EPPO Datasheet: *Aphelenchoides besseyi*

Last updated: 2020-07-24

IDENTITY

Preferred name: *Aphelenchoides besseyi*
Authority: Christie
Taxonomic position: Animalia: Nematoda: Chromadorea: Rhabditida: Aphelenchoididae
Other scientific names: *Aphelenchoides oryzae* Yokoo, *Asteroaphelenchoides besseyi* (Christie) Drozdovski
Common names: rice leaf nematode, rice white-tip nematode, strawberry crimp disease nematode, white-tip nematode
view more common names online...
EPPO Categorization: A2 list
view more categorizations online...
EU Categorization: RNQP (Annex IV)
EPPO Code: APLOBE

more photos...

Notes on taxonomy and nomenclature

The taxonomy used in this datasheet reflects developments suggested by several recent publications, summarised in Decraemer & Hunt (2013), which place *Aphelenchoides* in the Order Rhabditida, Suborder Tylenchina. This contrasts with the taxonomy nomenclature occasionally used by some authors (such as the CABI Invasive Species Compendium CABI, 2019; Wheeler & Crow, 2020), which place *Aphelenchoides* in the Order Aphelenchida, Suborder Aphelenchina (Hunt, 1993). Whilst this makes no difference to classification from the level of Superfamily (Aphelenchoidea) to species level (*Aphelenchoides besseyi*), those studying the species might need to be aware of differences in the literature.

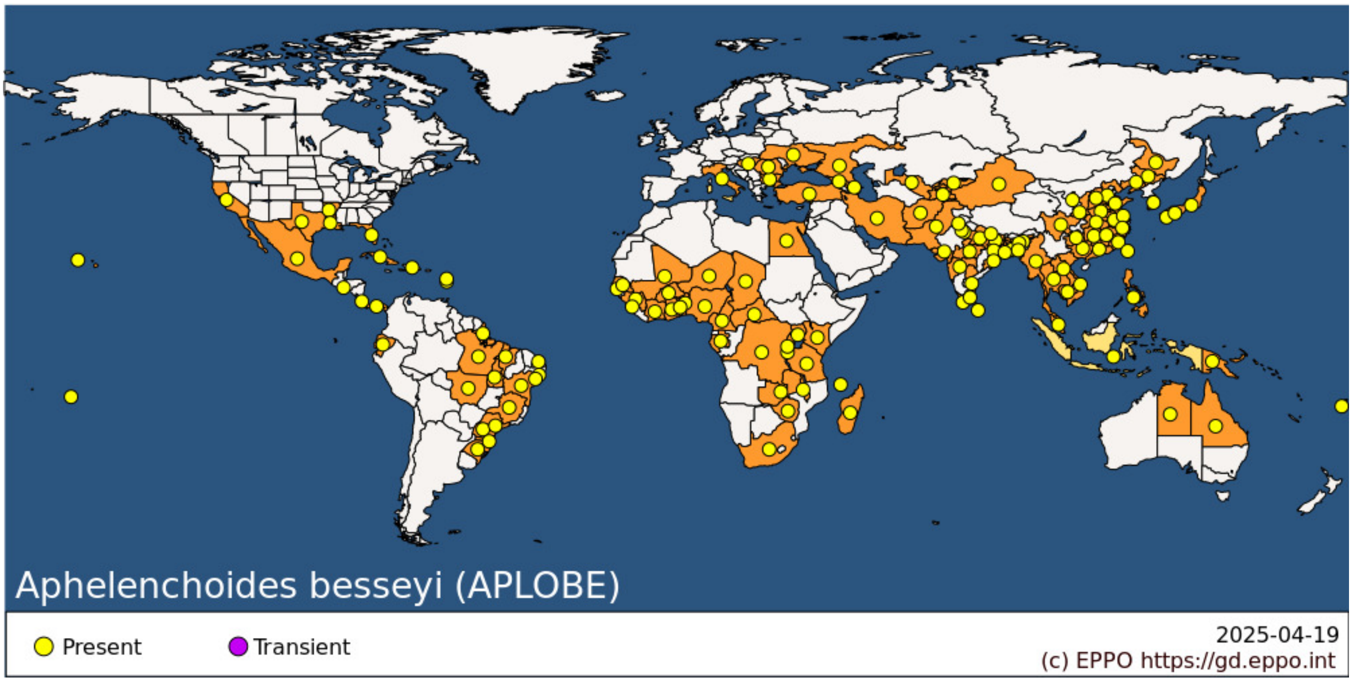
HOSTS

The main host plants at risk in the EPPO region are rice and strawberries. *A. besseyi* has also been found on other crop plants (including *Gossypium hirsutum*, *Capsicum annuum* var. *longum*, *Zea mays*) ornamental plants (including chrysanthemums, *Ficus elastica*, *Agave amica*), and grasses (including *Panicum*, *Setaria*). *Glycine max* appears to be a host of *A. besseyi* in laboratory tests (Oliveira *et al*., 2019) and was reported in field infestations (Meyer *et al*., 2017), but reports differ in the extent of the host susceptibility and subsequent damage. Extensive lists of plant groups that have been associated with *A. besseyi* in the literature are provided by Sanchez-Monge *et al*. (2015), but it should be noted that not all have necessarily been proven to be true hosts to date.

Host list: *Abelmoschus esculentus*, *Agave amica*, *Allium cepa*, *Asplenium nidus*, *Boehmeria nivea*, *Capsicum annuum* , *Chrysanthemum indicum*, *Colocasia esculenta*, *Dioscorea cayenensis*, *Dioscorea trifida*, *Ficus elastica*, *Fragaria x ananassa*, *Glycine max*, *Gossypium hirsutum*, *Ipomoea batatas*, *Oryza sativa*, *Panicum miliaceum*, *Phaseolus vulgaris*, *Setaria italica*, *Sporobolus junceus*, *Vigna unguiculata*, *Zea mays*

GEOGRAPHICAL DISTRIBUTION

A. besseyi has a wide geographic distribution, mostly in tropical and subtropical countries. In the EPPO region, it is reported in a few countries of the southern and eastern part of the region.



EPPO Region: Azerbaijan, Bulgaria, Georgia, Hungary, Italy (mainland), Kyrgyzstan, Romania, Russian Federation (the) (Southern Russia), Türkiye, Ukraine, Uzbekistan
Africa: Benin, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Comoros, Congo, The Democratic Republic of the, Cote d'Ivoire, Egypt, Gabon, Gambia, Ghana, Guinea, Kenya, Madagascar, Malawi, Mali, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, South Africa, Tanzania, United Republic of, Togo, Uganda, Zambia, Zimbabwe
Asia: Afghanistan, Bangladesh, Cambodia, China (Anhui, Fujian, Guangdong, Guangxi, Guizhou, Hebei, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Jiangxi, Jilin, Liaoning, Ningxia, Shaanxi, Shandong, Shanxi, Sichuan, Xinjiang, Zhejiang), India (Andhra Pradesh, Assam, Bihar, Delhi, Gujarat, Haryana, Jharkand, Kerala, Madhya Pradesh, Maharashtra, Meghalaya, Odisha, Punjab, Tamil Nadu, Tripura, Uttar Pradesh, West Bengal), Indonesia, Iran, Islamic Republic of, Japan (Honshu, Kyushu, Shikoku), Korea, Republic of, Kyrgyzstan, Lao People's Democratic Republic, Malaysia (West), Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Taiwan, Tajikistan, Thailand, Uzbekistan, Vietnam
North America: Mexico, United States of America (Arkansas, California, Florida, Hawaii, Louisiana, Texas)
Central America and Caribbean: Costa Rica, Cuba, Dominica, Dominican Republic, El Salvador, Guadeloupe, Panama
South America: Brazil (Alagoas, Amapa, Bahia, Maranhao, Mato Grosso, Minas Gerais, Para, Parana, Rio Grande do Norte, Rio Grande do Sul, Santa Catarina, Sao Paulo, Sergipe, Tocantins), Ecuador
Oceania: Australia (Northern Territory, Queensland), Cook Islands, Fiji, Papua New Guinea

BIOLOGY

On rice, infested seed is the primary inoculum source. When the crop is sown, the nematodes become active and move to the growing points of leaves and stems. *A. besseyi* is most active and feeds at a relative humidity greater than 70%, when symptoms are more likely to occur. At 30°C the life cycle is about 10 days and lengthens significantly at temperatures below 20°C. There is no development below 13°C (Bridge *et al*., 2005). The optimum temperature for development is 21-25°C, the life cycle taking 10 days at 21°C and 8 days at 23°C, and there are several generations in a season. There are many publications that mention *A. besseyi* ‘in the grain’, but they feed mainly ectoparasitically on young tissue (Duncan & Moens, 2013). Adult females congregate in the glume axis (i.e. under the husk of the seed rather than in the seed grain itself), where they respond to the end of the growing season by living in a quiescent state until conditions become favourable to start the life cycle again, which can be up to 3 years after harvest, on dry grain (Duncan & Moens, 2013; Huang & Huang, 1972). Reproduction is by amphimixis (cross-fertilisation with male and female nematodes) but this species can also reproduce parthenogenetically (Duncan & Moens, 2013).

The nematode survives between crops by obligate quiescence and there has been research to understand the mechanisms involved but more investigations are required (Chen *et al*., 2018). *A. besseyi* will die in 4 months on grain left in the field; the nematode is not thought to survive long periods in the soil between crops.

Mixed populations of plant-parasitic nematodes are usually found infesting plants and *A. besseyi* often occurs with another foliar nematode, *Ditylenchus angustus,* on rice. Thus, competition between the species may affect the biology of each species (Latif *et al*., 2013).

On strawberries, the nematode is also ectoparasitic, feeding on young tissue. In Florida, nematode infestations have been uncommon since the 1950s, but in 2016 they were recorded in a few fields in Central Florida (Desaeger and Noling 2017). Oliveira *et al*. (2019) suggest that *A. besseyi* has the potential to become an emerging problem for the Florida strawberry growers, but probably not as a serious problem as it was more than 60 years ago, because the infestations of the nematode observed in the field in 2018 were less serious than those in 2017. Re-occurrence of nematode was observed in the season 2018/2019, but overall damage and yield loss appeared minimal. Details of the life cycle in strawberry crops during the season and over the winter months need to be reassessed under current cultural conditions.

Regarding other hosts, more research is required to investigate how different populations interact with their hosts. It has been thought for some time that host races exist (Bridge *et al*., 2005). Hsieh *et al*. (2012) reported several instances where isolates from some hosts were either unable or able to multiply on other hosts, but that morphology of the species remained the same. Oliveira *et al*. (2019) suggested that *A. besseyi* may exist as a species complex as they found both morphological and molecular differences in different populations on different hosts. Other studies found different cellulases in this species, identified in different hosts (Wu & Chen, 2015; Wu *et al*., 2016).

DETECTION AND IDENTIFICATION

Symptoms

On rice

Susceptible and lightly infested plants can be symptomless (*A. besseyi* was found in panicles without white tip symptoms by Tülek & Çobanog?lu, 2010), but in general yield loss only occurs in plants showing symptoms on the tillers of the affected plants, where the tips of the leaves whiten for a distance of 3 to 5 cm, and then die off and shred. The panicles are shorter and often atrophied at the tips. The fertile flowers sometimes produce misshapen grains with low germination potential and delayed date of maximum germination. Affected plants have reduced vigour and height. Infected panicles are shorter with fewer spikelets and a smaller proportion of filled grain. In severe infestations, the shortened flagleaf is twisted and can prevent the complete extrusion of the panicle from the boot. Infestations reduce seed swelling, the grain is small and distorted and the kernel may be discoloured and cracked. Infested plants mature late and have sterile panicles borne on tillers produced from high nodes (Tülek *et al*., 2015; Bridge *et al*., 2005).

Symptoms may be confused with calcium and magnesium deficiency.

On strawberries

Symptoms include leaf crinkling and distortion, and dwarfing of the plant with an associated reduction in flowering (Desaeger & Noling, 2017).

On other hosts

A. besseyi may be endoparasitic, as in *Ficus elastica* and *Agave amica*, in which it causes leaf drop and leaf lesions, respectively. In the grass *Sporobolus poirettii*, the nematode stimulates growth, resulting in increased inflorescences (Marlatt, 1970).

Symptoms are further detailed in the EPPO Diagnostic protocol PM 7/39(2) (EPPO, 2017a).

Morphology

Typical *A. besseyi* have a slender body 0.44-0.84 mm long and 14-22 µm wide. In females, the excretory pore is usually near the anterior edge of the nerve ring; the spermatheca is elongate-oval and usually packed with sperm; the ovary is relatively short, the post-vulval uterine sac narrow, and the terminus bears a mucro of diverse shape with three to four processes (stellate). In males, the proximal end of the spicule lacks a dorsal process. The EPPO Diagnostic Protocol PM 7/39(2) (EPPO, 2017a) sets out the morphology as described in the original description of the species, along with other previously published data up to 2017. Oliveira *et al.* (2019) have recently provided more details of the morphometrics of an *A. besseyi* population found on strawberry in Florida and compared this with other *Aphelenchoides* considered by them as having stellate tails which helps to provide further clarity to the identification process.

There is currently (June 2020) much discussion on the identity of *A. besseyi* especially when it is suspected of occurring on crops other than rice. According to de Jesus *et al.* (2016), who studied populations in infested rice and forage crops, the identity of *A. besseyi* has often been confused with a morphologically similar species, *A. fujianensis* (Zhuo *et al.*, 2010), but their molecular investigations suggested the species were so similar they were in fact the same species. Buonicontro *et al*. (2018) investigated the identities of these species as identified in forage grass seed using real-time PCR but concluded further research was required. Oliveira *et al*., (2019), who investigated infestations of *A. besseyi* in strawberries using morphological and molecular tools (the latter not identical to those used by the previous authors), also reported that the species could be confused with other species with stellate mucros, namely *A. fujianensis* and a new species, *A. pseudogoodeyi*. They also suggested that *A. besseyi* is a complex of species. Other new species described as having stellate tails have also been described since the publication of the last edition of the EPPO Diagnostic protocol for this species (EPPO, 2017a), such as *A. medicagus* (Wang *et al*., 2019). There is clearly more research to be done concerning the identity of *A. besseyi* and those nematodes that are morphologically similar to it, especially because, at present, only *A. besseyi* is listed as a quarantine pest. Thus identification should be done in conjunction with a laboratory quality accredited in nematological identifications, using the latest findings in research.

Detection and inspection methods

Detection and identification methods are detailed in the EPPO Diagnostic protocol PM7/39(2) (EPPO, 2017a), which refers to a detection standard method, recently updated, used by the International Seed Testing Association (ISTA) method for use on rice (ISTA, 2020). Inspection of consignments of rice seed is covered in EPPO Phytosanitary Procedure PM 3/78(1) (EPPO, 2016).

Inspection of consignments of *Fragaria* plants for planting is covered in EPPO Phytosanitary procedure PM 3/73(1) (EPPO, 2008a, 2009), and inspection procedures for places of production are set out in EPPO Phytosanitary procedure PM3/83(1) (EPPO, 2017b).

The nematode may also be found in host plant detritus (EPPO, 2017a; Wheeler & Crow, 2020).

In relation to molecular methods, PCR tests and DNA barcoding can be used (EPPO, 2017a). Research on molecular methods to support the identification of *A. besseyi*, and to distinguish it from morphologically similar species, both in the laboratory and in the field, is on-going (Rybarczyk-Mydlowska *et al*., 2012; Sanchez-Monge *et al*. 2017; Buonicontro *et al*., 2018; Yang & Yu, 2018. Recently, Çelik & Devran (2019) and Çelik *et al*. (2020) developed a real-time PCR testbased on small subunit ribosomal DNA (SSU rDNA) of *A. besseyi,* and validated it successfully in populations collected from rice-growing fields in Turkey and subsequently developed a qualitative assay. Where molecular tools can also be used to support detection, the combined use of the 18S rRNA, 28S rRNA and COI genes appears to provide the most reliable support (Oliveira *et al*., 2019). Such developments in research will provide support for internationally approved protocols (IPPC, 2016; EPPO, 2017a).

PATHWAYS FOR MOVEMENT

A. besseyi is disseminated in plant material, such as infested rice seed (as it lives in a quiescent state under the hull), or associated with infested plants for planting of strawberries and other hosts. Locally, floods or irrigation water can spread the pest from infested hosts (Duncan & Moens, 2013).

PEST SIGNIFICANCE

Economic impact

A. besseyi makes a significant contribution to the estimated 16 billion USD worth of damage caused by nematodes to rice crops (Jones *et al*., 2013). The economic impact of this seed-borne nematode varies between regions, countries, and localities. Yield losses are also affected by the rice cultivar used, growing year, temperature, cultural practices and other variable factors (Tulek *et al*., 2015). In addition, Latif *et al.* (2013) found infestations of either *A. besseyi* or *D. angustus* alone resulted in greater disease incidence and greater yield reductions than mixed populations of these nematodes found in some fields, probably due to the effects of competition for feeding sites.

Generally, where little information on the pest status for *A. besseyi* exists, estimates for damage prediction have used the threshold of 300 live nematodes per 100 seeds, according to Bridge *et al*. (2005). However, research has resulted in conflicting data concerning the relationship between nematode density and yield loss. Tsay *et al*. (1998) reported yield losses of 24.2, 34.7, and 44.9% when the estimated infestation rate was 18, 34 and 57% respectively. Tülek *et al*. (2015) found a significant correlation between yield loss and observation of the white tip symptoms but not nematode density.

Recent work has proposed a prediction model for losses in field crops based on a significant correlation between mean yield reduction and nematode populations (Jamali *et al*., 2012). Where outbreaks have occurred in Japan, the economic value of infested, discoloured grain is reduced if infestation levels exceed 0.7%. In China, yield losses can be as high as 45% when plant infestation levels exceed 50%. In contrast, local cultivars in Thailand appear to be tolerant of *A. besseyi* and no symptoms have been observed despite widespread infestation (Bridge *et al*., 2005).

On strawberries, *A. besseyi* was recorded over 60 years ago in the USA as the incitant of summer dwarf or crimp disease, and causing much reduced strawberry fruit yields. Recent field infestations in the USA have been significant but often only temporary once control measures have been put in place; it is difficult to predict the financial impact that the loss of previously available control treatments will have on the industry (Wheeler & Crow, 2020).

Control

Prophylactic methods are of utmost importance. Seed treatments and resistant cultivars have significantly reduced the economic impact of this pest in some parts of the world (Duncan & Moens, 2013; Tülek *et al*., 2015). Cultural methods for rice include early planting if the rice season is preceded by a cooler period, and lower seedbed planting densities (Bridge *et al*., 2005).

Contrary to that which might be expected, good seed storage conditions probably prolong nematode survival, as more nematodes survive in seeds stored with low moisture than in seeds with high moisture levels at most temperatures. Nevertheless, clean seed remains the primary means of reducing infestation levels, together with the use of resistant cultivars (Bridge *et al*., 2005). For infested rice seeds a hot water treatment at 52-57°C for 15 min is recommended by the International Rice Research Institute to eradicate *A. besseyi* (Misra *et al*., 1994).

Chemical treatments of rice seeds and soil have been used in the past. Similarly, nematicides, applied either as foliar sprays or as soil treatments, can reduce the nematode population sufficiently to prevent symptom expression. However, few, if any, treatments still exist. The emphasis is now on sustainable production of crops.

Strawberry runners may also be treated prior to planting by immersion in water for 10 min at 46°C (EPPO, 2012). The nematode numbers can thus be markedly reduced but not always eliminated, and symptoms can be expected to be expressed in a later growing season. However, strawberry planting material should be free from nematodes; this is best achieved within a certification scheme, which produces planting material from nematode-free nuclear stock, and is a vital component in minimising the risk of infestation. *A. besseyi* is included in the EPPO certification scheme for strawberries PM 4/11(2) (EPPO, 2008b).

Phytosanitary risk

A. besseyi has the potential to be a significant pest outdoors in warmer climates of the EPPO region, as well as under protection in other parts of the region. It presents a risk particularly to rice, and possibly to strawberry and other hosts.

PHYTOSANITARY MEASURES

A. besseyi is listed on the EPPO A2 List of pests recommended for regulation as quarantine pests by EPPO. In addition, it was assessed during the EPPO RNQP Project to evaluate whether the pest was also fulfilling criteria for a RNQP, when not regulated as a quarantine pest (Picard *et al*., 2018). As recommended during this Project, *A. besseyi* is subject to a zero tolerance for rice seeds in the EU (as a RNQP) (EU, 2019). The Project suggested that the risk in strawberry plants could be managed along with the measures for other species of *Aphelenchoides* with tolerances for certified, basic and pre-basic material, and the absence of visual symptoms on the traded material for non-certified material. The pest is subject in the EU to a zero tolerance for plants for planting (except seeds) of strawberry (EU, 2019). Possible phytosanitary measures recommended for rice seeds in the EPPO RNQP Project (Picard *et al.*, 2018) and in EPPO Specific quarantine requirements (EPPO, 1995) for strawberry plants for planting (except seeds) included origin from a pest-free area or treatment. In addition, the EPPO RNQP Project recommended that rice seeds could be tested. Phytosanitary procedures for rice seeds are available for inspection of consignments (EPPO, 2016), and for strawberry plants for planting for inspection (EPPO, 2008a, 2009, 2017b), hot water treatment (EPPO, 2012) and certification schemes (EPPO, 2008b).

REFERENCES

Bridge J, Plowright RA & Peng D (2005) Nematode parasites of rice. In: *Plant parasitic nematodes in subtropical and tropical agriculture* (eds Luc M, Sikora RA & Bridge J), pp. 87-130.

Buonicontro DS, Roberts DM, Oliveira CMG, Blok VC, Neilson R & Oliveira RD'arcDL (2018) A rapid diagnostic for detection of *Aphelenchoides besseyi* and *A. fujianensis* based on real-time PCR. *Plant Disease* **102**, 519-526

CABI (2019) Datasheet. *Aphelenchoides besseyi* (rice leaf nematode). *Invasive Species Compendium*. CAB International, Wallingford, UK. https://www.cabi.org/isc/datasheet/6378#toidentity [Accessed 28 May 2020].

Çelik ES & Devran Z (2019) Identification and quantification of *Aphelenchoides besseyi* from rice using qPCR. *European Journal of Plant Pathology* **154**, 691–703.

Çelik ES, Tülek A & Devran Z (2020) Development of a novel scale based on qPCR for rapid and accurate prediction of the number of *Aphelenchoides besseyi* in paddy rice. *Crop Protection* **127**, 104975.

Chen Q, Wang F, Li D, Zhang R & Ling Y (2018) Trehalose metabolism genes render rice white tip nematode *Aphelenchoides besseyi* (Nematoda: Aphelenchoididae) resistant to an anaerobic environment. *Journal of Experimental Biology* **221**(4): jeb171413.

De Jesus DS, Oliveira CMG, Roberts D, Blok V, Neilson R, Prior T, Balbino HM, MacKenzie KM & Oliveira RDAL (2016) Morphological and molecular characterisation of *Aphelenchoides besseyi* and *A. fujianensis* (Nematoda: Aphelenchoididae) from rice and forage grass seeds in Brazil. *Nematology* **18**, 337-356.

Decraemer W & Hunt DJ (2013) Structure and Classification. In: *Plant Nematology*, 2nd Edition (eds Perry R & Moens M), pp. 32-37. CAB International.

Desaeger J & Noling J (2017) Foliar or bud nematodes in Florida strawberries. University of Florida IFAS Extension Publication ENY-068. https://edis.ifas.ufl.edu/in1184 [Accessed 14 July 2020].

Duncan LW & Moens M (2013) Migratory endoparasitic nematodes. In: Plant Nematology 2nd Edition (eds Perry RN & Moens M), pp.144-178. CAB International.

EPPO (1995) Specific Quarantine Requirements. 1995 Revised version of EPPO Technical Documents n°1008. European and Mediterranean Plant Protection Organization. [Available from the EPPO Secretariat on request]

EPPO (2008a) EPPO Standards PM 3/73(1). Phytosanitary procedures. Consignment inspection of *Fragaria* plants for planting. *EPPO Bulletin* **38**, 396–406.

EPPO (2008b) EPPO Standards PM 4/11(2). Schemes for the production of healthy plants for planting. Certification scheme for strawberry. *EPPO Bulletin* **38**, 430-437.

EPPO (2009) Corrigendum [to EPPO Standards, including EPPO Standards PM 3/73(1) EPPO Consignment inspection of *Fragaria* plants for planting]. *EPPO Bulletin* **39**, 486. Relevant part detailed in the last paragraph of the Corrigendum https://onlinelibrary.wiley.com/doi/epdf/10.1111/j.1365-2338.2009.02342_3.x

EPPO (2012) EPPO Standards PM 10/19(1) Phytosanitary Treatments. Hot water treatment of strawberry plants to control *Aphelenchoides besseyi* and *Aphelenchoides fragaria*. *EPPO Bulletin* **42**, 493-495.

EPPO (2016). EPPO Standards PM 3/78(1). Phytosanitary Procedures. Consignment inspection of seed and grain of cereals. *EPPO Bulletin* **46**, 49–57.

EPPO (2017a) EPPO Standards PM7/39(2) Diagnostics. *Aphelenchoides besseyi*. *EPPO Bulletin* **47**, 384-400.

EPPO (2017b) EPPO Standards PM 3/83(1). Phytosanitary Procedures. *Fragaria* plants for planting – inspection of places of production. *EPPO Bulletin* **47**, 349-365.

EPPO (2019) EPPO Standards PM 1/2 (28) General. *EPPO A1 and A2 Lists of pests recommended for regulation as quarantine pests.* https://www.eppo.int/media/uploaded_images/ACTIVITIES/plant_quarantine/pm1-002-28-en.pdf [Accessed 7 July 2020].

EU (2019) Commission Implementing Regulation (EU) 2019/2072 of 28 November 2019 establishing uniform conditions for the implementation of Regulation (EU) 2016/2031 of the European Parliament and the Council, as regards protective measures against pests of plants, and repealing Commission Regulation (EC) No 690/2008 and amending Commission Implementing Regulation (EU) 2018/2019. *Official Journal of the European Union* 10.12.2019, L319/1, 279 pp.

Hsieh S-H, Lin C-J, Chen P (2012) Sexual compatibility among different host-originated isolates of *Aphelenchoides besseyi* and the inheritance of the parasitism. *PLoS ONE* **7**(7): e40886. https://doi.org/10.1371/journal.pone.0040886 [Accessed 2 July 2020].

Huang CS & Huang SP (1972) Bionomics of white-tip nematode, *Aphelenchoides besseyi* in rice florets and developing grains. *Botanical Bulletin of Academia Sinica* **13**, 1-10. https://www.cabi.org/isc/abstract/19730804884 [Accessed 1 July 2020].

Hunt DJ (1993) Order Aphelenchida. In: *Aphelenchida, Longidoridae and Trichodoridae: Their Systematics and Bionomics*, pp. 30-160. CAB International.

IPPC (2016) Annex DP 17 to ISPM 27 - *Aphelenchoides besseyi*, *A. fragariae* and *A. ritzemabosi*. Rome, IPPC, FAO. https://www.ippc.int/static/media/files/publication/en/2016/11/DP_17_2016_En_2016-11-01_iaK6Hls.pdf [Accessed 18 June 2020].

ISTA (2020) Detection of *Aphelenchoides besseyi* in *Oryza sativa* (rice) seed. Version 7-025-6. International Rules for Seed Testing 2020. https://www.seedtest.org/upload/cms/user/ISTASHmethods20207-025.pdf (Accessed 2 July 2020).

Jamali S, Porjam E, & Safai N (2012) Determining the relationship between population density of white tip nematode and rice yield. *Journal of Agricultural Science and Technology*, **14**, 195-203.

Jones JT, Haegeman A, Danchin EGJ, Gaur HS, Helder J, Jones MGK, Kikuchi T, Manzanilla-Lopez R, Palomares-

Rius JE, Wesemael WML & Perry RN (2013) Top 10 plant-parasitic nematodes in molecular plant pathology. *Molecular Plant Pathology* **14**, 946-961.

Latif MA, Haque A, Tajul MI, Monsur MA & Rafii MY (2013) Interactions between the nematodes *Ditylenchus angustus* and *Aphelenchoides besseyi* on rice: population dynamics and grain yield reductions. *Phytopathologia Mediterranea* **52**, 490?500.

Marlatt RB (1970) Transmission of *Aphelenchoides besseyi* to *Ficus elastica* via *Sporobolus poiretii* inflorescences. *Phytopathology* **60**, 543-544.

Meyer MC, Favoreto L & Klepker D (2017) Soybean green stem and foliar retention syndrome caused by *Aphelenchoides besseyi*. *Tropical Plant Pathology* **42**, 403-409.

Misra JK, Mew TW & Huelma CC (1994) Seed Treatment. In: *A Manual of Rice Seed Health Testing* (eds Mew TW & Misra JK), p. 59. International Rice Research Institute. ISBN 971-22-0049-3.

Oliveira CJ, Subbotin SA, Ávarez-Ortega S, Desaeger J, Brito JA, Xavier KV, Freitas LG, Silvia V & Inserra RN (2019) Morphological and molecular identification two Florida populations of foliar nematodes (*Aphelenchoides* spp.) isolated from strawberry with the description of *Aphelenchoides pseudogoodeyi* sp.n. (Nematoda: Aphelenchoididae) and notes on their bionomics. *Plant Disease* **103**, 2825-2842.

Picard C, Afonso T, Benko-Beloglavec A, Karadjova O, Matthews-Berry S, Paunovic SA, Pietsch M, Reed P, van der Gaag DJ & Ward M (2018) Recommended regulated non-quarantine pests (RNQPs), associated thresholds and risk management measures in the European and Mediterranean region. *EPPO Bulletin* **48**, 552-568. Measures accessible from https://rnqp.eppo.int/recommendations/

Rybarczyk-Mydlowska K, Mooyman P, van Megen H, van den Elsen S, Vervoort M, Veenhuizen P, van Doorn J, Dees R, Karssen G, Bakker J & Helder J (2012) Small subunit ribosomal DNA-based phylogenetic analysis of foliar nematodes (*Aphelenchoides* spp.) and their quantitative detection in complex DNA backgrounds. https://apsjournals.apsnet.org/doi/10.1094/PHYTO-05-12-0114-R [Accessed 18 June 2020].

Sanchez-Monge A, Flores L, Salazar L, Hockland S & Wim Bert (2015) An updated list of the plants associated with plant-parasitic *Aphelenchoides* (Nematoda: Aphelenchoididae) and its implications for plant-parasitism within this genus. *Zootaxa* **4013**, 207-224.

Sánchez-Monge A, Janssen T, Fang Y, Couvreur M, Karssen G & Bert W (2017) mtCOI successfully diagnoses the four main plant-parasitic *Aphelenchoides* species (Nematoda: Aphelenchoididae) and supports a multiple origin of plant-parasitism in this paraphyletic genus. *European Journal of Plant Pathology* **148**, 853–866.

Todd EH & Atkins JG (1958) White tip disease of rice. I. Symptoms, laboratory culture of nematode and pathogenicity tests. *Phytopathology* **48**, 632-637.

Tsay TT, Cheng YH, Teng YC, Lee MD, Wu WS & Lin YY (1998). Bionomics and control of rice white tip disease nematode, *Aphelenchoides besseyi*. *Plant Protection Bulletin (Taipei)* **40**, 277-286.

Tülek A & Çobanog?lu S (2010) Distribution of the rice white tip nematode, *Aphelenchoides besseyi*, in rice growing areas in the Thrace region of Turkey. *Nematologica Mediterranea* **38**, 215–217.

Tülek A, Kepenekçi I, Çiftcigil T, Sürek H, Akin K & Kaya R (2015) Reaction of some rice cultivars to the white tip nematode, *Aphelenchoides besseyi*, under field conditions in the Thrace region of Turkey. *Turkish Journal of Agriculture and Forestry* **39**, 958-966

Wang Z, Bert W, Gu J, Couvreur M & Li H (2019) *Aphelenchoides medicagus* n.sp. (Tylenchida: Aphelenchoididae) found in *Medicago sativa* imported into China from the USA. *Nematology* **21**, 709-723.

Wheeler L & Crow WT (2020). Foliar nematode *Aphelenchoides* spp. (Nematoda: Aphelenchida: Aphelenchoididae). *University of Florida Entomology and Nematology Department, IFAS Extension Document EENY-749*. https://edis.ifas.ufl.edu/pdffiles/IN/IN127900.pdf [Accessed 28 May 2020].

Wu G & Chen PJ (2015) The profile of GHF5 and GHF45 cellulases in 14 *Aphelenchoides besseyi* isolates originated from different hosts. *Proceedings of the American Phytopathological Society 2015 Annual Meeting*. Pasadena, California, USA. https://www.apsnet.org/meetings/Documents/2015_meeting_abstracts/aps2015abP194.htm [accessed on 18 June 2020].

Wu G-L, Kuo T-H, Tsay T-T, Tsai IJ, Chen PJ (2016) Glycoside hydrolase (GH) 45 and 5 candidate cellulases in *Aphelenchoides besseyi* isolated from bird's-nest fern. *PLoS ONE* **11**(7): e0158663.

Yang JI & Yu GY (2018) A loop-mediated isothermal amplification assay combined with lateral flow dipstick for rapid detection of *Aphelenchoides besseyi*. *Phytopathology* **108**, Supplement 1.59.

Zhuo K, Cui R, Ye W, Luo M, Wang H, Hu X & Liao J (2010). Morphological and molecular characterization of *Aphelenchoides fujianensis* n.sp. (Nematoda: Aphelenchoididae) from *Pinus massoniana* in China. *Zootaxa* **2509**, 39-52.

ACKNOWLEDGEMENTS

This datasheet was extensively revised in 2020 by Sue Hockland. Her valuable contribution is gratefully acknowledged.

How to cite this datasheet?

EPPO (2025) *Aphelenchoides besseyi*. EPPO datasheets on pests recommended for regulation. Available online. https://gd.eppo.int

Datasheet history

This datasheet was first published in the EPPO Bulletin in 1981 and revised in the two editions of 'Quarantine Pests for Europe' in 1992 and 1997. 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.

CABI/EPPO (1992/1997) *Quarantine Pests for Europe (1st and 2nd edition)*. CABI, Wallingford (GB).

EPPO (1981) Data sheets on quarantine organisms No. 122, *Aphelenchoides besseyi. Bulletin OEPP/EPPO Bulletin* **11** (1). https://doi.org/10.1111/j.1365-2338.1981.tb01752.x

Co-funded by the
European Union