

Nematode damage is significantly pronounced in seedling production facilities, where optimal irrigation promotes root development and consequently increases nematode populations, adversely affecting the performance of mature trees (Diab and El-Eraki, 1968; Castillo et al., 1999; Nico et al., 2002; El-Borai and Duncan, 2005; Aït Hamza et al., 2017).

Olive trees serve as hosts for these parasites; yet current knowledge regarding the PPN communities linked to olive cultivation is quite limited (Nico et al., 2002). The first record originated in the USA, where root-knot nematodes (*Meloidogyne* spp.) were detected (Buhrer et al., 1933). Since then, studies on olive-associated PPNs have been conducted in various countries, particularly in Italy (Scognamiglio et al., 1968; Inserra and Vovlas, 1981), Chile (Jimenez, 1982), Jordan (Hashim, 1983), Libya (Edongali, 1989), Spain (Peña-Santiago, 1990; Nico et al., 2002), Portugal (Isabel and de A Santos, 1991), Egypt (Ibrahim, 1990; Ibrahim et al., 2000; Ibrahim et al., 2010), Iran (Sanei and Okhovvat, 2011), Türkiye (Kepenekci, 2001; Cilbircioğlu, 2007), Argentina (Pérez et al., 2001), and Syria (Ayoub and Ghaoui, 2011).

Previous research has largely focused on the definition of PPN without examining its possible effects on the product (Hashim, 1982). Studies have mainly concentrated on nematode groups regarded as posing substantial risks to olive cultivation, especially in the Mediterranean region, with particular focus on root-knot nematodes (*Meloidogyne* spp.) (Lamberti and Lownsbery, 1968; Jimenez, 1982; Sasanelli et al., 1997; Sasanelli et al., 2002), lesion nematodes *Pratylenchus* (Lamberti and Baines, 1969b), spiral nematodes *Helicotylenchus* (Graniti, 1955; Tarjan, 1964; Diab and El-Eraki, 1968), kidney-like nematodes *Rotylenchulus* (Philis and Siddiqi, 1976; Inserra and Vovlas, 1980; Hashim, 1983; Castillo et al., 2003a), cyst nematodes *Heterodera* (Hirschmann et al., 1966; Vovlas and Inserra, 1983; Castillo et al., 1999), and dagger nematodes *Xiphinema* (Minz et al., 1963; Diab and El-Eraki, 1968) (Tablo 1).

Other studies, particularly in Iran (Sanei and Okhovvat, 2011) and Spain (Nico et al., 2002), have primarily investigated the effects of these parasites on olive nurseries.

Tablo 1. Reported plant-parasitic nematodes of olive worldwide

Species	Country	Reference
Aphelenchus avenae Bastian 1865	Greece	Hirschmann et al., 1966
	Iran	Sanei and Okhovvat, 2011
	Jordan	Hashim, 1983
	Spain	Peña-Santiago, 1990
	Türkiye	Kesici, 2022
	Türkiye	Öztürk, 2020
	Türkiye	Yıldırım, 2023
Aphelenchus sp. Bastian 1865	Iran	Hosseininejad et al., 1996
	Italy	Scognamiglio et el., 1968
Paraphelenchus pseudoparietinus Micoletzky 1921	Spain	Peña-Santiago, 1990
Aphelenchoides sacchari Hooper 1958	Türkiye	Öztürk, 2020
A. clarus Thorne and Malek, 1968	Türkiye	Öztürk, 2020
Continued from Table 1.		
A. confuses Thorne and Malek, 1968	Türkiye	Öztürk, 2020
Aphelenchoides sp. Fischer 1984	Egypt	Ibrahim et al., 2010
	Italy	Scognamiglio et el., 1968
	Italy	Fiume, 1978
	Jordan	Hashim, 1983
	Spain	Peña-Santiago, 1990
	Syria	Ayoub and Ghaoui, 2011
	Türkiye	Aktürk and Gözel, 2025
Aprutides guidettii Scognamiglio 1974	Spain	Peña-Santiago, 1990
Longidorus africanus Merny 1966	Egypt	Tarjan, 1964
L. belloi Andres and Arias 1988	Portugal	Bravo and Roca, 1998
L. closelongatus Stoyanov 1964	Greece	Lamberti et al., 1996
L. cretensis Tzortzakakis et al., 2001	Greece	Tzortzakakis et al., 2008
L. elongatus De Man 1876	Egypt	Ibrahim et al., 2010
	Türkiye	Öztürk, 2023
L. macrosoma Hooper 1961	Spain	Peña-Santiago, 1990
L. siddiqii Aboul-Eid 1970	Jordan	Hashim, 1979
L. vinearum Bravo and Roca 1995	Portugal	Bravo and Roca, 1998
L. magnus Lamberti, Bleve-Zacheo & Arias, 1982	Spain	Castillo et al., 2010
L. attenuatus Hooper,1961	Türkiye	Öztürk, 2020
Longidorus sp. Micoletzky 1922	Egypt	Diab and El-Eraki, 1968
	Italy	Scognamiglio et el., 1968
	Spain	Nico et al., 2002
	Syria	Ayoub and Ghaoui, 2011
	Spain	Castillo et al., 2010
	Spain	Ali et al., 2014
Paralongidorus sp. Siddiqi et al., 1963	Italy	Fiume, 1978
Xiphinema adenohystherum Lamberti, Castillo, Gomez-Barcina et al., 1992	Spain	Castillo et al., 2010
Xiphinema aequum Roca and Lamberti, 1988	Italy	Roca and Lamberti, 1988
X. barense Lamberti et al., 1986	Italy	Lamberti et al., 1986

X. californicum Lamberti and Bleve-Zacheo 1979	USA	Lamberti, 1969c
X. diversicaudatum Micoletzky, 1927	Portugal	Navas et al., 1988
X. elongatum Schuurmans Stekhoven and Teunissen, 1938	Egypt	Diab and El-Eraki, 1968
X. index Thorne and Allen 1950	Greece	Vlachopoulos, 1991
	Italy	Sasanelli et al., 1999
	Jordan	Hashim, 1983
	Türkiye	Öztürk, 2020
X. ingens Luc and Dalmasso 1964	Italy	Lamberti et al., 1975b
	Jordan	Hashim, 1979
X. italiae Meyl 1953	Italy	Martelli and Taylor, 1990
	Spain	Castillo et al., 2010
	Spain	Nico et al., 2002
	Spain	Ali et al., 2014
	Türkiye	Öztürk, 2020
	Türkiye	Akdemir, 2022
X. lusitanicum Sturhan, 1983	Portugal	Bravo and Roca, 1998
X. macroacanthum Lamberti et al., 1990	Italy	Lamberti et al., 1989
X. nuragicum Lamberti et al., 1992	Spain	Palomares-Rius et al., 2012
	Spain	Castillo et al., 2010
X. pachtaicum Tulaganov 1938	Italy	Castillo et al., 2010
Continued from Table 1.		
	Spain	Castillo et al., 2010
	Spain	Nico et al., 2002
	Spain	Ali et al., 2014
	Jordan	Hashim, 1979
	Portugal	Bravo and Roca, 1998
	Spain	Palomares-Rius et al., 2012
	Spain	Nico et al., 2002
	Türkiye	Kesici, 2022
	Türkiye	Öztürk, 2020
	Türkiye	Öztürk, 2023
	Türkiye	Satmaz, 2012
X. sahelense Dalmasso, 1969	Spain	Arias, 1975
X. turcicum Luc and Dalmasso, 1964	Spain	Peña-Santiago, 1990
X. vuittenezi Luc et al., 1964	Spain	Arias, 1975
Xiphinema sp. Cobb, 1913	Chile	Gallo and Jimenez, 1976
	Egypt	Ibrahim et al., 2010
	Iran	Hosseininejad et al., 1996
	Israel	Minz et al., 1963
	Italy	Scognamiglio et el., 1968
	Jordan	Anon, 1970
	Spain	Tobar-Jimenez, 1964
Paratrichodorus alleni Siddiqi, 1974	Italy	Decraemer, 1994
P. minor Colbran 1956	Spain	Nico et al., 2002
P. teres Hooper 1962	Spain	Nico et al., 2002
Paratrichodorus sp. Siddiqi 1974	Jordan	Hashim, 1983

Trichodorus aequalis Allen 1957	Spain	Peña-Santiago, 1990
T. andalusicus Decraemer et al., 2012	Spain	Decraemer et al., 2013
	Spain	Nico et al., 2002
	Spain	Castillo et al., 2010
T. iliplaensis Decraemer et al., 2012	Spain	Decraemer et al., 2013
T. giennensis Decraemer et al., 1993	Spain	Nico et al., 2002
	Spain	Nico et al., 2002
	Spain	Castillo et al., 2010
T. lusitanicus Siddiqi, 1974	Portugal	Sturhan, 1989
T. parasilvestris Decraemer et al., 2012	Spain	Decraemer et al., 2013
T. primitivus De Man 1880	Portugal	Sturhan, 1989
	Portugal	Almeida et al., 1989
T. silvestris Decraemer et al., 2012	Spain	Decraemer et al., 2013
T. taylori Mancine 1980	Italy	De Waele et al., 1982
T. variopapillatus Hooper, 1972	Italy	Decraemer, 1994
Trichodorus sp. Cobb 1913	Chile	Gallo and Jimenez, 1976
	Italy	Scognamiglio et el., 1968
Ditylenchus anchiliposomus Tarjan 1958	Spain	Peña-Santiago, 1990
D. parvus Zell, 1988	Türkiye	Öztürk, 2020
D. valveus Thorne and Malek, 1968	Türkiye	Öztürk, 2020
D. dipsaci Kuhn 1857	Jordan	Hashim, 1983
	Spain	Talavera and Tobar Jimenez, 1997
	Türkiye	Öztürk, 2023
D. virtudesae Tobar-Jimenez 1964	Spain	Tobar-Jimenez, 1964
D. destructor Thorne, 1945	Türkiye	Kepenekci, 2001
D. myceliophora Goodey, 1958	Türkiye	Öztürk, 2020
Ditylenchus sp. Filipjev 1936	Italy	Scognamiglio et el., 1968
	Jordan	Anon, 1970
	Spain	Peña-Santiago, 1990

Continued from Table 1.

Criconema annuliferum De Man 1921	Spain	Peña-Santiago, 1990
	Spain	Castillo et al., 2010
	Spain	Nico et al., 2002
C. princeps Andra´ ssy 1962	Portugal	Castillo et al., 2010
Criconema sp. Hofma¨ nner and Menzel 1914	Greece	Vlachopoulos, 1991
Criconemella informis Micoletzky 1922	Spain	Peña-Santiago, 1990
C. sphaerocephala Taylor 1936	Spain	Peña-Santiago, 1990
C. xenoplax Raski 1952	Jordan	Hashim, 1983
	Spain	Nico et al., 2002
C. rosmarini Castillo et al., 1988	Spain	Castillo et al., 2010
C. sicula (Vovlas, 1982) Raski & Luc, 1987	Italy	Vovlas, 1982
Criconemella sp. De Grisse and Loof 1965	Spain	Peña-Santiago, 1990
Criconemoides informis Micoletzky 1922	Jordan	Hashim, 1979
	Spain	Hashim, 1979
	Spain	Castillo et al., 2010
	Spain	Nico et al., 2002

Criconemoides amorphus De Grisse, 1967	Spain	Castillo et al., 2010
	Spain	Nico et al., 2002
Criconemoides sphaerocephalum Taylor, 1936	Spain	Castillo et al., 2010
	Spain	Nico et al., 2002
Criconemoides sp. Taylor 1936	Chile	Gallo and Jimenez, 1976
	Egypt	Diab and El-Eraki, 1968
	Greece	Hirschmann et al., 1966
	Italy	Scognamiglio et al., 1968
	Jordan	Anon, 1970
	Greece	Vlachopoulos, 1991
Crossonema multisquamatum Kirjanova 1948	Zimbabwe	Mehta and Raski, 1971
Hemicriconemoides gaddi Loos 1949	Türkiye	Cilbircioğlu, 2007
	Türkiye	Öztürk, 2023
	Türkiye	Kepenekci, 2001
Mesocriconema curvatum Raski 1952	Spain	Castillo et al., 2010
M. onoense Luc 1959	Brazil	Rossi and Ferraz, 2005a
M. sicula Loof and De Grisse 1989	Italy	Vovlas, 1982
M. siculum (Vovlas, 1982) Loof & De Grisse, 1989	Italy	Vovlas, 1982
M. sphaerocephalum Taylor 1936	Spain	Castillo et al., 2010
M. xenoplax Raski 1952	Spain	Nico et al., 2002
	Türkiye	Öztürk, 2023
Neolobocriconema olearum Hashim 1984	Jordan	Hashim, 1984b
Nothocriconema princeps De Grisse and Loof 1965	Portugal	Decraemer, 1994
	Portugal	Abrantes et al., 1987
Ogma civellae Steiner 1949	Zimbabwe	Mehta and Raski, 1971
Macroposthonia xenoplax, Raski, 1922, Loof and De Grisse, 1989	Türkiye	Öztürk, 2020
O. rhomobosquamatum Mehta and Raski 1971	Spain	Peña-Santiago, 1990
	Spain	Castillo et al., 2010
	Spain	Nico et al., 2002
	Spain	Ali et al., 2014
	Portugal	Abrantes et al., 1987
	Italy	Vovlas and Inserra, 1981b
O. seymouri Wu 1965	Jordan	Hashim, 1983

Continued from Table 1.

	Italy	Vovlas and Inserra, 1981b
	Portugal	Abrantes et al., 1987
	Spain	Castillo et al., 2010
Ogma sp. Mehta and Raski 1971	Italy	Fiume, 1978
Dolichodorus heterocephalus Cobb 1911	Italy	D'Errico et al., 1977
Dolichodorus sp. Cobb 1915	Italy	Fiume, 1978
Trophurus sp. Loof 1956	Italy	Scognamiglio et al., 1968
Hemicycliophora sturhani Loof 1984	Türkiye	Cilbircioğlu, 2007
	Türkiye	Kepenekci, 2001
Hemicycliophora sp. De Man 1921	Chile	Gallo and Jimenez, 1976

	Spain	Nico et al., 2002
Heterodera avenae Filipjev 1934	Spain	Nico et al., 2002
	Greece	Hirschmann et al., 1966
H. mediterranea Vovlas et al., 1981	Italy	Vovlas and Inserra, 1983
	Spain	Castillo et al, 1999
	Spain	Castillo et al, 2010
	Spain	Ali et al., 2014
Heterodera sp. Filipjev and Schuurmans Stekhoven 1941	Italy	Scognamiglio et al., 1968
Heteroderinae Filipjev and Schuurmans Stekhoven 1941	Spain	Peña-Santiago, 1990
Aorolaimus perscitus Doucet 1980	Spain	Santiago and Geraert, 1990
Helicotylenchus digonicus Perry 1959	Cyprus	Philis and Siddiqi, 1976
	Greece	Hirschmann et al., 1966
	Jordan	Bridge, 1978
	Jordan	Hashim, 1983
	Spain	Palomares-Rius et al., 2012
	Spain	Nico et al., 2002
	Türkiye	Cilbircioğlu, 2007
	Türkiye	Kepenekci, 2001
	Türkiye	Öztürk, 2020
	Türkiye	Öztürk, 2023
	Türkiye	Kesici, 2022
	Spain	Castillo et al., 2010
	Spain	Ali et al., 2014
	Spain	Nico et al., 2003a
H. multicinctus (Cobb, 1893) Golden, 1956	Türkiye	Yıldız, 2012
	Türkiye	Öztürk, 2020
	Türkiye	Kesici, 2022
H. dihystera Cobb 1893	Brazil	Rossi and Ferraz, 2005b
	Cyprus	Philis and Siddiqi, 1976
	Egypt	Tarjan, 1964
	Italy	Vovlas and Inserra, 1981a
	Jordan	Bridge, 1978
	Spain	Nico et al., 2002
	Spain	Romero and Arias, 1969
	Spain	Ali et al., 2014
	Spain	Diab and El-Eraki, 1968
	Zimbabwe	Sher, 1966
	Türkiye	Öztürk, 2020
	Türkiye	Öztürk, 2023
H. erythrinae Zimmermann 1904	Italy	Graniti, 1955
H. minzi Sher 1966	Jordan	Hashim, 1983
H. neopaxili Inserra et al., 1979	Italy	Inserra et al., 1979

Continued from Table 1.

H. oleae Inserra et al., 1979	Italy	Inserra et al., 1979

	Spain	Castillo et al., 2010
	Spain	Ali et al., 2014
H. pseudorobustus Steiner 1914	Greece	Hirschmann et al., 1966
	Iran	Sanei and Okhovvat, 2011
	Italy	Castillo et al., 2010
	Jordan	Hashim, 1979
	Spain	Nico et al., 2002
	Spain	Nico et al., 2002
	Spain	Castillo et al., 2010
	Spain	Ali et al., 2014
	Spain	Nico et al., 2003a
H. tunisiensis Siddiqi 1963	Israel	Sher, 1966
	Jordan	Hashim, 1979
	Portugal	Abrantes et al., 1987
	Spain	Talavera and Tobar Jimenez, 1997
	Türkiye	Cilbircioğlu, 2007
	Türkiye	Öztürk, 2020
	Türkiye	Öztürk, 2023
H. vulgaris Yuen 1964	Jordan	Hashim, 1983
	Portugal	Abrantes et al., 1987
	Spain	Nico et al., 2002
	Spain	Talavera and Tobar Jimenez, 1997
	Türkiye	Cilbircioğlu, 2007
	Türkiye	Kepenekci, 2001
	Spain	Castillo et al., 2010
	Spain	Ali et al., 2014
H. canadensis Waseem, 1961	Spain	Castillo et al., 2010
	Türkiye	Öztürk, 2020
H. exallus Sher, 1966	Spain	Castillo et al., 2010
H. cavanessi Waseem, 1961	Türkiye	Satmaz, 2012
	Türkiye	Öztürk, 2020
H. varicaudatus Yuen, 1964	Türkiye	Öztürk, 2020
	Türkiye	Öztürk, 2023
Helicotylenchus sp. Steiner 1945	Algeria	Lamberti et al., 1975a
	Chile	Gallo and Jimenez, 1976
	Egypt	Ibrahim et al., 2010
	Greece	Hirschmann et al., 1966
	Greece	Vlachopoulos, 1991
	Iran	Hosseininejad et al., 1996
	Italy	Scognamiglio et al., 1968
	Jordan	Anon, 1970
	Syria	Ayoub and Ghaoui, 2011
	Türkiye	Aktürk and Gözel, 2025
Hoplolaimus aorolaimoides Siddiqi 1972	Portugal	Abrantes et al., 1987
H. galeatus Cobb 1913	Türkiye	Cilbircioğlu, 2007
	Türkiye	Kepenekci, 2001

Hoplolaimus sp. Daday 1905	Egypt	Diab and El-Eraki, 1968
	Syria	Ayoub and Ghaoui, 2011
Plesiorotylenchus striaticeps Vovlas et al., 1993	Türkiye	Cilbircioğlu, 2007
	Türkiye	Kepenekci, 2001
Rotylenchus buxophilus Golden 1956	Türkiye	Cilbircioğlu, 2007
	Türkiye	Kepenekci, 2001

Continued from Table 1.

R. cypriensis Antoniou 1980	Jordan	Hashim, 1983
	Türkiye	Cilbircioğlu, 2007
	Türkiye	Kepenekci, 2001
	Türkiye	Öztürk, 2020
	Türkiye	Öztürk, 2023
R. robustus De Man 1876	Portugal	Decraemer, 1994
	Portugal	Abrantes et al., 1987
	Spain	Ali et al., 2014
Rotylenchus sp. Filipjev 1936	Cyprus	Philis and Siddiqi, 1976
	Greece	Hirschmann et al., 1966
	Greece	Vlachopoulos, 1991
	Italy	Scognamiglio et al., 1968
	Spain	Nico et al., 2002
Aorolaimus perscitus (Doucet, 1980)	Spain	Nico et al., 2002
	Spain	Castillo et al., 2010
Hoplolaiminae Filipjev 1934	Spain	Peña-Santiago, 1990
Meloidogyne acrita Chitwood 1949	China	Yang and Zhong, 1980
M. arenaria Neal 1889	Chile	Jimenez, 1982
	China	Yang and Zhong, 1980
	Spain	Nico et al., 2002
	Spain	Ali et al., 2014
	Spain	Castillo et al., 2010
	Spain	Nico et al., 2003a
M. baetica Castillo et al. 2003b	Spain	Castillo et al., 2003b
M. hapla Chitwood 1949	Chile	Jimenez, 1982
	Israel	Minz, 1961
	Portugal	Santos, 1982
M. incognita Kofoid and White 1919	Argentina	Castillo et al., 2010
	Brazil	Rossi and Ferraz, 2005b
	Chile	Jimenez, 1982
	China	Yang and Zhong, 1980
	Egypt	Ibrahim et al., 2000
	India	Sethi et al., 1988
	Israel	Minz, 1961
	Italy	Lamberti and Vito, 1972
	Italy	Inserra and Vovlas, 1981
	Jordan	Abu-Gharbieh et al., 1978
	Jordan	Hashim,1979
	Lebanon	Saad and Nienhaus, 1969
	Lybia	Edongali, 1989

	Portugal	Abrantes, 1981
	Spain	Nico et al., 2002
	Türkiye	Çetintaş, 2017
M. javanica Treub 1885	Argentina	Pérez et al., 2001
	Chile	Jimenez, 1982
	China	Yang and Zhong, 1980
	Egypt	Diab and El-Eraki, 1968
	Greece	Hirschmann et al., 1966
	Iran	Sanei and Okhovvat, 2011
	Israel	Tarjan, 1953
	Italy	Lamberti and Vito, 1972
	Italy	Inserra and Vovlas, 1981
	Jordan	Hashim, 1979
	Lybia	Edongali, 1989

Continued from Table 1.

	Pakistan	Castillo et al., 2010
	Portugal	Castillo et al., 2010
	Spain	Nico et al., 2002
	USA	Lamberti and Lownsbery, 1968
	Türkiye	Özarslandan and Elekcioğlu, 2010
M. lusitanica Abrantes and Santos 1991	Portugal	Isabel and de A Santos, 1991
	Spain	Nico et al., 2002
Meloidogyne sp. Goeldi 1887	Chile	Gallo and Jimenez, 1976
	Chile	Jimenez, 1982
	China	Yang and Zhong, 1980
	Cyprus	Philis and Siddiqi, 1976
	Iran	Hosseininejad et al., 1996
	Israel	Tarjan, 1953
	Italy	Graniti, 1955
	Jordan	Anon, 1970
	Portugal	Macara, 1971
	Portugal	Santos and Abrantes, 1980
	Syria	Ayoub and Ghaoui, 2011
	USA	Buhrer et al., 1933
Gracilacus peratica Raski 1962	Italy	Vovlas and Inserra, 1983
	Italy	Inserra and Vovlas, 1977
	Portugal	Abrantes et al., 1987
	Italy	Scognamiglio et al., 1968
	Spain	Castillo et al., 2010
G. teres Raski 1976	Spain	Santiago and Geraert, 1990
Gracilacus latescens Raski, 1976	Türkiye	Kesici et al., 2022
Gracilacus sp. Raski 1962	Italy	Scognamiglio et al., 1968
	Spain	Peña-Santiago, 1990
Paratylenchus arculatus Luc and de Guiran 1962	Spain	Nico et al., 2002
	Türkiye	Cilbircioğlu, 2007

	Türkiye	Kepenekci, 2001
P. nawadus Khan, Prasad and Mathur, 1967	Türkiye	Öztürk, 2023
P. baldacii Raski 1975	Spain	Peña-Santiago, 1990
P. ciccaronei Raski 1975	Spain	Palomares-Rius et al., 2012
	Spain	Nico et al., 2002
	Spain	Castillo et al., 2010
P. microdorus Andrassy 1959	Spain	Talavera and Tobar Jimenez, 1997
	Spain	Palomares-Rius et al., 2012
	Spain	Nico et al., 2002
	Spain	Castillo et al., 2010
P. nanus Cobb 1923	Spain	Talavera and Tobar Jimenez, 1997
P. sheri Raski 1973	Spain	Talavera and Tobar Jimenez, 1997
	Spain	Nico et al., 2002
	Spain	Castillo et al., 2010
P. vandenbrandei De Grisse 1962	Italy	Inserra et al., 1976
	Spain	Nico et al., 2002
	Spain	Castillo et al., 2010
Paratylenchus sp. Filipjev 1936	Italy	Vovlas and Inserra, 1983
	Italy	Scogniamiglio et al., 1968
	Jordan	Anon, 1970
	Syria	Ayoub and Ghaoui, 2011
Pratylenchoides erzurumensis Yüksel 1977	Türkiye	Cilbircioğlu, 2007
	Türkiye	Kepenekci, 2001

Continued from Table 1.

P. ritteri Sher 1970	Spain	Nico et al., 2002
	Iran	Inserra et al., 1979
	Türkiye	Kepenekci, 2001
P. alkani Yüksel, 1977	Türkiye	Öztürk, 2023
Pratylenchoides sp. Winslow 1958	Jordan	Anon, 1970
Pratylenchus coffeae Zimmerman 1898	Australia	Colbran, 1964
	Jordan	Hashim, 1983
P. crenatus Loof 1960	Italy	Inserra et al., 1979
	Spain	Nico et al., 2002
	Spain	Castillo et al., 2010
P. fallax Seinhorst 1968	Spain	Nico et al., 2002
P. mediterraneus Corbett 1983	Türkiye	Cilbircioğlu, 2007
	Türkiye	Kepenekci, 2001
P. musicola Cobb 1919	USA	Condit and Horne, 1938
P. neglectus Rensch 1924	Greece	Hirschmann et al., 1966
	Italy	Inserra et al., 1976
	Iran	Zari et al., 2011
	Jordan	Hashim, 1983
	Spain	Talavera and Tobar Jimenez, 1997
	Spain	Nico et al., 2002

	Türkiye	Kepenekci, 2001
	Türkiye	Öztürk, 2023
P. penetrans Cobb 1917	Australia	McLeod et al., 1994
	Italy	Inserra et al., 1976
	Jordan	Hashim, 1983
	Spain	Peña-Santiago, 1990
	Spain	Ali et al., 2014
	Spain	Nico et al., 2002
	Spain	Nico et al., 2003a
P. thornei Sher and Allen 1953	Iran	Sanei and Okhovvat, 2011
	Jordan	Hashim, 1979
	Spain	Nico et al., 2002
	Türkiye	Satmaz, 2012
P. vulnus Allen and Johnson 1951	Algeria	Lamberti et al., 1975a
	Australia	McLeod et al., 1994
	Italy	Lamberti and Baines, 1969b
	Spain	Nico et al., 2002
	USA	Condit and Horne, 1938
	USA	Serr and Day, 1949
	Türkiye	Kepenekci, 2001
P. zeae Graham 1951	Türkiye	Cilbircioğlu, 2007
	Türkiye	Kepenekci, 2001
Pratylenchus sp. Thorne 1949	Algeria	Lamberti et al., 1975a
	Chile	Gallo and Jimenez, 1976
	Egypt	Ibrahim et al., 2010
	Greece	Hirschmann et al., 1966
	Iran	Hosseininejad et al., 1996
	Italy	Vovlas and Inserra, 1983
	Jordan	Anon, 1970
	Spain	Peña-Santiago, 1990
	Syria	Ayoub and Ghaoui, 2011
Radopholus sp. Thorne 1949	Greece	Hirschmann et al., 1966
	Greece	Vlachopoulos, 1991
Zygotylenchus guevarai Tobar-Jimenez 1963	Spain	Peña-Santiago, 1990

Continued from Table 1.

	Spain	Nico et al., 2002
	Türkiye	Cilbircioğlu, 2007
	Türkiye	Kepenekci, 2001
Psilenchus hilarulus De Man 1921	Iran	Sanei and Okhovvat, 2011
	Türkiye	Öztürk, 2023
P. iranicus Kheiri 1970	Jordan	Hashim, 1983
	Spain	Peña-Santiago, 1990
Psilenchus sp. De Man 1921	Greece	Vlachopoulos, 1991
	Iran	Hosseininejad et al., 1996
Rotylenchulus macrodoratus Dasgupta et al., 1968	Greece	Koliopanos and Vovlas, 1977
	Italy	Vovlas and Inserra, 1976
	Italy	Vovlas and Lamberti, 1974

R. macrosoma Dasgupta et al., 1968	Israel	Dasgupta et al., 1968
	Jordan	Hashim, 1983
	Spain	Castillo et al., 2003a
	Türkiye	Cilbircioğlu, 2007
	Türkiye	Öztürk, 2020
	Türkiye	Öztürk, 2023
R. reniformis Linford and Oliveira 1940	Egypt	Badra and Khattab,1980
	Greece	Hirschmann et al., 1966
Rotylenchulus sp. Linford and Oliveira 1940	Algeria	Lamberti et al., 1975a
	Syria	Ayoub and Ghaoui, 2011
Amplimerlinius amplus Siddiqi 1976	Portugal	Siddiqi, 1976
A. longicauda Castillo & al., 1990	Spain	Castillo et al., 2010
A. magnistylus Castillo et al., 1991	Spain	Castillo et al., 2010
A. dubius Steiner 1914	Türkiye	Cilbircioğlu, 2007
	Türkiye	Kepenekci, 2001
A. macrurus Goodey 1932	Jordan	Hashim, 1979
A. paraglobigerus Castillo et al., 1990	Spain	Nico et al., 2002
	Spain	Castillo et al., 2010
Amplimerlinius sp. Siddiqi 1976	Spain	Peña-Santiago, 1990
Bitylenchus goffarti Sturhan 1966	Türkiye	Cilbircioğlu, 2007
	Türkiye	Kepenekci, 2001
Bitylenchus hispaniensis Handoo et al., 2014	Spain	Castillo et al., 2010
Merlinius brevidens Allen 1955	Cyprus	Philis and Siddiqi, 1976
	Greece	Hirschmann et al., 1966
	Iran	Sanei and Okhovvat, 2011
	Jordan	Hashim, 1979
	Spain	Peña-Santiago, 1990
	Spain	Castillo et al., 2010
	Spain	Palomares-Rius et al., 2012
	Türkiye	Yıldırım, 2023
M. microdorus Geraert 1966	Jordan	Hashim, 1983
	Spain	Talavera and Tobar Jimenez, 1997
	Türkiye	Yıldırım, 2023
M. nothus Allen 1955	Jordan	Hashim, 1983
	Spain	Castillo et al., 2010
Merlinius leptus (Allen, 1955) Siddiqi, 1970	Spain	Castillo et al., 2010
Merlinius obscurus	Spain	Castillo et al., 2010
Merlinius nanus (Allen 1955) Siddiqi 1970	Spain	Castillo et al., 2010
Quinisulcius acutus Allen 1955	Türkiye	Cilbircioğlu, 2007
	Türkiye	Kepenekci, 2001
Paratrophurus loofi Arias 1970	Spain	Peña-Santiago, 1990

Continued from Table 1.

	Türkiye	Öztürk, 2020
Scutylenchus lenorus Brown 1956	Türkiye	Cilbircioğlu, 2007
	Türkiye	Kepenekci, 2001

Telotylenchus sp. Siddiqi 1960	Greece	Hirschmann et al., 1966
Trophurus sp.	Italy	Vovlas and Inserra, 1983
Tylenchorhynchus aduncus De Guiran 1967	Spain	Nico et al., 2002
T. clarus Allen 1955	Jordan	Hashim, 1979
	Spain	Nico et al., 2002
	Spain	Castillo et al., 2010
T. claytoni Steiner 1937	Cyprus	Castillo et al., 2010
	Türkiye	Cilbircioğlu, 2007
	Türkiye	Kepenekci, 2001
T. cylindricus Cobb 1913	Türkiye	Cilbircioğlu, 2007
	Türkiye	Kepenekci, 2001
	Türkiye	Öztürk, 2020
	Türkiye	Öztürk, 2023
T. dubius Buetschli 1873	Greece	Hirschmann et al., 1966
	Spain	Peña-Santiago, 1990
	Spain	Nico et al., 2002
	Spain	Castillo et al., 2010
T. goffarti Sturhan 1966	Jordan	Hashim, 1979
T. huesingi Paetzold 1958	Spain	Nico et al., 2002
T. mamillatus Tobar-Jimenez 1966	Spain	Nico et al., 2002
T. penniseti Gupta and Uma 1980	Türkiye	Cilbircioğlu, 2007
	Türkiye	Kepenekci, 2001
T. striatus Allen 1955	Greece	Hirschmann et al., 1966
T. tenuis Micoletzky 1922	Jordan	Hashim, 1984a
T. tritici Golden et al., 1987	Türkiye	Cilbircioğlu, 2007
	Türkiye	Kepenekci, 2001
T. maximus Allen, 1955	Spain	Nico et al., 2002
	Spain	Castillo et al., 2010
T. mediterraneus Handoo, 2014	Spain	Castillo et al., 2010
T. ventrosignatus Tobar Jiménez, 1969	Spain	Castillo et al., 2010
T. zeae Sethi & Swarup, 1968	Spain	Castillo et al., 2010
Tylenchorhynchus sp. Cobb 1913	Algeria	Lamberti et al., 1975a
	Chile	Gallo and Jimenez, 1976
	Egypt	Ibrahim et al., 2000
	Greece	Hirschmann et al., 1966
	Iran	Hosseininejad et al., 1996
	Italy	Vovlas and Inserra, 1983
	Jordan	Anon, 1970
	Spain	Nico et al., 2002
	Syria	Ayoub and Ghaoui, 2011
Aglenchus agricola De Man 1884	Spain	Peña-Santiago, 1990
Basiria duplexa Hagemeyer and Allen 1952	Spain	Peña-Santiago, 1990
	Türkiye	Kepenekci, 2001
Basiria sp. Siddiqi 1959	Jordan	Hashim, 1983
Boleodorus thylactus Thorne 1941	Iran	Sanei and Okhovvat, 2011
	Türkiye	Kepenekci, 2001
	Türkiye	Öztürk, 2020

	Türkiye	Öztürk, 2023
Boleodorus sp. Thorne 1941	Iran	Hosseininejad et al., 1996
	Jordan	Hashim, 1983
	Spain	Peña-Santiago, 1990

Continued from Table 1.

Coslenchus cancellatus Cobb 1925	Spain	Peña-Santiago, 1990
C. costatus De Man 1921	Greece	Hirschmann et al., 1966
C. lateralis Andrassy 1982	Spain	Peña-Santiago, 1990
C. diversus Lal and Khan, 1988	Türkiye	Kepenekci, 2001
	Türkiye	Kesici et al., 2022
C. franklinae Siddiqi, 1981	Türkiye	Öztürk, 2020
C. turkeyensis Siddiqi, 1981	Türkiye	Kepenekci, 2001
	Türkiye	Öztürk, 2023
Coslenchus sp. Siddiqi 1978	Spain	Peña-Santiago, 1990
Discotylenchus discretus Siddiqi 1980	Jordan	Hashim, 1983
Filenchus discretus Siddiqi 1979	Spain	Peña-Santiago, 1990
F. filiformis Buetschli 1873	Greece	Hirschmann et al., 1966
	Türkiye	Öztürk, 2023
F. sandneri Wasilewska 1965	Spain	Palomares-Rius et al., 2012
F. thornei (Andrassy, 1954) Andrassy, 1963	Türkiye	Satmaz, 2012
	Türkiye	Öztürk, 2020
	Türkiye	Öztürk, 2023
F. sheri (Khan and Khan, 1978) Siddiqi 1986	Türkiye	Öztürk, 2023
F. cylindricus (Thorne and Malek, 1968) Niblack and Bernard, 1958	Türkiye	Öztürk, 2023
Filenchus sp. Andra´ ssy 1954	Jordan	Hashim, 1983
	Spain	Palomares-Rius et al., 2012
Irantylenchus clavidorus (Kheiri) Sumenkova, 1984	Türkiye	Kepenekci, 2001
Irantylenchus sp. Kheiri 1972	Iran	Sanei and Okhovvat, 2011
Neopsilenchus magnidens Thorne 1949	Spain	Peña-Santiago, 1990
N. peshawarensis Shahin and Maqbool, 1994	Türkiye	Kepenekci, 2001
Tylenchus arcuatus Siddiqi 1963	Spain	Peña-Santiago, 1990
T. davainei Bastian 1865	Spain	Palomares-Rius et al., 2012
	Türkiye	Öztürk, 2023
Tylenchus sp. Bastian 1865	Chile	Gallo and Jimenez, 1976
	Greece	Hirschmann et al., 1966
	Iran	Hosseininejad et al., 1996
	Italy	Vovlas and Inserra, 1983
	Jordan	Hashim, 1979
	Spain	Palomares-Rius et al., 2012
	Türkiye	Aktürk and Gözel, 2025
Trophotylenchulus saltensis Hashim 1983	Jordan	Hashim, 1983
Tylenchulus semipenetrans Cobb 1913	Australia	Colbran, 1964
	Chile	Castillo et al., 2010
	Egypt	Yang and Zhong, 1980
	Greece	Vlachopoulos, 1991

	Italy	Inserra and Vovlas, 1981
	USA	Baines, 1951
Tylenchulus sp. Cobb 1913	Chile	Gallo and Jimenez, 1976
	Italy	Fiume, 1978
	Syria	Ayoub and Ghaoui, 2011
Geocenamus brevidens (Allen, 1955) Siddiqi, 1970	Türkiye	Öztürk, 2023
Lelenchus leprosoma de Man, 1880	Türkiye	Öztürk, 2023
Sauertylenchus maximus Allen, 1955	Türkiye	Öztürk, 2023

Meloidogyne spp. are recognized as some of the most destructive plant pathogens worldwide (Karssen and Moens, 2006). The root-knot nematode (*Meloidogyne* spp.) species that damage olive trees are well adapted to temperate and subtropical climates, and among them is *M. acrita, M. arenaria, M. baetica, M. hapla, M. incognita, M. javanica*, and *M. lusitanica* (Yang and Zhong, 1980; Jimenez, 1982; Santos, 1982; Isabel and de A Santos, 1991; Ibrahim et al., 2000; Pérez et al., 2001; Castillo et al., 2003b; Nico et al., 2003b; Castillo et al., 2010; Çetintaş, 2017; Özarslandan and Elekcioğlu, 2010; Sanei and Okhovvat, 2011; Ali et al., 2014).

These species exhibit sporadic distribution in naturally growing olive trees, seedling production facilities and cultivated orchards, where they induce distinct gall formation on roots and cause stunted plant growth (Lamberti and Baines, 1969a; Sasanelli et al., 1997; Nico et al., 2002; Castillo et al., 2003a). As a result of infection, formationos sustained feeding sites structures known as "giant cells" develop in the root tissues, accompanied by damage to the vascular cylinder (stele). Under controlled conditions, low to moderate levels of infection have been shown to cause moderate galling in most olive cultivars (Sasanelli et al., 2002; Nico et al., 2003b).

Pratylenchus spp. are obligate migratory endoparasites that feed on the cortical parenchyma cells of olive roots. This parasitic activity causes severe tissue death in both the cortex and endodermis, accompanied by a decline in the number and lenght of lateral roots and the formatin of lesions along the root surface (Castillo and Vovlas, 2007).

The *Pratylenchus* species known to cause damage to olive trees include *P. coffeae, P. crenatus, P. fallax, P. mediterraneus, P. musicola, P. neglectus, P. penetrans, P. thornei, P. vulnus,* and *P. zeae* (Condit and Horne, 1938; Colbran, 1964; Inserra et al., 1979; McLeod et al., 1994; Kepenekci, 2001; Nico et al., 2002; Cilbircioğlu, 2007; Castillo et al., 2010; Sanei and Okhovvat, 2011; Satmaz, 2012; Öztürk, 2023).

The penetration of root tissues and subsequent migration of the nematode within the host occur through an integration of mechanical pressure exerted by its stylet and enzymatic degradation of the cell wall (Zunke, 1990).

Several genera of reported plant-parasitic nematodes of olive worldwide, including *Helicotylenchus, Longidorus, Xiphinema, Gracilacus*, and *Rotylenchulus*, are capable of damaging olive roots through a variety of feeding strategies (Diab and El-Eraki, 1968; Scognamiglio et al., 1968; Lamberti et al., 1975b; Gallo and Jimenez, 1976; Philis and Siddiqi, 1976).

In particular, nematodes belonging to the genus *Helicotylenchus*, commonly known as spiral nematodes, are associated with root necrosis and can negatively influence plant growth under specific environmental conditions (Inserra et al., 1979). *Helicotylenchus* species generally exhibits semi-endoparasitic feeding behavior, targeting the fine roots of olive trees. In contrast, *Xiphinema* and *Longidorus* species feed directly on root cells, resulting in tissue damage.

Moreover, certain nematode species have been reported to transmit plant viruses, causing diseases in various fruit and vegetable crops (Martelli and Taylor, 1990). For instance, SLRV has been shown to induce leaf and fruit deformities in the olive cultivar *Ascolana tenera* (Marte et al., 1986). Additionally, *Xiphinema elongatum* Schuurmans Stekhoven & Teunissen, 1938, was reported to reduce above-ground biomass in olive seedlings by up to 65% in Egypt (Lamberti and Vovlas, 1993).

4. GENERAL CONTROL METHODS FOR PLANT-PARASITIC NEMATODES

4.1. Quarantine Measures

Quarantine measures are a fundamental strategy for the control of plant-parasitic nematodes in olive trees. Since nematode infestations usually occur during the early stages of production, preventing their establishment is particularly important in nurseries (Stukenbrock et al., 2008). Although the use of sterile growing media in modern seedling production minimizes the risk of infestation, the application of sterile soil in subsequent stages is also essential for effective quarantine. Pathogen-free certification programs for olive seedlings have been developed in the European Union and Spain; however, since their implementation is not mandatory, producers are strongly advised to obtain propagation material from certified or reputable nurseries (EPPO/OEPP, 1993; BOJA, 1997; Lorrain, 1998; BOE, 1999). Whitehead (1998) recommends control efficiency levels of 95% for *Pratylenchus* spp. and 99.9% for *Meloidogyne* spp.. In addition, species such as *X. Californicum,*

X. americanum, *Longidorus diadecturus, Xiphinema italiae* and *Heterodera mediterranea* (Ministerio de Agricultura, Servicio Agrícola y Ganadero, 2007) have been designated as quarantine pests.

4.2. Cultural Control Methods

4.2.1. Use of resistant cultivars

Host plant resistance represents an environmentally friendly, economical, and long-term control strategy against plant-parasitic nematodes. While the use of resistant rootstocks is widely applied against root-knot nematodes in *Prunus* species (Pinochet et al., 1991), its application in olive trees remains limited, primarily because olives are generally propagated by cuttings rather than grafting. Nevertheless, encouraging results achieved with the clonal rootstock 'Allegra' in California indicate that this strategy may also be effective for managing nematodes in olive cultivation (McKenry, 1994).

The susceptibility of olive cultivars to nematodes varies according to genotypic differences and species-specific traits. In a study conducted in Egypt, the cultivars Meashon and Tofany were reported to be resistant to *Meloidogyne incognita* but moderately susceptible to *Rotylenchulus reniformis*, whereas the cultivars Manzanillo and Egazi exhibited the opposite tolerance pattern (Al-Sayed and Abdel-Hameed, 1991). Similarly, studies in Italy revealed that the cultivar Coratina was resistant to both root-knot nematode species, while Leccino and Yusti showed resistance only to *M. javanica*. In contrast, the rootstock DA 12 1 was found to be highly susceptible (Sasanelli et al., 1997; Sasanelli et al., 2002). Moreover, the use of in vitro explants has been demonstrated to be an efficient method for rapidly evaluating nematode resistance in olive genotypes (Sasanelli et al., 2000).

4.2.2. Organic material applications

One of the environmentally friendly approaches in soil disinfection is the addition of organic materials (e.g., organic manure or compost) (Akhtar and Alam, 1993). Although various agricultural and industrial by-products have been tested for this purpose (D'Addabbo, 1995), composts recommended for the suppression of soil-borne fungi have been found to be insufficiently effective in nematode control.

In a study investigating the suppression of *M. incognita*, different proportions of dry mushroom shell compost were incorporated into the olive growing medium. The results demonstrated a pronounced reduction in nematode populations as compost ratios increased, with the most significant suppressive effect observed in the treatment utilizing pure compost (Nico et al., 2004).

4.2.3. Biofumigation

Biofumigation is an environmentally sustainable approach for controlling soil-borne pathogens, involving the incorporation of specific organic materials into the soil (Kierkegaard et al., 1993). This method exploits the biocidal volatile compounds released during the decomposition of tissues from *Brassica* and *Sorghum* species. When applied under plastic cover, the retention of these volatiles enhances the overall effectiveness of the treatment. Under laboratory conditions, leaf tissues of *Sorghum sudanense* were observed to suppress *Meloidogyne incognita*; however, effective control was achieved only after prolonged treatments lasting 30–60 days (A. Nico, R. M. Jiménez-Díaz, and P. Castillo, unpublished data). Therefore, while biofumigation can contribute to nematode suppression, its efficacy is generally lower than that of soil solarization.

4.3. Physical Control

Increasing concerns regarding the environmental consequences of pesticide use have prompted the development of non-chemical soil disinfection methods in agriculture. Among these, soil solarization is recognized as one of the most effective strategies. Solarization is a hydrothermal technique in which moist soil, covered with transparent plastic sheets, is heated by solar radiation to temperatures lethal to soil-borne pathogens (Katan, 1981).

Olive cultivation in Mediterranean climate regions provides favorable conditions for soil solarization due to elevated summer temperatures. Solarizing nursery substrates, such as peat or perlite, in small piles under greenhouse conditions has been demonstrated as an effective approach for controlling soil-borne pathogens (Nico et al., 2003b). A ten-day solarization treatment led to a substantial reduction of *M. incognita* eggs and egg masses down to a soil depth of 40 cm (Nico et al., 2003b). Furthermore, these high temperatures can inactivate other nematode species detrimental to olive trees, including *Pratylenchus vulnus* and *P. penetrans* (Nico et al., 2003a).

Soil solarization has been successfully applied not only to manage nematode infestations in established olive groves but also to control other soil-borne pathogens. For example, Tjamos (1983) and López-Escudero & Blanco-López (2001) reported that solarization markedly reduced the incidence of *Verticillium* wilt in olive trees infected with *Verticillium dahliae*.

4.4. Chemical Control

Although soil fumigation prior to planting is commonly employed for nematode management in certain fruit crops, its use in olive production

remains limited. In nursery settings, chemical control methods are considered an effective approach for producing nematode-free planting material.

Research on the post-planting application of non-fumigant nematicides (NFNs) in olive groves is still scarce. In a field trial conducted in Chile, Jiménez et al. (2002) compared fenamiphos fumigation, a biocontrol formulation, and organic fertilizer applications in olive trees naturally infected with *Tylenchulus semipenetrans*. No significant differences were observed in root biomass, and both the biocontrol and organic fertilizer treatments were found to be as effective as fenamiphos. Similarly, in Egypt, Shawky et al. (2004) evaluated the efficacy of fenamiphos, ethoprop, carbofuran, oxamyl, and aldicarb against *M. incognita*. All nematicides effectively reduced nematode populations, with fenamiphos showing the highest efficacy and carbofuran the lowest.

Furthermore, Lamberti and Baines (1969b) reported that incorporating fenamiphos into the growing medium effectively reduced root-knot nematode infections in olive trees.

Among the NFNs licensed worldwide are ethoprophos, fosthiazate, fenamiphos, and oxamyl, but none of these substances are authorized for use on olive trees (Sobreiro and Reis, 2008; APVMA, 2009; CASAFE, 2009; MARM, 2009; Ministero delle politiche agricole, alimentari e forestali, 2009).

4.5. Biological Control

Arbuscular mycorrhizal fungi (AMF) enhance phosphorus uptake by forming symbiotic associations with plant roots and protect plants against soil-borne diseases and pests by competing with pathogens for infection sites and nutrient resources (Azcón-Aguilar and Barea, 1996). The effectiveness of AMF in suppressing plant-parasitic nematodes has been demonstrated in various pathosystems, including *Meloidogyne* species and olive trees (Castillo et al., 2006).

Early inoculation with *Glomus viscosum*, *G. intraradices*, and *G. mosseae* in the Arbequina and Picual olive varieties promoted plant growth and conferred significant protection against *Meloidogyne javanica* and *M. incognita* infections. This protective effect has been attributed to the suppression of nematode reproduction and a reduction in root gall formation (Castillo et al., 2006).

Consequently, the use of seedlings grafted with arbuscular mycorrhizal fungi (AMF) during the nursery stage can be regarded as an effective biological strategy for mitigating damage caused by root-knot nematodes and promoting long-term resilience in olive groves.

6. RESULTS

Host suitability for plant-parasitic nematodes (PPNs) is generally evaluated by assessing the level of nematode reproduction in the plant following artificial inoculation (Lewis, 1987). In nematological research, the reproduction factor (Rf) is the most commonly employed parameter for this purpose (Marull and Pinochet, 1991; Pinochet et al., 1991). When a compatible host–parasite interaction occurs, nematode infection induces pathogenesis by disrupting normal physiological processes within the plant (Melakeberhan and Webster, 1993).

Beyond the phytopathogenic effects of PPN populations in olive soils, limited information exists regarding their potential use as bioindicators for soil health or for guiding olive grove management practices (Bongers and Ferris, 1999). Studies have reported a positive correlation between soil degradation and PPN abundance, species diversity, and the Plant Parasite Index (PPI) (Freckman and Ettema, 1993). Additionally, enhanced plant nutrition has been shown to influence the composition and structure of PPN populations (Bongers et al., 1997).

Consequently, examining the distribution, density, and community structure of plant-parasitic nematodes (PPNs) in relation to various agricultural management systems is essential for both controlling nematode-associated diseases and developing sustainable production strategies.

Growing concerns regarding environmental and human health have led to the prohibition of many nematicides, highlighting the need for alternative approaches to manage PPNs in crops, including olives. Given the limited availability of nematode-resistant olive rootstocks, quarantine measures remain one of the most critical control strategies. In this context, the use of pathogen-free seedling material and nematode-free soil is vital for minimizing early-stage infections, thereby reducing growth losses and yield declines.

In certified seedling production, grafting and cutting materials should be obtained exclusively from rootstocks with equivalent or higher certification levels. Production soils must be free of harmful nematode species, including *Xiphinema diversicaudatum*, *Meloidogyne arenaria*, and *Pratylenchus vulnus*, as well as other quarantine organisms (Anonymous, 2006).

The insufficient nematode resistance in olive trees can be offset through non-chemical alternatives, particularly soil solarization, biofumigation, and biological control applications. This integrated approach supports both the economic and ecological sustainability of olive cultivation in Mediterranean agricultural systems.

References

Abrantes, I. D., 1981. Nematode problems of olive trees. European Society of Nematologists, in: Abstracts of the 15th International Nematology Symposium of the European Society of Nematologists, Bari, Italy, 24-30 August, pp. 27-28.

Abrantes, I. D. O., Vovlas, N., & Santos, M. D. A., 1987. Morphological studies on six Tylenchid nematode species assocated with olive in Portugal. Cienc. Biol. Ecol. Syst. 7, 1-9.

Abu-Gharbieh, W. I., Makkouk, K. M., & Saghir, A. R., 1978. Response of different tomato cultivars to the root-knot nematode, tomato yellow leaf curl virus, and *Orobanche* in Jordan. Plant Dis. Rep. 62, 263-266.

Aït Hamza, M., Ali, N., Tavoillot, J., Fossati-Gaschignard, O., Boubaker, H., El Mousadik, A., & Mateille, T., 2017. Diversity of root-knot nematodes in Moroccan olive nurseries and orchards: does *Meloidogyne javanica* disperse according to invasion processes?. BMC ecology, 17(1), 1-13. https://doi.org/10.1186/s12898-017-0153-9

Akdemir, Y. K., 2022. İzmir ili park ve bahçe alanlarında bulunan bitki paraziti nematod türleri üzerine taksonomik araştırmalar. Bursa Uludağ Üniversitesi, Fen Bilimleri Enstitüsü, Bitki Koruma Ana Bilim Dalı, Doktora Tezi. 291 s.

Akhtar, M., & Alam, M. M., 1993. Utilization of waste materials in nematode control: A review. Biores. Technol. 45:1-7.

Aktürk, Ç., & Gözel, U. 2025. Determination of Plant Parasitic Nematode Fauna and Evaluation of Soil Quality in Olive Orchards of Çanakkale Province, Türkiye. Kahramanmaraş Sütçü İmam Üniversitesi Tarım ve Doğa Dergisi, 28(3), 830-842.

Ali N., Chapuis E., Tavoillot J., Mateille T., 2014. Plant-parasitic nematodes associated with olive tree (*Olea europaea* L.) with a focus on the Mediterranean Basin: A review. C R Biol 337, 423-442. doi: 10. 1016/j.crvi.2014.05.006 PMID: 25103828

Almeida, M.T.M., Waele, D. De, Santos, M.S.N. De A. & Sturhan, D., 1989 Species of *Trichodorus* from Portugal. Revue de Nhmatologie 12, 219-233.

Al-Sayed, A., & Abdel-Hameed, S. H., 1991. Resistance and susceptibility of olives to *Meloidogyne incognita* and *Rotylenchulus reniformis*. Ann. Agric. Sci. Moshtohor 29, 1221-1226.

Anon, 1970. Nematology section, Annual Report, Department of Agricultural Research, Ministry of Agriculture, Jordan, pp. 92-96 (in Arabic).

Anonymous. 2006. Schemes for the production of healthy plants for planting. Pathogentested olive trees and rootstocks. EPPO Bull. 36, 77-83.

Arias, M. (1975). Nuevas aportaciones al conocimiento del genero Xiphinema (Nematoda) y su distribucion en los suelos espanoles. An. Edafol. Agrobiolog. 34, 183–198.

Australian Pesticides and Veterinary Medicines Authority (APVMA). 2009. APVMA PUBCRIS database. http://services.apvma. gov.au/PubcrisWebClient/welcome.do.

Ayoub, M. & L. Ghaoui, 2011. Nematode problems on olive from nurseries to orchards, Report diploma, Plant Protection Department, Faculty of Agriculture, University of Tishreen, Lattakia, Syria, (in Arabic).

Azcón-Aguilar, C. & Barea, J. M., 1996. Arbuscular mycorrhizas and biological control of soil-borne plant pathogens – An overview of the mechanisms involved. Mycorrhiza 6, 457-564.

Badra, T. & Khattab, M. M., 1980. The effect of nitrogen fertilizers on the growth of olive and in relation to infestations of *Rotylenchulus reniformis*. *Nematologia Mediterranea*. 8, 67–72.

Baines, R. C., 1951. Citrus-root nematodes on olive. Pest pathologically and morphologically similar to that on orange roots infests and reproduces on olive roots. Calif. Agric. 5, 11 p..

Baldoni, L., & Belaj, A., 2010. Olive, Oil crops, 397-421,."

Barker, K.R., Todd, F.A., Shane, W.W. & Nelon, L.A., 1981. Interrelationships of *Meloidogyne* species with Flus-Cured Tabacco. Journal of Nematology, 13, 67-79.

BOE. 1999. Modificación del reglamento técnico de control y certificación de plantas de vivero de frutales. Boletín Oficial Estado 276, 40077-40079.

BOJA. 1997. Reglamento específico de producción integrada del olivar. Boletín Junta Andalucía 100, 10543-10555.

Bongers, T., Ferris, H., 1999. Nematode community structure as a bioindicator in environmental monitoring. Trends Ecol Evol 14: 224–228. doi: 10.1016/S0169-5347(98)01583-3 PMID: 10354624

Bongers, T., van der Meulen, H., & Korthals, G., 1997. Inverse relationship between the nematode maturity index and plant parasite index under enriched nutrient conditions. *Applied Soil Ecology*, *6*(2), 195-199. doi: 10.1016/S0929-1393(96)00136-9

Bravo, M. A., & Roca, F., 1998. Two *Longidorus* species (Nematoda: Longidoridae) occurring in the rhizosphere of olive trees in Northeastern Portugal. Agronomia Lusitana 46, 101-121.

Bridge J., 1978. Plant Nematology in Jordan, Report of Scientific Liaison Office, Overseas Development Ministry, London, UK, (20 p.).

Buhrer, E. M., Cooper, C. & Steiner, G., 1933. A list of plants attacked by the root knot nematode (*Heterodera mariom*). Plant Dis. Rep. 17, 64–96.

CASAFE. 2009. Guía de Productos Fitosanitarios. Tomo I: generalidades e insecticidas. Cámara de Sanidad Agropecuaria y Fertilizantes, Buenos Aires, Argentina.

Castillo, P., Nico A., Navas-Cortés J.A.,Landa BB,Jiménez-Díaz RM,etal. (2010) Plant-parasitic nematodes attacking olive trees and their management. Plant Dis 94: 148–162. doi: 10.1094/PDIS-94-20148.doi: 10.1094/PDIS-94-20148.

Castillo, P., and Vovlas, N. 2002. Factors affecting egg hatch of *Heterodera mediterranea* and differential responses of olive cultivars to infestation. J. Nematol. 34, 146-150.

Castillo, P., and Vovlas, N. 2007. *Pratylenchus* (Nematoda: Pratylenchidae): Diagnosis, Biology, Pathogenicity and Management. Brill, Leiden, Netherlands.

Castillo, P., Nico, A. I., Azcón Aguilar, C., Del Río Rincón, C., Calvet, C., and Jiménez Díaz, R. M. 2006. Protection of olive planting stocks against parasitism of root-knot nematodes by arbuscular mycorrhizal fungi. Plant Pathol. 55, 705-713.

Castillo, P., Nico, A. I., Navas-Cortes, J. A., Landa, B. B., Jiménez-Díaz, R. M., & Vovlas, N. (2010). Plant-parasitic nematodes attacking olive trees and their management. Plant Disease, 94(2), 148-162.

Castillo, P., Vovlas, N., & Troccoli, A. 2003a. The reniform nematode, *Rotylenchulus macrosoma*, infecting olive in southern Spain. Nematology, 5(1), 23-29.

Castillo, P., Vovlas, N., Nico, A. I., & Jiménez-Díaz, R. M. 1999. Infection of olive trees by Heterodera mediterranea in orchards in southern Spain. *Plant disease*, *83*(8), 710-713.

Castillo, P., Vovlas, N., Subbotin, S., & Troccoli, A. 2003b. A new root-knot nematode, *Meloidogyne baetica* n. sp. (Nematoda: Heteroderidae), parasitizing wild olive in Southern Spain. *Phytopathology*, *93*(9), 1093-1102.

Çetintaş, R. 2017. Kahramanmaras sütçü imam üniversitesi meyve bahçesindeki nematodlar ve trofik grupları. *KSÜ Doğa Bilimleri Dergisi*, *13*(1), 34-41.

Cilbircioğlu, C. 2007. Plant-parasitic nematodes associated with *Olea europea* L. fauna of Turkey. Journal of Agricultural and Urban Entomology, 24(4), 227-231.

COI (Consejo Oleícola Internacional), 1991. Olive, olive oil, and table olives. COI, Madrid. in Spanish.

Colbran, R. C., 1964. Studies of plant and soil nematodes. 7. Queensland records of the order Tylenchida and the genera *Trichodorus* and *Xiphinema*. *Queensland Journal of Agricultural Science*, *21*(1), 77-123.

Condit, I. J., & Horne, W. T., 1938. Nematode infestation of olive roots. Phytopathology 28, 756-757.

D'Addabbo, T. 1995. The nematicidal effect of organic amendments: A review of the literature: 1982:1994. Nematol. Mediterr. 23, 299-305.

Dasgupta, D. R., Raski, D. J., & Sher, S. A., 1968. A revision of the genus *Rotylenchulus* Linford and Oliveira, 1940 (Nematoda: Tylenchidae). Proc. Helminthol. Soc. Wash. 35, 169-192.

De Waele, D., Mancini, G., Roca, F., & Lamberti, F., 1982. *Trichodorus taylori* sp. n. (Nematoda: Dorylaimida) from Italy. Nematologia mediterranea, 10, 27-37.

Decraemer, W. 1994. The family Trichodoridae: stubby root and virus vector nematodes (Doctoral dissertation, Ghent University). Springer.

Decraemer, W., & Hunt, D. J., 2006. Structure and classification. *Plant nematology*, *1*, 3-32.

Decraemer, W., Palomares-Rius, J. E., Cantalapiedra-Navarrete, C., Landa, B. B., Duarte, I., Almeida, T., ... & Castillo, P., 2013. Seven new species of *Trichodorus* (Diphtherophorina, Trichodoridae) from Spain, an apparent centre of speciation. Nematology, 15(1), 57-100.

D'Errico, F. P., Lamberti, F., & Fiume, F., 1977. Ritrovamento di Dolichodorus heterocephalus Cobb nell'Italia meridionale. *Nematologia Mediterranea*.

Diab, K. A., & El-Eraki, S., 1968. Plant-parasitic nematodes associated with olive decline in the United Arab Republic. Plant Dis. Rep. 52, 150-154.

Djian-Caporalino, C., Védie, H., & Arrufat, A., 2009. Gestion des nématodes à galles: lutte conventionnelle et luttes alternatives. L'atout des plantes pièges. *Phytoma*, *624*, 21-25.

Ecevit, O. ve Akyazı, F., 2010. Bitki Paraziti nematodlar. Ordu Üniversitesi Yayınları, Yardımcı Ders Kitabı, Ordu. 1-111, 360.

Edongali, E. A., 1989. Plant-parasitic nematodes associated with olive trees in Libya. Int. Nematol. Netw. Newslett. 6 (1989), 36-37.

Efe R., Soykan A., Cürebal İ., & Sönmez S., 2011. Dünyada, Türkiye'de, Edremit Körfezi çevresinde zeytin ve zeytinyağı. Edremit Belediyesi Kültür Yayınları No:6, 2011.

El-Borai, F. E., & Duncan, L. W. 2005. Nematode parasites of subtropical and tropical fruit tree crops. Pages 469-492 in: Plant-parasitic Nematodes in Subtropical and Tropical Agriculture. M. Luc, R. A. Sikora, and J. Bridge, eds. CABI Publishing, Wallingford, UK.

EPPO/OEPP 1993. Certification schemes. No. 7. Nursery requirements-recommended requirements for establishments participating in certification of fruit or ornamental crops. Bull. OEPP/EPPO Bull. 23:249-252.

Fao (2022). Food and Agriculture Organization of The United Nations, fStatistics Division.https://www.fao.org/faostat/en/#data/QCL

Fiume F. 1978. The genera of nematodes living in the rhizosphere of olive trees in Calabria, Informat. fitopat. 7, 11-14.

Freckman, D. W., & Ettema, C. H., 1993. Assessing nematode communities in agroecosystems of varying human intervention. Agriculture, Ecosystems & Environment, 45(3-4), 239-261. doi: 10.1016/0167-8809(93)90074-Y

Gallo, D. P., & Jimenez, R. M., 1976. The phytoparasitic nematofauna associated with olive in Azapa valley. IDESIA, 4, 105-109.

Gaugler, R., & Anwar, L.B. 2004. Nematode Behaviour. Oxford University Press, 419 p

Graniti, A., 1955. Un deperimento dell'olivo in Sicilia associato a due specie di nematodi. in: Olearia, 9, pp. 114-120.

Handoo, Z. A., Palomares-Rius, J. E., Cantalapiedra-Navarrete, C., Liébanas, G., Subbotin, S. A., & Castillo, P., 2014. Integrative taxonomy of the stunt nematodes of the genera *Bitylenchus* and *Tylenchorhynchus* (Nematoda, Telotylenchidae) with description of two new species and a molecular phylogeny. Zoological Journal of the Linnean Society, 172(2), 231-264.

Hashim, Z., 1982. Distribution, pathogenicity and control of nematodes associated with olive. Rev Nématol 5, 169-181.

Hashim, Z., 1979. A preliminary report on the plant-parasitic nematodes in Jordan. Nematologia mediterranea. 7, 177-186.

Hashim, Z., 1983. Plant-parasitic nematodes associated with olive in Jordan. Nematologia Mediterranea 11, 27-32.

Hashim, Z., 1984a. Description of *Tylenchorhynchus teeni* n. sp. and observations on *Rotylenchus cypriensis* Antoniou, 1980 (Nematoda: Tylenchida) from Jordan. Systematic parasitology, 6(1), 33-38.

Hashim, Z., 1984b. Re-diagnosis and a key to species of *Neolobocriconema* Mehta & Raski, 1971 (Nematoda: Tylenchida), with a description of *N. olearum* n. sp. from Jordan. Systematic parasitology, 6(1), 69-73.

Hirschmann, H. E. D. W. I. G., Paschalaki-Kourtzi, N., & Triantaphyllou, A. C., 1966. A survey of plant-parasitic nematodes in Greece. Ann. Inst. Phytapathol. Benaki. 7, 144-156.

Hosseininejad S.A., Tanha Moafy Z., & Barooty S.H., 1996. Nematodes with olive trees in Iran, Iranian Plant Pests and Diseases, 65, pp. 46-53.

Ibrahim, I. K. A., 1990. The status of phytoparasitic nematodes and the associated host plants in Egypt.

Ibrahim, I. K. A., Handoo, Z. A., & El-Sherbiny, A. A., 2000. A survey of phytoparasitic nematodes on cultivated and non-cultivated plants in Northwestern Egypt. Journal of Nematology, 32(4S), 478.

Ibrahim, I. K. A., Mokbel, A. A., & Handoo, Z. A., 2010. Current status of phytoparasitic nematodes and their host plants in Egypt. Nematropica, 239-262.

Inserra, R. N., & Vovlas, N., 1977. Parasitic habits of *Gracilacus peratica* on olive feeder roots. Nematologia Mediterranea.5, 345-348.

Inserra, R. N., & Vovlas, N., 1980. The biology of *Rotylenchulus macrodoratus*. Journal of Nematology, 12(2), 97.

Inserra, R. N., & Vovlas, N., 1981. Indagine sulla distribuzione geografica dei nematodi parassiti dell'olivo in Italia. *Informatore Fitopatologico*, *31*.

Inserra, R. N., Vovlas, N., and Morgan Golden, A. 1979. *Helicotylenchus oleae* n. sp. and H. neopaxilli n. sp. (Hoplolaimidae), two new spiral nematodes parasitic on olive trees in Italy. J. Nematol. 11(1), 56-62.

Inserra, R., Vovlas, N., Lamberti, F., & Bleve Zacheo, T., 1976. Plant-parasitic nematodes associated with declining olive trees in southern Italy. Poljoprivredna Znanstvena Smotra, Agric. Conspec. Sci. 419-424.

Isabel, M. D. O., & de A Santos, M. S. N., 1991. *Meloidogyne lusitanica* n. sp. (Nematoda: Meloidogynidae), a root-knot nematode parasitizing olive tree (*Olea europaea* L.). Journal of Nematology, 23(2), 210-224.

Jimenez R, M., 1982. Phytoparasitic nematodes and olive growing. in: Primeras Jornadas Olivı´colas Nacionales, 23-27 de Noviembre, 1981, Arica, Chile, Trabajos y resumenes, Universidad de Tarapaca, Departamento de Agricultura, 127-138.

Jimenez, A., 1964. *Ditylenchus virtudesae* n. sp. (Nematoda: Tylenchidae) habitante de los suelos granadinos. Revista Iberica Parasitology, 24, 51-56.

Jiménez, R. M., Gallo, D. P., and Sotomayor, L. E. 2002. Experimental control of *Tylenchulus semipenetrans* Cobb. affecting olive-tree crop. IDESIA. 20:91-102

Karssen, G., and Moens, M., 2006. Root-knot nematodes. Pages 59-90 in: Plant Nematology. R. N. Perry and M. Moens, eds. CABI, Wallingford, UK.

Katan, J., 1981. Solar heating (solarization) of soil for control of soilborne pests. Annu. Rev. Phytopathol. 19, 211-236.

Kepenekci, I., 2001. Preliminary list of Tylenchida (Nematoda) associated with olive in the Black Sea and the Mediterranean regions of Turkey. Nematologia Mediterranea.

Kepenekçi, İ., 2012. Nematoloji (Bitki Paraziti ve Entomopatojen Nematodlar) [Genel Nematoloji (Cilt-I) ISBN 978-605-4672-11-0, Taksonomik Nematoloji (Cilt-II) ISBN 978-605-4672-12-7]. Eğitim Yayım ve Yayımlar Dairesi Başkanlığı. Tarım Bilim Serisi Yayın, 3, 1155.

Kesici, M. A., 2022. Aydın ilinde incir (*Ficus carica* L.), kestane (*Castanea sativa* Mill.) ve zeytin (*Olea europaea* L.) bahçelerinde bulunan bitki paraziti nematod türleri üzerinde faunistik ve taksonomik çalışmalar. Aydın Adnan

Menderes Üniversitesi, Fen Bilimleri Enstitüsü, Bitki Koruma Ana Bilim Dalı, Doktora Tezi. 80 s.

Kierkegaard, J. A., Gardner, P. A., Desmarchelier, J. M., and Angus, J. F., 1993. Bio- Plant Disease / February 2010 161 fumigation: Using Brassica species to control pests and diseases in horticulture and agriculture. Pages 77-82 in: 9th Australian Research Assembly on Brassicas. N. Wratten and R. J. Mailer, eds. Agricultural Research Institute, Wagga Wagga, Australia.

Koenning, S. R., Overstreet, C., Noling, J. W., Donald, P. A., Becker, J. O., and Fortnum, B. A., 1999. Survey of crop losses in response to phytoparasitic nematodes in the United States for 1994. J. Nematol. 31 (4S), 587-618.

Koliopanos, C. N., & Vovlas, N., 1977. Records of some plant-parasitic nematodes in Greece with morphometrical descriptions. *Nematologia mediterranea*. 5, 207-215.

Lamberti, F. & Baines, R. C., 1969a. Pathogenicity of four species of *Meloidogyne* on three varieties of olive trees. Journal of Nematology, 1(2), 111-115.

Lamberti, F. & Baines, R. C., 1969b. Effect of *Pratylenchus vulnus* on the growth of'Ascolano'and'Manzanillo'olive trees in a glasshouse. Plant Dis. Rep. 53, 557-558.

Lamberti, F. & Vovlas, N., 1993. Plant parasitic nematodes associated with olive. Bulletin OEPP/EPPO 23: 481-488. doi: 10.1111/j.1365-2338.1993.tb01356.x

Lamberti, F., 1969c. The olive as a host for *Xiphinema americanum* Cobb. Phytopathol. Mediterr., 8, 230.

Lamberti, F., & Lownsbery, B. F., 1968. Olive varieties differ in reaction to the root-knot nematode *Meloidogyne javanica* (Treub) Chitw/Differente reazione di varietà d'Olivo al nematode galligeno *Meloidogyne javanica* (Treub) Chitw. *Phytopathologia Mediterranea*, *7*(1), 48-50.

Lamberti, F., & Vito, M. D., 1972. Sanitation of root-knot nematode infected olive-stocks. in: Proceeding of the 3th Congress of the Mediterranean Phytopathology Union, Oeiras, Portugal, 401-411.

Lamberti, F., Greco, N., & Zaouchi, H., 1975a. A nematological survey of date palms and other major crops in Algeria. FAO Plant Prot. Bull. 23, 156-160.

Lamberti, F., Roca, F., & Agostinelli, A., 1989. *Xiphinema macrocanthum* (Nematoda: Dorylaimida) a new species from southern Italy closely resembling X. ingens Luc et Dalmasso. Nematologia Mediterranea, 17, 115-119.

Lamberti, F., Roca, F., Agostinelli, A., & Bleve-Zacheo, T., 1986. *Xiphinema barense* sp. n. (Nematoda: Dorylaimida) from Italy. Nematologia Mediterranea, 14, 101-106.

Lamberti, F., Vouyoukalou, E., & Agostinelli, A., 1996. Longidorids (Nematoda: Dorylaimoidea) occurring in the rhizosphere of olive trees in Western Crete, Greece. Nematologia Mediterranea, 24, 79-86.

Lamberti, F., Zacheo, T. B., & Martelli, G. P., 1975b. Un caso di intersesso in *Xiphinema ingens* Luc et Dalmasso (Nematoda, Longidoridae). Nematologia mediterranea, 3, 181-183

Lewis, S. A. 1987. Nematode-plant compatibility. Pp. 246-252. in J. A. Veech and D. W. Dickson, eds. Vistas on nematology. Hyattsville, MD: The Society of Nematologists.

Liphschitz, N., Gophna, R., Hartman, M., & Biger, G., 1991. The beginning of olive (*Olea europaea*) cultivation in the old world: A reassessment. J. Arch. Sci. 18, 441-453.

Lopes-Caitar, V.S., Pinheiro, J.B. & Marcelino-Guimarães, F.C., 2019. Nematodes in horticulture: An overview. Journal of Horticultural Science & Crop Research 1, 1-11.

López-Escudero, F. J., & Blanco-López, M. A., 2001. Effect of a single or double soil solarization to control Verticillium wilt in established olive orchards in Spain. Plant Dis. 85:489-496.

Lorrain, R., 1998. Moyens de contrôle du risque nématologique. L'arboric. Fruit. 514, 37-41.

Macara, A., 1971. A importa^ncia agrı´cola dos nema´todos *Meloidogyne* spp. no espac¸o portugues, Bol. Agron. Nitrat. Portugal Agran 9, 3-15.

Maggenti, A.R., 1991. Nemata: higher classification. Manual of Agricultural Nematology, Marcel Decker, New York, 147-187.

Marte, M., Gadani, F., Savino, V., & Rugini, E., 1986. Strawberry latent rings pot virus associated with a new disease of olive in Central Italy. Plant Dis. 70, 171-172.

Martelli, G. P., & Taylor, C. E., 1990. Distribution of viruses and their nematode vectors. In Advances in disease vector research (pp. 151-189). New York, NY: Springer New York.

Marull, J., & J. Pinochet. 1991. Host suitability of *Prunus* rootstocks to four *Meloidogyne* species and *Pratylenchus vulnus* in Spain. Nematropica 21, 185-195.

McKenry, M. V., 1994. Nematodes of Olive. Pages 97-99 in: Olive Production Manual. L. Ferguson, G. S. Sibett, and G. C. Martin, eds. University of California, Oakland, Publ. 3353.

McLeod, R., Reay, F., & Smyth, J., 1994. Plant nematodes of Australia listed by plant and by genus 201 pp.

Mehta, U. K., & Raski, D. J., 1971. Revision of the genus *Criconema* Hofmänner and Menzel, 1914 and other related genera (Criconematidae: Nematoda). Indian J. Nematol. 1, 145-198.

Melakerberhan, H., & Webster, J. M., 1993. The phenology of plant-nematode interaction and yield loss. Pp. 26–41 in M. M. Khan, ed. Nematode interactions. London: Chapman and Hall.

Ministerio de Agricultura, Servicio Agrícola y Ganadero. 2007. Regulaciones para la importación de material de reproducción de olivo (*Olea europaea* subsp. *europaea*) procedente de los estados miembros de la Comunidad Europea. No. 2425.

Ministerio de Medio Ambiente y Medio Rural y Marino (MARM). 2009. Registro de Productos Fitosanitarios.http://www.mapa.es/es/ agricultura/ pags/fitos/registro/menu.asp

Ministero delle politiche agricole, alimentari e forestali. 2009. Fitofarmaci e Sostanze Attive. http://www.sian.it/fitovis/

Minz, G., 1961. Additional hosts of the root-knot nematode, *Meloidogyne* spp., recorded in Israel during 1958-1959. Ktavim, 11, pp. 69-70.

Minz, G., Strich-Harari, D., & Cohn, E., 1963. Plant-parasitic nematodes in Israel and their control. 84 p. in Hebrew.

Navas, A., Bello, A., & Arias, M., 1988. Ecology and potential distribution of *Xiphinema diversicaudatum* and *X. pachtaicum* (Nematoda: Longidoridae) in continental Spain. Nematologica, 34(3), 314-330.

Nejad, S. A. H., Maafi, Z. T., & Barooti, S. 1997. Nematodes associated with olive trees (*Olea europaea* L.) in Iran. Appl. Entomol. Phytopathol. 65, 10-12.

Nico, A. I., Jiménez-Díaz, R. M., & Castillo, P., 2003a. Host suitability of the olive cultivars Arbequina and Picual for plant-parasitic nematodes. Journal of Nematology, 35(1), 29.

Nico, A. I., Jiménez-Díaz, R. M., & Castillo, P. 2003b. Solarization of soil in piles for the control of *Meloidogyne incognita* in olive nurseries in southern Spain. Plant Pathol. 52, 770-778.

Nico, A. I., Jiménez-Díaz, R. M., & Castillo, P. 2004. Control of root-knot nematodes by composted agro-industrial wastes in potting mixtures. Crop Prot. 23, 581-587.

Nico, A. I., Rapoport, H. F., Jiménez-Díaz, R. M., & Castillo, P., 2002. Incidence and population density of plant-parasitic nematodes associated with olive planting stocks at nurseries in southern Spain. Plant disease, 86(10), 1075-1079.

Nicol, J. M., Turner, S. J., Coyne, D. L., Nijs, L. D., Hockland, S., & Maafi, Z. T., 2011. Current nematode threats to world agriculture. Genomics and molecular genetics of plant-nematode interactions, 21-43.

Owen, R. W., Mier, W., Giacosa, A., Hull, W. E., Spiegelhalder, B., Bartsch, H., 2000. Phenolic Compounds and Squalene in Olive Oils: The Concentration and Antioxidant Potential of 95 Total Phenols, Simple Phenols, Secoiridoids, Lignans and Squalene. Food and Chemical Toxicology, 38(2000), 647-659.

Özarslandan, A., & Elekcioğlu, İ. H., 2010. Türkiye'nin farklı alanlarından alınan Kök-ur nematodu türlerinin (*Meloidogyne* spp.) (Nemata: Meloidogyni-

dae) moleküler ve morfolojik tanılama ile belirlenmesi1. *Türkiye entomoloji dergisi*, *34*(3), 323-335.

Özdemir, F. G. G., 2022. Bazı bitki besin elementlerinin bitki paraziti nematodlar üzerine etkisi. Bartın University International Journal of Natural and Applied Sciences, 5(2), 114-121.

Öztürk, 2020. Trakya bölgesi meyve ve bağ alanlarındaki nematod türlerinin belirlenmesi ve virus nematod ilişkilerinin araştırılması. Çukurova Üniversitesi, Fen Bilimleri Enstitüsü, Bitki Koruma Ana Bilim Dalı, Doktora Tezi. 469 s.

Öztürk, L., 2023. Community structure of nematodes in olive growing areas in İzmir, Manisa, Balıkesir, and Çanakkale provinces, Türkiye. *Harran* Tarım ve Gıda Bilimleri Dergisi, 27(2), 175-188.

Palomares-Rius, J. E., Castillo, P., Montes-Borrego, M., Müller, H., & Landa, B. B., 2012. Nematode community populations in the rhizosphere of cultivated olive differs according to the plant genotype. Soil Biology and Biochemistry, 45, 168-171. https://doi.org/10.1016/j.soilbio.2011.11.009

Peña Santiago, R., Castillo, P., Escuer, M., Guerrero, P., Talavera, M., & Vieira, P., 2004. Tylenchid species (Nematoda, Tylenchida) recorded in the Iberian Peninsula and the Balearic Islands: A Compendium. Servicio de Publicaciones, Universidad de Jaén, Spain.

Peña-Santiago, R., 1990. Plant-parasitic nematodes associated with olive (*Olea europea* L.) in the province of Jaen, Spain, Rev. Nematol. 13, 113-115

Pérez, B. A., Barreto, D., Docampo, D., Otero, L., Costilla, M., Roca, M., & Babbitt, S. (2001). Current status of the drying syndrome (seca) of olive trees in Argentina. Phytopathology, 91(6), S71.

Philis, J., & Siddiqi, M. R., 1976. A list of plant-parasitic nematodes in Cyprus. Nematologia mediterranea. 4, 171-174.

Pinochet, J., S. Verdejo, and J. Marull. 1991. Host suitability of eight *Prunus* spp. and one *Pyrus* communis rootstocks to *Pratylenchus vulnus*, *P. neglectus*, and *P. thornei*. Journal of Nematology 23:570–575.

Roca, F., & Lamberti, F., 1988. *Xiphinema aequum* sp. n.(Nematoda: Dorylaimida) from Italy, with description of the male of *Longidorus eridanicus*. Nematologia mediterranea.

Romero, M. D., & Arias, M. (1969). Nematodes of solanaceous plants cultivated in the southern Spanish Mediterranean area. 1. Tylenchida. Boln R. Soc. esp. Hist. nat. (Biol.) 67, 121-142.

Rossi, C. E., & Ferraz, L. C. C. B., 2005a. Fitonematoides das superfamílias Criconematoidea e Dorylaimoidea associados a fruteiras de clima subtropical e temperado nos Estados de São Paulo e Minas Gerais. Nematologia Brasileira, 29(2), 183-192.

Rossi, C. E., & Ferraz, L. C. C. B., 2005b. Plant-parasitic nematodes of the superfamily Tylenchoidea associated with subtropical and temperate fruits in the States of São Paulo and Minas Gerais, Brazil. Nematol. Bras. 29, 171-182.

Saad, A. T., & Nienhaus, F., 1969. Plant diseases in Lebanon. Zeitschrift für Pflanzenkrankheiten (Pflanzenpathologie) und Pflanzenschutz, 537-551.

Sanei, S., & Okhovvat, S., 2011. Incidence of plant-parasitic nematodes associated with olive planting stocks at nurseries in northern Iran. Int. J. Appl, 1, 79-82.

Santiago, R. P., & Geraert, E., 1990. New data on *Aorolaimus perscitus* (Doucet, 1980), and *Gracilacus teres* Raski, 1976 (Nematoda: Tylenchida) associated with olive (Olea europaea L.) in the province of Jaén, Spain. 36(1), 408-416.

Santos, M. D. A., & Abrantes, I. D. O., 1980. Root-knot nematodes in Portugal. In Proceedings of the Second Research Planning Conjhrence on Root-knot Nematodes, *Meloidogyne* spp., pp. I7 23. Athens (GR).

Santos, N., 1982. Studies on root-knot nematodes, *Meloidogyne* spp. from olive trees in Portugal. in: Nematologica, E. J. Brill, Leiden, The Netherlands, (169 p.).

Sasanelli, N., Coiro, M. I., D'addabbo, T., Lemos, R. J., Ridolfi, M., & Lamberti, F., 1999. Reaction of an olive cultivar and an olive rootstock to *Xiphinema index*. Nematologia Mediterranea, 27(2), 253-256.

Sasanelli, N., D'Addabbo, T., Dell'Orco, P., and Mencuccini, M. 2000. The in vitro use of olive explants in screening trials for resistance to the root-knot nematode, *Meloidogyne incognita*. Nematropica 30, 101-106.

Sasanelli, N., D'Addabbo, T., & Lemos, R. M., 2002. Influence of *Meloidogyne javanica* on growth of olive cuttings in pots. Nematropica, 32, 59-63.

Sasanelli, N., Fontanazza, G., Lamberti, F., D'Addabo, T., Patumi, M., & Vergari, G., 1997. Reaction of olive cultivars to Meloidogyne species. *Nematologia mediterranea*, 25, 183-190.

Sasser, J. N., & Freckman, D. W., 1987. A world perspective on nematology: the role of the society.

Sasser, J.N., & Carter, C.C. 1985. An advenced treatise on *Meloidogyne* spp. Volume I:Biology and Control. North Carolina State University Graphics. 1-442 p

Satmaz, D., 2012. Hatay ili tarım alanlarında önemli kültür bitkilerinde zararlı bitki paraziti nematot türleri. Çukurova Üniversitesi, Fen Bilimleri Enstitüsü, Bitki Koruma Ana Bilim Dalı, Yüksek Lisans Tezi. 70 s.

Scognamiglio, A., Talame, M., & Giandomenico, N., 1968. Indagine sui nematodi viventi nella rizosfera dell'olivo (1 contributo). *Boll. Lab. Ent. Agr*, *26*, 205-226.

Serr, E. F., & Day, L. H., 1949. Lesion nematode injury to California fruit and nut trees, and comparative tolerance of various species of Juglandaceae. Proceedings of the American Society,for Horticultural Science 53, 34-140.

Sethi, C. L., Gaur, H. S., Kaushal, K. K., Srivastava, A. N., & Khan, E., 1988. Occurrence of root-knot nematodes on fruit plants in association with *Agrobacterium tumefaciens*. Int. Nematol. Netw. Newslett. 5, 12-13.

Shawky, S. M., El-Sawi, M. A. M., & Nabil, Y. M., 2004. Effect of some nematicides on controlling root knot nematodes and determine their residues in olive fruits and soil. Ann. Agric. Sci. (Cairo) 49, 389-399.

Sher, S. A., 1966. Revision of the Hoplolaiminae (Nematoda). VI. *Helicotylenchus* Steiner, 1945. Nematologica 12, 1-56.

Siddiqi, M. R., 1976. New plant nematode genera *Plesiodorus* (Dolichodorinae), *Meiodorus* (Meiodorinae subfam. n.), *Amplimerlinius* (Merliniinae) and *Gracilancea* (Tylodoridae grad. n.). *Nematologica*, *22*(4), 390-416.

Sobreiro, J., & Reis, C. J., 2008. Guia dos Produtos Fitofarmacêuticos - Condições de Utilização -Insecticidas, Fungicidas e Outros. DGPC, Oeiras, PPA (H/D) 2/99.

Somova, L. I., Shode, F. O., Ramnanan, P., & Nadar, A., 2003. Antihypertensive, antiatherosclerotic and antioxidant activity of triterpenoids isolated from *Olea europaea*, subspecies africana leaves. Journal of Ethnopharmacology, 84, 299-305.

Soni, M. G., Burdock, G. A., Christian, M. S., Bitler, C. M., & Crea, R., 2006. Safety assessment of aqueous olive pulp extract as an antioxidant or antimicrobial agent in foods. Food Chem Toxicol., 44, 903-915.

Stukenbrock, E. H., & McDonald, B. A. 2008. The origins of plant pathogens in agroecosystems. Annu. Rev. Phytopathol. 46, 75-100.

Sturhan, D., 1989. Species of *Trichodorus* (Nematoda: Trichodoridae) from Portugal. Revue Nématol, 12(3), 219-233.

Talavera, M., & Tobar Jimenez, A., 1997. Plant-parasitic nematodes from unirrigated fields in Alhama, southeastern Spain. Nematologia mediterranea, 25, 73-82.

Tarjan, A. C., 1953. Geographical distribution of some *Meloidogyne* spp. in Israel. Plant Dis. Rep. 37, 315-316

Tarjan, A. C., 1964. Plant-parasitic nematodes in the United Arab Republic. FAO Plant Protection Bulletin, 12, 49-56.

Tjamos, E. C., 1983. Prospects for controlling Verticillium wilt of olive trees by soil solarization. (Abstr.) Page 15 in: Hellenic Congress on Plant Diseases, Athens, Greece.

Tzortzakakis, E. A., Peneva, V., Brown, D. J. F., & Avgelis, A. D., 2008. A literature review on the occurrence of nematodes of the family Longidoridae in Greece. Nematologia mediterranea.36, 153-156

Ünsal, A., 2023. Ölmez ağacın peşinde Türkiye'de zeytin ve zeytinyağı, Yapı Kredi Yayınları, İstanbul, 344.

Vlachopoulos, E. G., 1991. Nematode species in nurseries of Greece. Ann. Inst. Phytapathol. Benaki. 115-122.

Vovlas, N. & Lamberti, F., 1974 [New hosts of *Rotylenclzulus macrodoratus* in the Mediterranean region.] Nematologiu Mediterranea 2, 177-1 79 (in Italian).

Vovlas, N., 1982. *Macroposthonia sicula* n. sp. (Nematoda: Criconematidae), a parasite of olive trees in Sicily. Journal of Nematology, 14(1), 95.

Vovlas, N., & Inserra, R. N., 1976. Istopatologia di radici di olivo infestate da *Rotylenchulus macrodoratus* Dasgupta, Raski et Sher. *Nematologia Mediterranea*. 4, 223-230.

Vovlas, N., & Inserra, R. N., 1981a. Notes on *Helicotylenchus dihystera* on Olive in Sicily. Inform. Fitopatol, 31, 23-25.

Vovlas, N., & Inserra, R. N., 1981b. Parasitic habits of *Ogma rhombosquamatum* and description of the male. Journal of Nematology, 13(1), 87.

Vovlas, N., & Inserra, R. N., 1983. Biology of *Heterodera mediterranea*. Journal of Nematology, 15(4), 571.

Whitehead, A. G., 1998. Plant Nematode Control. CABI, Wallingford, UK.

Yang, B. J., & Zhong, X. W., 1980. The identification of root-knot nematode in *Olea europaea* L. Sci. Silvae Sin. 16, 264-265.

Yıldırım, A. E., 2023. Hatay ilinde önemli kültür bitkilerinde bitki paraziti nematodların belirlenmesi ve popülasyon yoğunlukları. Hatay Mustafa Kemal Üniversitesi, Fen Bilimleri Enstitüsü, Bitki Koruma Ana Bilim Dalı, Doktora Tezi. 89 s.

Yıldız, V., 2012. Ödemiş (İzmir) ilçesi sert ve yumuşak çekirdekli meyve fidanlıklarında bulunan bitki paraziti nematod faunasının belirlenmesi. Çanakkale Onsekiz Mart Üniversitesi, Fen Bilimleri Enstitüsü, Bitki Koruma Ana Bilim Dalı, Yüksek Lisans Tezi. 79 s.

Zari, A., Khozeini, F., Barouti, S., & Zamanizadeh, H., 2011. Detection and distribution of Root-lesion nematodes (Pratylenchidae) on fruit trees in Northeast regions of Iran. In *Phytopathology* (Vol. 101, No. 6, pp. S175-S175).

Zohary, D., & Spiegel-Roy, P. 1975. Beginnings of fruit growing in the Old World. Science 187, 319-327.

Zunke, U. 1990. Observations on the invasion and endoparasitic behavior of the root lesion nematode *Pratylenchus penetrans*. J. Nematol. 22, 309-320.