EPPO Datasheet: *Xiphinema americanum sensu lato*

Last updated: 2023-10-10

Datasheets on *Xiphinema americanum sensu stricto, Xiphinema bricolense, Xiphinema californicum* and *Xiphinema rivesi* are also available in Global Database.

IDENTITY

Preferred name: *Xiphinema americanum sensu lato*
Authority: Cobb
Taxonomic position: Animalia: Nematoda: Enoplea: Dorylaimida: Longidoridae
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EPPO Code: XIPHAM

Notes on taxonomy and nomenclature

The group known as *Xiphinema americanum sensu lato* (*s.l.*) is considered to comprise 64 nominal species (EPPO, 2017; Mobasseri *et al*., 2019; Lazarova *et al*., 2019; Vazifeh *et al*., 2019). Both morphologically and biochemically, most members of the group are difficult to distinguish and there remains considerable taxonomic debate regarding the number of species assigned to the group (Coomans *et al*., 2001). For this reason, much phytosanitary legislation in Europe continues to list all species assigned to *X. americanum s.l.* (non-European populations). Investigations into the identity of *X. americanum s.l* began in 1979 when Lamberti & Bleve-Zacheo studied populations from disparate geographical areas and concluded that there were in fact 25 different species, 15 regarded as new. Subsequently, new studies and standard virus transmission tests were required to confirm the identity of those species that transmitted viruses (Trudgill *et al*., 1983).

This datasheet considers the group, *X. americanum s.l.* However, as the quarantine significance of these nematodes derives primarily from the ability to transmit important North American viruses, the datasheet concentrates on the few species which have been demonstrated to be vectors. Several other species, not shown to be vectors, have been reported to be present in the EPPO region. They are also mentioned in this datasheet, as they were previously referred to as *X. americanum* and it is necessary to indicate clearly that they are distinct from the vector species and, as a consequence, have no quarantine significance for the EPPO region. These species are *X. brevicolle* Lordello & Da Costa, *X. pachtaicum* (Tulaganov) Kiryanova (=*X. mediterraneum* Martelli & Lamberti), *X. incertum* Lamberti, Choleva & Agostinelli, and *X. simile* Lamberti, Choleva & Agostinelli.

HOSTS

X. americanum s.l. appears to be non-specific with regard to host plants, having been recorded from agricultural, horticultural and forest soils. The host plants of particular quarantine significance are those to and from which *X. americanum s.l.* transmits viruses. The host range is wide including mainly woody hosts.

GEOGRAPHICAL DISTRIBUTION

Nematodes belonging to *X. americanum s.l.* occur in Africa and are widespread in Asia, Central and South America, Europe and North America. They have been found infrequently in Australasia and Oceania (EPPO, 2017).

BIOLOGY

Nematodes belonging to *X. americanum s.l.* are migratory ectoparasites and spend their entire life cycle in the soil, moving in the moisture film covering soil particles. The individuals appear to be attracted to young growing roots

where they feed by puncturing, with their stylet, several successive layers of cells and extracting cytoplasm. Females produce eggs parthenogenetically (males being rare or absent) and, in most populations, four juvenile stages are produced; among the North American populations, however, three juvenile stages only are commonly found (Brown *et al.*, 1994). The life cycle requires at least 1 year to complete. Optimum temperatures for reproduction are 20-24°C (Hunt, 1993). There is no specialized survival stage and all stages have been found to survive and mature in soil in the absence of a host, but the population will not multiply. The nematode does not survive long periods in frozen soil, and in areas of low winter temperatures overwintering is mainly in the egg stage. Where the soil is not frozen, all stages can survive the winter.

In North America, *X. americanum s.l.* species are efficient vectors of several viruses, with adults and juvenile stages able to transmit virus (McGuire, 1964; Teliz *et al*., 1966). When the nematode feeds on a virus-infected plant, virus particles are extracted from the cells within the cytoplasm, and these adhere to the lining of the stylet and pharynx. The virus particles are injected into the next healthy plant on which the the nematode feeds and nematodes may transmit virus acquired up to 2 years previously (Bitterlin & Gonsalves, 1987).

Although, direct damage by *X. americanum sensu stricto* (*s.s.*) appears to be economically important in several states in the United States (CABI, 2022), the importance of the group overall is due to the ability of some species to transmit economically important viruses. Brown *et al.* (1994) reported that *X. americanum s.s.*, *Xiphinema californicum* and *Xiphinema rivesi* transmit cherry rasp leaf virus (CRLV) (*Cheravirus*), tobacco ringspot virus (TRSV) (*Nepovirus*) and tomato ringspot virus (ToRSV) (*Nepovirus*) and noted the broad-spectrum virus transmission capabilities of these North American populations compared with the relatively narrow specificity of transmission that exists between indigenous European viruses and their vector species. Stobbs & Van Schagen (1996) reported *X. rivesi* as a vector of peach rosette mosaic virus (PRMV) (*Nepovirus*) by recovering 4 *X. rivesi* nematodes per litre of soil sampled around the roots of PRMV infected vines, however, vector association does not fulfil standard transmission test criteria (Taylor & Brown, 1997). *Xiphinema bricolense* was shown to transmit only the two serologically distinguishable strains of ToRSV but was a more efficient vector of the peach stem pitting (PSP) strain than the prune line (PBL) strain of the virus. *Xiphinema tarjanense* and *Xiphinema intermedium* are both reported to vector TRSV and ToRSV, and *Xiphinema inaequale* has been shown to vector ToRSV (Verma *et al*., 2003). CRLV, PRMV TRSV and ToRSV are listed as recommended for regulation by EPPO. Until recently, no European populations of *X. americanum s.l.* had been shown to transmit these viruses; however, Sirca *et al.* (2007) reported transmission of TRSV and ToRSV to bait plants by a Slovenian population of *X. rivesi* with no known links to imported consignments.

DETECTION AND IDENTIFICATION

An EPPO diagnostic protocol is available for the identification of *Xiphinema americanum sensu lato* (EPPO, 2017) as well as an IPPC Diagnostic Protocol (IPPC, 2016).

Symptoms

Plants roots attacked by *X. americanum s.l.*, in the absence of a virus, generally exhibit no clear characteristic symptoms in the aerial parts. Symptoms are most often similar to those resulting from environmental stresses. With high populations, a general reduction in vigour is observed and this appears in characteristic patches in the crop corresponding to the highest concentration of nematodes (Heve *et al*., 2015). When nematode feeding results in virus transmission the characteristic symptoms of the particular virus develop in the crop. These usually first appear in the aerial parts of the plant in the growing season after transmission to the roots has occurred. However, some host plants remain symptomless after infection and therefore may escape detection (NVWA, 2010).

Morphology

These nematodes are minute soft-bodied, vermiform and almost transparent. They have a hard, needle-like 'stylet' (odontostyle and odontophore) at the mouth-end of the body. The following combination of characters distinguishes members of *X. americanum s.l.* from other *Xiphinema* species; however, characters marked with an asterisk (*) are seldom observed in those species considered to be part of a *Xiphinema pachydermum*-group based on morphology: body length small to medium (length varies from 1.2 to 3.0 mm); body shape assumes a more or less open C to spiral

shape when heat-relaxed; lip region rarely continuous, usually demarcated by a shallow depression or deep constriction; guide ring more anterior and the folded part of the guiding sheath shorter than in other *Xiphinema* species; odontostyle robust, length rarely exceeds 150 µm; pharyngeal bulb usually with thick platelet reinforcements of the lumen wall (bulb not offset from the rather wide slender part); nuclei in the pharyngeal bulb: dorsal nucleus is often recorded as further from the dorsal orifice and the subventral nucleus is placed more posteriorly than in other *Xiphinema* species; V% around or behind the middle of the body (V% = 42–65); female genital branches equally developed but generally short (short or very short uteri without Z-differentiation or spines and usually with weakly developed sphincter muscles*); compact ovaries, comprising rather few and narrow germ cells and typically associated with verrucomicrobial endosymbionts*; tail short, conoid, rounded to slightly digitate, rarely broadly rounded; tail terminus generally pointed or rounded; males rare, females devoid of sperm*; male usually with 5–11 ventromedian supplements, with the most posterior lying closer to the paired precloacal papillae (adanal papillae) than in other *Xiphinema* species (i.e. within spicula range); three or four juvenile stages (EPPO, 2017).

Detection and inspection methods

X. americanum s.l. can be detected by extraction from soil or growing media (as is the case for most ectoparasitic plant?parasitic nematodes). Nematode extraction techniques, such as the Flegg?modified Cobb technique (Flegg, 1967) or Oostenbrink (Oostenbrink, 1960) or other suitable elutriation methods can be used for extraction of longidorid nematodes. Migratory endoparasites may also be present in soil residues adhered to plant roots, bulbs and tubers. Consequently, *X. americanum s.l.* may be found following processing of plant material using other methods such as modified Baermann processes. Detailed descriptions of extraction equipment and procedures can be found in EPPO PM 7/119 Nematode extraction (EPPO, 2013). After extraction, nematodes are examined using high-power microscopy in order to identify the specimens.

PATHWAYS FOR MOVEMENT

X. americanum s.l. species spend their entire life cycle in the soil, feeding on the roots of host plants. These nematodes can live only in moist soil and in that medium can move at most 1 m per year, unless assisted by run-off. Bare rooted plants free from soil are not a pathway for movement. The pest is transported solely in soil associated with plants for planting, plant products (such as, soil associated with ware potatoes), bulk soil and any other goods contaminated with soil. Spread over longer distances is possible in moist soil transported with or without plants. Soil and growing media attached to (agricultural) machinery, tools and packaging materials may also constitute a pathway for movement, but such soil may dry out and consequently lead to reduced viability of the pest.

PEST SIGNIFICANCE

Economic impact

Nematodes within this group are most important as a vector of the following American viruses (Taylor & Brown, 1981), which are important mainly on fruit crops: ToRSV, TRSV, CLRV, and PRMV. Soybean severe stunt nepovirus is a relatively minor North American pathogen also reported to be transmitted by *X. americanum s.l.*

Transmission of viruses is the major cause of damage. In the EPPO region, *X. pachtaicum* and other *Xiphinema* spp. of the *americanum* group are not reported to cause any significant damage (Lamberti & Siddiqi, 1977), nor to transmit viruses. Transmission of PRMV by *X. rivesi* has never been independently confirmed in transmission tests. It is implied that PRMV is only transmitted by *X. americanum s.l.*, (see biology). In many areas of North America, *X. rivesi* occurs more frequently than *X. americanum s.s.* and is the most widespread *X. americanum* group species (Robbins & Brown, 1991). In the EPPO region, transmission of nepoviruses by *X. rivesi* in the field has not been reported. Under experimental conditions, the ability to transmit ToRSV and TRSV has been shown in Slovenia (Širca *et al*., 2007). Similarly, a population of *X. rivesi* population from Chile, was shown to transmit ToRSV (Auger *et al*., 2009). It is assumed that the *X. rivesi* populations present in other areas in the EPPO region may also transmit these viruses but so far this has not been reported.

Both ToRSV and TRSV have wide host ranges. A review of effects of the viruses on economically important crops was performed by NVWA (2010) and is summarized here. Adverse economic effects caused by ToRSV are

principally related to fruit crops, particularly grapes and raspberries. In grapes, yield reductions of between 37 and 63% were reported in vineyards in New York, USA. Fifty percent yield reductions were reported in some raspberry cultivars whilst other cultivars were unaffected. ToRSV was also implicated in apple union necrosis and decline in American apple orchards. Severe losses have also been reported on blueberry in New York and peach in Pennsylvania. The virus is known to infect species of *Prunus* (cherries and plum), *Ribes* and *Rubus* (some cultivars) but no reduction in yield has been reported in these crops. Among the horticultural crops ToRSV has been reported to produce symptoms on leaves of pelargonium, making plants unmarketable. In Türkiye, symptoms of infection were reported on wild blackberry plants, however, not in neighbouring peach orchards (Sertkaya, 2010). In Lithuania, ToRSV was detected in 4.6% of one raspberry cultivar (Stankiene *et al*., 2012), but impacts due to the virus infection are unknown. TRSV causes yield losses in soybean and blueberries in the USA. Serious losses were also reported in grapes in vineyards affected by a dual infection of TRSV and ToRSV. The virus also affects cucurbits but causes only minor damage to these crops. Elsewhere, 60-80% yield losses were reported in aubergine in India and minor losses were reported in capsicum in Mexico (FERA, 2014).

After introduction into the production area, the virus associated with its vector will spread slowly since the nematodes will spread naturally 1 m at maximum per year. The virus and its vector may spread over longer distance mainly with trade of plants with soil attached but the total infested area will however increase slowly. Thus, in the short term, e.g. the first 10 years after introduction the impact is assessed to be low and impact may occur only very locally. In the long term (decades), the virus-vector combination is expected to spread further mainly by human assistance and the impact may become similar to that in the USA where both the virus and vector are present. In Europe the impact of ToRSV and TRSV in combination with the vector may become higher than in the USA because of the limited availability of soil fumigants in EPPO countries (e.g. EU countries). The potential impact of the viruses in combination with the vector in Europe was assessed as follows (NVWA, 2010):

- - ToRSV: high impact for several fruit crops.
  - TRSV: high impact for blueberry and probably also for grapes.
  - CLRV: low impact.
  - PRMV: low impact.

Control

Control of viruliferous nematodes in the field is problematic. Disinfection of soil can be carried out by physical (heat, steam) or chemical (nematicides) treatments, however the efficacy of these measures is limited (it is considered that the efficacy never reaches 100%) and the nematodes that remain in the soil can still transmit viruses to the roots of the host plants (EFSA, 2018). Soil disinfection by physical treatments does not eliminate nematodes under field conditions due to the vertical distribution (depth) of the nematode which depends on availability of roots of host plants and moisture regime (EFSA, 2018). The use of nematicides is restricted in EPPO countries (e.g. EU countries) and at present, no methods are available to control nematode populations in an established orchard (NVWA, 2010).

Keeping the soil free from plants for over 2 years will significantly reduce the nematode population.

Phytosanitary risk

The main phytosanitary risk lies in the known potential of certain species of *X. americanum s.l.* to transmit the four American viruses (ToRSV, TRSV, CLRV, and PRMV) which are also on the EPPO lists of pests recommended for regulation as quarantine pests. These nematode species may introduce these viruses. If the viruses were introduced or spread further in the EPPO region, introduction of the vector nematodes would increase the risk of spread, and more complex measures for the certification of virus-free material of fruit crops would be needed. Populations of these nematodes from outside the EPPO region, especially those from North America, could establish and spread within the EPPO region. Only *X. americanum s.s.*, *X. bricolense*, *X. californicum* and *X. rivesi* are known vectors of the American viruses and thus qualify as pests to be recommended for regulation for the EPPO region.

PHYTOSANITARY MEASURES

It can be recommended that import of soil from non-EPPO countries where *X. americanum s.l.* species occur should be prohibited. Plants with roots may also be prohibited from import or precautions should be taken to ensure that the nematodes will not be carried in the roots. The field from which the plants originate should have been tested and found to be free from the nematodes and, if the plants were in a growing medium, this medium should be either inorganic or have been tested, or treated against nematodes. If this is not the case, soil or growing medium attached to the plants can be removed and after removal, the plants can be repotted in pest-free soil or growing medium before export. Plants should then have been kept under special conditions to avoid the risk of reinfestation.

Soil or growing medium can be treated to kill nematodes by heating to 60°C and maintaining at that temperature for 1 h.

The use of certified or tested plants for planting, grown under conditions that ensure pest freedom reduces the risk of introducing and spreading of viruses not present or having a limited distribution in the region, and of their vector nematodes. Only planting material originating from areas where the nematodes have not been reported, and where surveillance is carried out to confirm the absence of the pest (Pest Free Area, Pest Free Production Site) can be declared as pest free material.

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Datasheet history

This datasheet was first published in the EPPO Bulletin in 1984 and revised in the two editions of 'Quarantine Pests for Europe' in 1992 and 1997, as well as in 2023. It is now maintained in an electronic format in the EPPO Global Database. The sections on 'Identity', ‘Hosts’, and 'Geographical distribution' are automatically updated from the database. For other sections, the date of last revision is indicated on the right.

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