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Pest categorisation of *Nacobbus aberrans*

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Abstract

The Panel on Plant Health performed a pest categorisation of *Nacobbus aberrans* (Nematoda: Pratylenchidae), the false root-knot nematode, for the EU. The nematode was originally described from the American continent. Due to differences in host range as well as molecular variability among populations, *N. aberrans* should be regarded as a species complex (*N. aberrans sensu lato*). All populations belonging to this species complex are pests of important host plants in the EU. *N. aberrans* had been detected indoors in the EU in the 1950s and 1960s but is no longer reported to be present in the EU. It is regulated by Council Directive 2000/29/EC, listed in Annex IAI as *N. aberrans* (Thorne) Thorne and Allen. Species within the *N. aberrans* complex are endoparasitic with migratory and sedentary stages. They are highly polyphagous attacking many plant species. They are also found in soil where they can survive dry conditions and freezing temperatures. Plants for planting and soil are potential pathways for this nematode. Climatic conditions in the EU are similar to those found in the countries where the pest is present. Hosts of the nematode from which high-yield losses have been reported include potato, sugar beet, tomato and beans. The nematode only moves short distances (around 1m) but may be spread with plants and soil moving activities. Measures are available to inhibit EU entry via potatoes and soil as such but not all host plants are covered by current legislation. Entry of the nematode with plants and soil attached to plants for planting that are not regulated is therefore possible. *N. aberrans* does satisfy all the criteria that are within the remit of EFSA to assess to be regarded as a Union quarantine pest.

Keywords: European Union, pest risk, plant health, plant pest, quarantine, false root-knot nematode

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1. Introduction

1.1. Background and Terms of Reference as provided by the requestor

1.1.1. Background

Council Directive 2000/29/EC[1] on protective measures against the introduction into the Community of organisms harmful to plants or plant products and against their spread within the Community establishes the present European Union plant health regime. The Directive lays down the phytosanitary provisions and the control checks to be carried out at the place of origin on plants and plant products destined for the Union or to be moved within the Union. In the Directive's 2000/29/EC annexes, the list of harmful organisms (pests) whose introduction into or spread within the Union is prohibited, is detailed together with specific requirements for import or internal movement.

Following the evaluation of the plant health regime, the new basic plant health law, Regulation (EU) 2016/2031[2] on protective measures against pests of plants, was adopted on 26 October 2016 and will apply from 14 December 2019 onwards, repealing Directive 2000/29/EC. In line with the principles of the above mentioned legislation and the follow-up work of the secondary legislation for the listing of EU regulated pests, EFSA is requested to provide pest categorizations of the harmful organisms included in the annexes of Directive 2000/29/EC, in the cases where recent pest risk assessment/pest categorisation is not available.

1.1.2. Terms of reference

EFSA is requested, pursuant to Article 22(5.b) and Article 29(1) of Regulation (EC) No 178/2002,[3] to provide scientific opinion in the field of plant health.

EFSA is requested to prepare and deliver a pest categorisation (step 1 analysis) for each of the regulated pests included in the appendices of the annex to this mandate. The methodology and template of pest categorisation have already been developed in past mandates for the organisms listed in Annex II Part A Section II of Directive 2000/29/EC. The same methodology and outcome is expected for this work as well.

The list of the harmful organisms included in the annex to this mandate comprises 133 harmful organisms or groups. A pest categorisation is expected for these 133 pests or groups and the delivery of the work would be stepwise at regular intervals through the year as detailed below. First priority covers the harmful organisms included in Appendix 1, comprising pests from Annex II Part A Section I and Annex II Part B of Directive 2000/29/EC. The delivery of all pest categorisations for the pests included in Appendix 1 is June 2018. The second priority is the pests included in Appendix 2, comprising the group of *Cicadellidae* (non-EU) known to be vector of Pierce's disease (caused by *Xylella fastidiosa*), the group of *Tephritidae* (non-EU), the group of potato viruses and virus-like organisms, the group of viruses and virus-like organisms of *Cydonia* Mill., *Fragaria* L., *Malus* Mill., *Prunus* L., *Pyrus* L., *Ribes* L., *Rubus* L. and *Vitis* L.. and the group of *Margarodes* (non-EU species). The delivery of all pest categorisations for the pests included in Appendix 2 is end 2019. The pests included in Appendix 3 cover pests of Annex I part A section I and all pests categorisations should be delivered by end 2020.

For the above mentioned groups, each covering a large number of pests, the pest categorisation will be performed for the group and not the individual harmful organisms listed under "such as" notation in the Annexes of the Directive 2000/29/EC. The criteria to be taken particularly under consideration for these cases, is the analysis of host pest combination, investigation of pathways, the damages occurring and the relevant impact.

Finally, as indicated in the text above, all references to 'non-European' should be avoided and replaced by 'non-EU' and refer to all territories with exception of the Union territories as defined in Article 1 point 3 of Regulation (EU) 2016/2031.

[1] Council Directive 2000/29/EC of 8 May 2000 on protective measures against the introduction into the Community of organisms harmful to plants or plant products and against their spread within the Community. OJ L 169/1, 10.7.2000, p. 1–112.

[2] Regulation (EU) 2016/2031 of the European Parliament of the Council of 26 October 2016 on protective measures against pests of plants. OJ L 317, 23.11.2016, p. 4–104.

[3] Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety. OJ L 31/1, 1.2.2002, p. 1–24.

1.1.2.1. Terms of Reference: Appendix 1

List of harmful organisms for which pest categorisation is requested. The list below follows the annexes of Directive 2000/29/EC.

Annex IIAI

(a) Insects, mites and nematodes, at all stages of their development

Aleurocantus spp.
Anthonomus bisignifer (Schenkling)
Anthonomus signatus (Say)
Aschistonyx eppoi Inouye
Carposina niponensis Walsingham
Enarmonia packardi (Zeller)
Enarmonia prunivora Walsh
Grapholita inopinata Heinrich
Hishomonus phycitis
Leucaspis japonica Ckll.
Listronotus bonariensis (Kuschel)
Numonia pyrivorella (Matsumura)
Oligonychus perditus Pritchard and Baker
Pissodes spp. (non-EU)
Scirtothrips aurantii Faure
Scirtothrips citri (Moultex)
Scolytidae spp. (non-EU)
Scrobipalpopsis solanivora Povolny
Tachypterellus quadrigibbus Say
Toxoptera citricida Kirk.
Unaspis citri Comstock

(b) Bacteria

Citrus variegated chlorosis
Erwinia stewartii (Smith) Dye
Xanthomonas campestris pv. *oryzae* (Ishiyama) Dye and pv. *oryzicola* (Fang. et al.) Dye

(c) Fungi

Alternaria alternata (Fr.) Keissler (non-EU pathogenic isolates)
Anisogramma anomala (Peck) E. Müller
Apiosporina morbosa (Schwein.) v. Arx
Ceratocystis virescens (Davidson) Moreau
Cercoseptoria pini-densiflorae (Hori and Nambu) Deighton
Cercospora angolensis Carv. and Mendes
Elsinoe spp. Bitanc. and Jenk. Mendes
Fusarium oxysporum f. sp. *albedinis* (Kilian and Maire) Gordon
Guignardia piricola (Nosa) Yamamoto
Puccinia pittieriana Hennings
Stegophora ulmea (Schweinitz: Fries) Sydow & Sydow
Venturia nashicola Tanaka and Yamamoto

(d) Virus and virus-like organisms

Beet curly top virus (non-EU isolates)
Black raspberry latent virus
Blight and blight-like
Cadang-Cadang viroid
Citrus tristeza virus (non-EU isolates)
Leprosis
Little cherry pathogen (non- EU isolates)
Naturally spreading psorosis
Palm lethal yellowing mycoplasm
Satsuma dwarf virus
Tatter leaf virus
Witches' broom (MLO)

Annex IIB

(a) Insect mites and nematodes, at all stages of their development

Anthonomus grandis (Boh.)
Cephalcia lariciphila (Klug)
Dendroctonus micans Kugelan
Gilphinia hercyniae (Hartig)
Gonipterus scutellatus Gyll.
Ips amitinus Eichhof
Ips cembrae Heer
Ips duplicatus Sahlberg
Ips sexdentatus Börner
Ips typographus Heer
Sternochetus mangiferae Fabricius

(b) Bacteria

Curtobacterium flaccumfaciens pv. flaccumfaciens (Hedges) Collins and Jones

(c) Fungi

Glomerella gossypii Edgerton

Gremmeniella abietina (Lag.) Morelet

Hypoxylon mammatum (Wahl.) J. Miller

1.1.2.2. Terms of Reference: Appendix 2

List of harmful organisms for which pest categorisation is requested per group. The list below follows the categorisation included in the annexes of Directive 2000/29/EC.

Annex IAI

(a) Insects, mites and nematodes, at all stages of their development

Group of Cicadellidae (non-EU) known to be vector of Pierce's disease (caused by *Xylella fastidiosa*), such as:

1) *Carneocephala fulgida* Nottingham
2) *Draeculacephala minerva* Ball
3) *Graphocephala atropunctata* (Signoret)

Group of Tephritidae (non-EU) such as:

1) *Anastrepha fraterculus* (Wiedemann)
2) *Anastrepha ludens* (Loew)
3) *Anastrepha obliqua* Macquart
4) *Anastrepha suspensa* (Loew)
5) *Dacus ciliatus* Loew
6) *Dacus curcurbitae* Coquillet
7) *Dacus dorsalis* Hendel
8) *Dacus tryoni* (Froggatt)
9) *Dacus tsuneonis* Miyake
10) *Dacus zonatus* Saund.
11) *Epochra canadensis* (Loew)
12) *Pardalaspis cyanescens* Bezzi
13) *Pardalaspis quinaria* Bezzi
14) *Pterandrus rosa* (Karsch)
15) *Rhacochlaena japonica* Ito
16) *Rhagoletis completa* Cresson
17) *Rhagoletis fausta* (Osten-Sacken)
18) *Rhagoletis indifferens* Curran
19) *Rhagoletis mendax* Curran
20) *Rhagoletis pomonella* Walsh
21) *Rhagoletis suavis* (Loew)

(c) Viruses and virus-like organisms

Group of potato viruses and virus-like organisms such as:

1) Andean potato latent virus
2) Andean potato mottle virus
3) Arracacha virus B, oca strain
4) Potato black ringspot virus
5) Potato virus T
6) non-EU isolates of potato viruses A, M, S, V, X and Y (including Yo, Yn and Yc) and Potato leafroll virus

Group of viruses and virus-like organisms of Cydonia Mill., Fragaria L., Malus Mill., Prunus L., Pyrus L., Ribes L.,Rubus L. and Vitis L., such as:

1) Blueberry leaf mottle virus
2) Cherry rasp leaf virus (American)
3) Peach mosaic virus (American)
4) Peach phony rickettsia
5) Peach rosette mosaic virus
6) Peach rosette mycoplasm
7) Peach X-disease mycoplasm
8) Peach yellows mycoplasm
9) Plum line pattern virus (American)
10) Raspberry leaf curl virus (American)
11) Strawberry witches' broom mycoplasma
12) Non-EU viruses and virus-like organisms of *Cydonia Mill., Fragaria L., Malus Mill., Prunus L., Pyrus L., Ribes L., Rubus L.* and *Vitis L.*

Annex IIAI

(a) Insects, mites and nematodes, at all stages of their development

Group of *Margarodes* (non-EU species) such as:

1) *Margarodes vitis* (Phillipi)
2) *Margarodes vredendalensis* de Klerk
3) *Margarodes prieskaensis* Jakubski

1.1.2.3. Terms of Reference: Appendix 3

List of harmful organisms for which pest categorisation is requested. The list below follows the annexes of Directive 2000/29/EC.

Annex IAI

(a) Insects, mites and nematodes, at all stages of their development

Acleris spp. (non-EU)
Amauromyza maculosa (Malloch)
Anomala orientalis Waterhouse
Arrhenodes minutus Drury
Choristoneura spp. (non-EU)
Conotrachelus nenuphar (Herbst)
Dendrolimus sibiricus Tschetverikov
Diabrotica barberi Smith and Lawrence
Diabrotica undecimpunctata howardi Barber
Diabrotica undecimpunctata undecimpunctata Mannerheim
Diabrotica virgifera zeae Krysan & Smith
Diaphorina citri Kuway
Heliothis zea (Boddie)
Hirschmanniella spp., other than *Hirschmanniella gracilis* (de Man) Luc and Goodey
Liriomyza sativae Blanchard
Longidorus diadecturus Eveleigh and Allen
Monochamus spp. (non-EU)
Myndus crudus Van Duzee
Nacobbus aberrans (Thorne) Thorne and Allen
Naupactus leucoloma Boheman
Premnotrypes spp. (non-EU)
Pseudopityophthorus minutissimus (Zimmermann)
Pseudopityophthorus pruinosus (Eichhoff)
Scaphoideus luteolus (Van Duzee)
Spodoptera eridania (Cramer)
Spodoptera frugiperda (Smith)
Spodoptera litura (Fabricus)
Thrips palmi Karny
Xiphinema americanum Cobb sensu lato (non-EU populations)
Xiphinema californicum Lamberti and Bleve-Zacheo

(b) Fungi

Ceratocystis fagacearum (Bretz) Hunt
Chrysomyxa arctostaphyli Dietel
Cronartium spp. (non-EU)
Endocronartium spp. (non-EU)
Guignardia laricina (Saw.) Yamamoto and Ito
Gymnosporangium spp. (non-EU)
Inonotus weirii (Murril) Kotlaba and Pouzar
Melampsora farlowii (Arthur) Davis
Mycosphaerella larici-leptolepis Ito et al.
Mycosphaerella populorum G. E. Thompson
Phoma andina Turkensteen
Phyllosticta solitaria Ell. and Ev.
Septoria lycopersici Speg. var. *malagutii* Ciccarone and Boerema
Thecaphora solani Barrus
Trechispora brinkmannii (Bresad.) Rogers

(c) Viruses and virus-like organisms

Tobacco ringspot virus
Tomato ringspot virus
Bean golden mosaic virus
Cowpea mild mottle virus
Lettuce infectious yellows virus
Pepper mild tigré virus
Squash leaf curl virus
Euphorbia mosaic virus
Florida tomato virus

(d) Parasitic plants

Arceuthobium spp. (non-EU)

Annex IAII

(a) Insects, mites and nematodes, at all stages of their development

Meloidogyne fallax Karssen
Rhizoecus hibisci Kawai and Takagi
Popillia japonica Newman

(b) Bacteria

Clavibacter michiganensis (Smith) Davis et al. ssp. *sepedonicus* (Spieckermann and Kotthoff) Davis et al.
Ralstonia solanacearum (Smith) Yabuuchi et al.

(c) Fungi

Melampsora medusae Thümen
Synchytrium endobioticum (Schilbersky) Percival

Annex I B

(a) Insects, mites and nematodes, at all stages of their development

Leptinotarsa decemlineata Say
Liriomyza bryoniae (Kaltenbach)

(b) Viruses and virus-like organisms

Beet necrotic yellow vein virus

1.2. Interpretation of the Terms of Reference

Nacobbus aberrans is one of a number of pests listed in the Appendices to the Terms of Reference (ToR) to be subject to pest categorisation to determine whether it fulfils the criteria of a quarantine pest or those of a regulated non-quarantine pest for the area of the European Union (EU) excluding Ceuta, Melilla and the outermost regions of Member States (MSs) referred to in Article 355(1) of the Treaty on the Functioning of the European Union (TFEU), other than Madeira and the Azores.

2. Data and methodologies

2.1. Data

2.1.1. Literature search

A literature search on *N. aberrans* was conducted at the beginning of the categorisation in the ISI Web of Science bibliographic database, using the scientific name, synonyms and common English name of the pest as search term. Relevant papers were reviewed and further references and information were obtained from experts as well as from citations within the references.

2.1.2. Database search

Pest information, on host(s) and distribution, was retrieved from the European and Mediterranean Plan Protection Organization (EPPO) Global Database (EPPO, 2017) and relevant publications.

Data about the import of commodity types that could potentially provide a pathway for the pest to enter the EU and about the area of hosts grown in the EU were obtained from EUROSTAT (Statistical Office of the European Communities).

The Europhyt database was consulted for pest-specific notifications on interceptions and outbreaks. Europhyt is a web-based network launched by the Directorate General for Health and Consumers (DG SANCO) and is a subproject of PHYSAN (Phyto-Sanitary Controls) specifically concerned with plant health information. The Europhyt database manages notifications of interceptions of plants or plant products that do not comply with EU legislation as well as notifications of plant pests detected in the territory of the MSs and the phytosanitary measures taken to eradicate or avoid their spread.

2.2. Methodologies

The Panel performed the pest categorisation for *N. aberrans*, following guiding principles and steps presented in the European Food Safety Authority (EFSA) guidance on the harmonised framework for pest risk assessment (EFSA PLH Panel, 2010) and as defined in the International Standard for Phytosanitary Measures No. 11 (FAO, 2013) and No. 21 (FAO, 2004).

In accordance with the guidance on a harmonised framework for pest risk assessment in the EU (EFSA PLH Panel, 2010), this work was initiated following an evaluation of the EU plant health regime. Therefore, to facilitate the decision-making process, in the conclusions of the pest categorisation, the Panel addresses explicitly each criterion for a Union quarantine pest and for a Union regulated non-quarantine pest in accordance with Regulation (EU) 2016/2031 on protective measures against pests of plants and includes additional information required in accordance with the specific ToR received by the European Commission. In addition, for each conclusion, the Panel provides a short description of its associated uncertainty.

Table 1 presents the Regulation (EU) 2016/2031 pest categorisation criteria on which the Panel bases its conclusions. All relevant criteria have to be met for the pest to potentially qualify either as a quarantine pest or as a regulated non-quarantine pest. If one of the criteria is not met, the pest will not qualify. A pest that does not qualify as a quarantine pest may still qualify as a regulated non-quarantine pest that needs to be addressed in the opinion. For the pests regulated in the protected zones only, the scope of the categorisation is the territory of the protected zone; thus, the criteria refer to the protected zone instead of the EU territory.

It should be noted that the Panel's conclusions are formulated respecting its remit and particularly with regard to the principle of separation between risk assessment and risk management (EFSA founding regulation (EU) No 178/2002); therefore, instead of determining whether the pest is likely to have an unacceptable impact, the Panel will present a summary of the observed pest impacts. Economic impacts are expressed in terms of yield and quality losses and not in monetary terms, whereas addressing social impacts is outside the remit of the Panel, in agreement with EFSA guidance on a harmonised framework for pest risk assessment (EFSA PLH Panel, 2010).

Table 1: Pest categorisation criteria under evaluation, as defined in Regulation (EU) 2016/2031 on protective measures against pests of plants (the number of the relevant sections of the pest categorisation is shown in brackets in the first column)

Criterion of pest categorisation	Criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Criterion in Regulation (EU) 2016/2031 regarding protected zone quarantine pest (articles 32–35)	Criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest
Identity of the pest (Section 3.1)	Is the identity of the pest established or has it been shown to produce consistent symptoms and to be transmissible?	Is the identity of the pest established or has it been shown to produce consistent symptoms and to be transmissible?	Is the identity of the pest established or has it been shown to produce consistent symptoms and to be transmissible?
Absence/ presence of the pest in the EU territory (Section 3.2)	Is the pest present in the EU territory? If present, is the pest widely distributed within the EU? Describe the pest distribution briefly!	Is the pest present in the EU territory? If not, it cannot be a protected zone quarantine organism.	Is the pest present in the EU territory? If not, it cannot be a regulated non-quarantine pest. (A regulated non-quarantine pest must be present in the risk assessment area).
Regulatory status (Section 3.3)	If the pest is present in the EU but not widely distributed in the risk assessment area, it should be under official control or expected to be under official control in the near future.	The protected zone system aligns with the pest-free area system under the International Plant Protection Convention (IPPC). The pest satisfies the IPPC definition of a quarantine pest that is not present in the risk assessment area (i.e. protected zone).	Is the pest regulated as a quarantine pest? If currently regulated as a quarantine pest, are there grounds to consider its status could be revoked?

Criterion of pest categorisation	Criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Criterion in Regulation (EU) 2016/2031 regarding protected zone quarantine pest (articles 32–35)	Criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest
Pest potential for entry, establishment and spread in the EU territory (Section 3.4)	Is the pest able to enter into, become established in and spread within the EU territory? If yes, briefly list the pathways!	Is the pest able to enter into, become established in and spread within the protected zone areas? Is entry by natural spread from EU areas where the pest is present possible?	Is spread mainly via specific plants for planting, rather than via natural spread or via movement of plant products or other objects? Clearly state if plants for planting is the main pathway!
Potential for consequences in the EU territory (Section 3.5)	Would the pests' introduction have an economic or environmental impact on the EU territory?	Would the pests' introduction have an economic or environmental impact on the protected zone areas?	Does the presence of the pest on plants for planting have an economic impact, as regards the intended use of those plants for planting?
Available measures (Section 3.6)	Are there measures available to prevent the entry into, establishment within or spread of the pest within the EU such that the risk becomes mitigated?	Are there measures available to prevent the entry into, establishment within or spread of the pest within the protected zone areas such that the risk becomes mitigated? Is it possible to eradicate the pest in a restricted area within 24 months (or a period longer than 24 months where the biology of the organism so justifies) after the presence of the pest was confirmed in the protected zone?	Are there measures available to prevent pest presence on plants for planting such that the risk becomes mitigated?
Conclusion of pest categorisation (Section 4)	A statement as to whether (1) all criteria assessed by EFSA above for consideration as a potential quarantine pest were met and (2) if not, which one(s) were not met.	A statement as to whether (1) all criteria assessed by EFSA above for consideration as potential protected zone quarantine pest were met, and (2) if not, which one(s) were not met.	A statement as to whether (1) all criteria assessed by EFSA above for consideration as a potential regulated non-quarantine pest were met, and (2) if not, which one(s) were not met.

The Panel will not indicate in its conclusions of the pest categorisation whether to continue the risk assessment process, but following the agreed two-step approach, will continue only if requested by the risk managers. However, during the categorisation process, experts may identify key elements and knowledge gaps that could contribute significant uncertainty to a future assessment of risk. It would be useful to identify and highlight such gaps so that potential future requests can specifically target the major elements of uncertainty, perhaps suggesting specific scenarios to examine.

3. Pest categorisation

3.1. Identity and biology of the pest

3.1.1. Identity and taxonomy

Is the identity of the pest established, or has it been shown to produce consistent symptoms and to be transmissible? (Yes or No)

Yes, the identity of *Nacobbus aberrans* (Thorne, 1935) Thorne and Allen, 1944 is established. However, it is still under debate whether *N. aberrans* is a single species because of molecular variability and differences in host preferences. Mating incompatibility of some populations of *N. aberrans* have also been reported.

The false root-knot nematode *N. aberrans* (Thorne, 1935) Thorne and Allen, 1944 is a root-endoparasitic nematode with migratory and sedentary stages belonging to the family Pratylenchidae. It was originally described in 1935 by (Thorne) as *Anguillulina aberrans* from specimens parasitising shadscale (*Atriplex confertifolia*) in Utah, USA.

By 1970, four species (*Nacobbus dorsalis*, *N. aberrans, Nacobbus batatiformis, Nacobbus serendipiticus*) and one subspecies (*Nacobbus serendipiticus bolivianus*) had been described (Sher, 1970). Due to morphometrical similarities, Sher synonymised in 1970 *N. batatiformis, N. serendipiticus* and *N. serendipiticus bolivianus* with *N. aberrans.* Since then, it is generally accepted that the genus *Nacobbus* consists of only two valid species, *N. dorsalis* and *N. aberrans* (Luc, 1987; Siddiqi, 2000). Due to differences in host range of populations from geographical areas, the term '*N. aberrans* complex (or *N. aberrans* sensu lato)', that refers to species which are morphologically very difficult to distinguish, was used (Jatala and Golden, 1977).

Based on molecular variation between populations, several authors later concluded that *N. aberrans* is a species complex containing more than one species (Reid et al., 2003; Vovlas et al., 2007). The hypothesis that at least two separate species in the *N. aberrans* complex exist has been corroborated by the results of crossing experiments by Anthoine and Mugniéry (2006).

3.1.2. Biology of the pest

Nacobbus aberrans is an endoparasitic nematode that causes galls on plant roots which are similar to those induced by *Meloidogyne* species. This nematode is the only known species which has both migratory and sedentary endoparasitic stages (Eves-van den Akker et al., 2015). All juvenile stages as well as young males and females are mobile and migratory inside plant tissue whereas mature females are sedentary.

The life cycle of *N. aberrans* includes the following stages: egg, four juvenile stages and adult (male and female). The first stage juveniles develop within eggs that are laid in a gelatinous matrix protruding out from the root surface into the soil. Second-stage juveniles hatch from eggs and similar to other developmental stages of this species (third and fourth stage juveniles as well as young females and males) move through the soil and may invade, leave and reinvade roots of host plants. When penetrating the roots, they cause lesions leading to necrosis and cavities in the root cortex (Inserra et al., 1983). Maturing females become sedentary and form special feeding sites, called syncytia by stimulating cell division, partial dissolution of cell walls and fusion of cell protoplasts. Around these feeding sites, galls which are induced by proliferation of cortical and vascular tissue are formed (Inserra et al., 1983).

N. aberrans is adapted to different climatic conditions. The number of generations of *N. aberrans* depends on the duration of the growing period of the host plant; two or more generations may develop (Thorne, 1961). The length of the nematode life cycle (from egg to egg) not only depends primarily on temperature but can also be influenced by the nematode genotype and host species. The entire life cycle of this species could last from 28 to 95 days (Inserra et al., 1983; Jatala, 1991; Manzanilla-Lopez et al., 2002). According to Inserra et al. (1983), this nematode may complete its life cycle within 48 days at 25°C. *N. aberrans* may resist unfavourable environmental conditions, such as extremely low soil humidity and low temperatures, by entering a dormant stage (Anthoine et al., 2006b).

3.1.3. Intraspecific diversity

Nacobbus aberrans has a wide host range which includes more than 80 crop and weed species from many plant families (Manzanilla-Lopez et al., 2002). Based on host preferences, at least three distinct physiological races, i.e. a bean, potato and sugar beet races, can be distinguished. Each physiological race is reported to be not only linked to a specific host range but also to a certain geographic area. The bean race is specialised to parasitise beans, tomatoes and peppers, but not sugar beet and potato and was reported from Mexico (Manzanilla-Lopez et al., 2002; Inserra et al., 2004). The potato race is able to parasitise potatoes but does not infect peppers; this race may also cause damage to many other cultivated crops such as sugar-beet, beet, carrot and turnip. It was reported from Mexico and the highlands of Argentina, Bolivia, Chile and Peru but has never been reported from USA (Manzanilla-Lopez et al., 2002; Inserra et al., 2004). The sugar beet race infects sugar beets and many common vegetable crops, but not potato. This race has been reported from USA and also from South America (Argentina and Ecuador) but has never been detected in US potato-growing areas so far (Manzanilla-Lopez et al., 2002; Inserra et al., 2004).

Despite the fact that the existence of different races of *N. aberrans* has been confirmed, there is at present, according to Lax et al. (2011), no consensus on a consistent system for race classification.

Based on ITS-RFLP and sequence analyses, Vovlas et al. (2007) also found that there are differences between *N. aberrans* populations, originating from different geographical areas and hosts, indicating the existence of different species.

3.1.4. Detection and identification of the pest

Are detection and identification methods available for the pest?

Yes, the nematode can be detected by visual observation, extraction of nematodes and identification using morphologic characters or molecular tools.

Detection of *N. aberrans* is based on the extraction of motile stages from roots, potato tubers or from soil or growing media (EPPO, 2009). Sedentary females can also be detected and extracted from plant tissue (e.g. roots) using standard dissection techniques (EPPO, 2009).

Identification of *N. aberrans* is based on morphological characteristics and molecular testing (EPPO, 2009). Two molecular methods (Anthoine and Mugniéry, 2005; Atkins et al., 2005) that are included in the EPPO protocol are based on differences in the ITS-rRNA sequences of *N. aberrans.* The method by Atkins et al. (2005) can be used for direct DNA extraction from soil or potato tubers for detection and identification of *N. aberrans*. The molecular method described by Anthoine and Mugniéry (2005) is based on DNA extraction following nematode extraction from soil or roots.

3.2. Pest distribution

3.2.1. Pest distribution outside the EU

Nacobbus aberrans has been reported from temperate and subtropical regions of North (USA, Mexico) and South America (Argentina, Bolivia, Chile, Ecuador and Peru) (Figure 1 and Table 2).

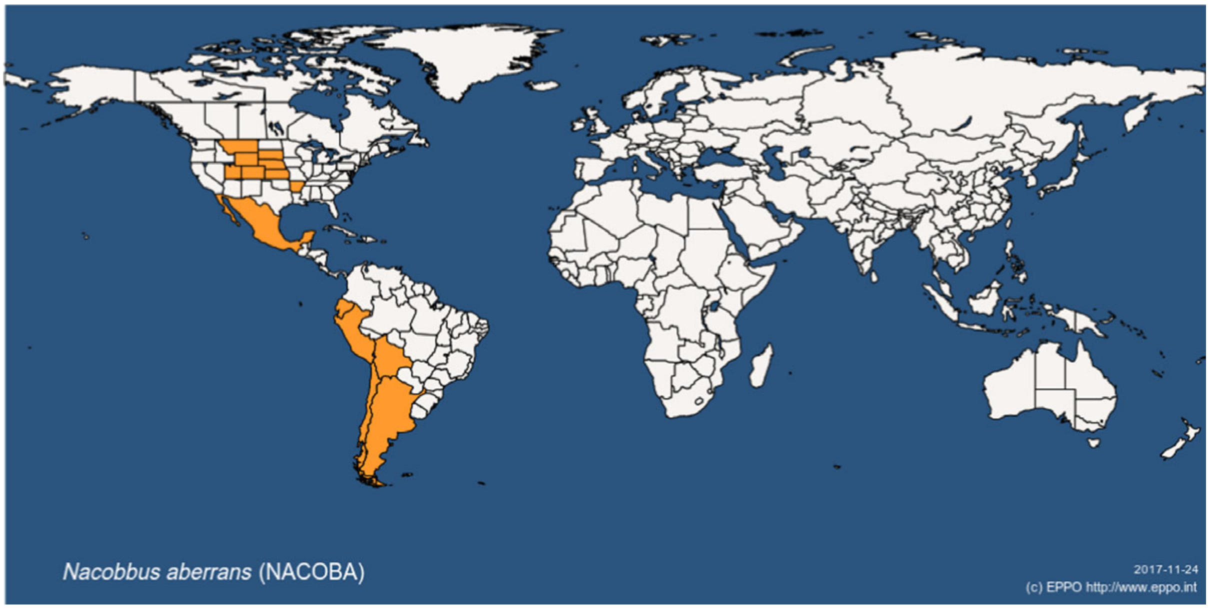

Figure 1: Global distribution map for *N. aberrans* (extracted from the EPPO Global Database accessed on 24.11.2017)

Table 2: Distribution of *N. aberrans* (extracted from the EPPO Global Database accessed on 24.11.2017)

Continent	Country	State	Status
America	Argentina		Present, widespread
	Bolivia		Present, restricted distribution
	Chile		Present, few occurrences
	Ecuador		Present, restricted distribution
	Mexico		Present, restricted distribution
	Peru		Present, restricted distribution
	USA	Arkansas	Present, no details
	USA	Colorado	Present, no details
	USA	Kansas	Present, no details
	USA	Montana	Present, no details
	USA	Nebraska	Present, no details
	USA	South Dakota	Present, no details
	USA	Utah	Present, no details
	USA	Wyoming	Present, no details

3.2.2. Pest distribution in the EU

Is the pest present in the EU territory? If present, is the pest widely distributed within the EU?

No, the pest is not present in EU.

Nacobbus aberrans has never been reported from outdoors in the EU territory (EPPO Global Database). However, *N. serendipiticus* (a synonym for *N. aberrans*) was found in glasshouses in the UK (Franklin, 1959; Clark, 1967) and the Netherlands (de Bruijn and Stemerding, 1968). The pest is no longer present in the UK and the Netherlands.

3.3. Regulatory status

3.3.1. Council Directive 2000/29/EC

Nacobbus aberrans is listed in Council Directive 2000/29/EC. Details are presented in Tables 3 and 4.

Table 3: *N. aberrans* in Council Directive 2000/29/EC

Annex I, Part A	**Harmful organisms whose introduction into, and spread within, all member states shall be banned**
Section I	**Harmful organisms not known to occur in any part of the community and relevant for the entire community**
(a)	Insects, mites and nematodes, at all stages of their development
	Species
16.	Nacobbus aberrans (Thorne) Thorne and Allen

3.3.2. Legislation addressing the hosts of *N. aberrans*

Nacobbus aberrans is listed in Annex IAI. It is a highly polyphagous pest. Certain host plants are regulated due to other quarantine pests, e.g. the import of potatoes is prohibited according to Annex III, part A of EU Directive 2000/29/EC. There are no specific hosts or commodities regulated for *N. aberrans*.

3.4. Entry, establishment and spread in the EU

3.4.1. Host range

Nacobbus aberrans is a highly polyphagous pest and has a wide range of hosts belonging to a number of commercial crops and weed species. Economically important crops that are affected by *N. aberrans* include potato (*Solanum tuberosum*), sugar beet (*Beta vulgaris*), tomato (*Solanum lycopersicum*) and bean (*Phaseolus* spp.). A detailed list of host plants can be found in Appendix A.

The nematode has been separated into three races or groups: the potato, sugar beet and bean group, respectively (Manzanilla-Lopez et al., 2002). Not all populations of *N. aberrans* are able to infect potato (Anthoine and Mugniéry, 2006; del Carmen et al., 2010; Lax et al., 2011). Some groups appear to have a limited geographical distribution. Populations of the bean group appear to be restricted to Mexico and will neither affect potato nor sugar beet (Manzanilla-Lopez et al., 2002). Tomato, however, appears to be a good host to nematode populations belonging to different groups (Anthoine and Mugniéry, 2006). At present, no system for race classification is in place (Lax et al., 2011) (see Section 3.1.3).

Resistance in host crops has been identified in pepper (*Capsicum annuum*) lines (Gómez-Rodriguez et al., 2017).

3.4.2. Entry

Is the pest able to enter into the EU territory? (Yes or No) If yes, identify and list the pathways!

Yes, the pest is able to enter into the EU territory on plants for planting, including potato tubers, but excluding seeds, irrespective of the presence of soil attached to them, as well as with soil associated with tools and machinery.

Nacobbus aberrans has been found on or in potato tubers (Jatala and de Scurrah, 1975; Rojas et al., 1997; Lax et al., 2008). Plants for planting originating form areas/places of production where the nematode is present may be infested, and the infestation of these imported consignments can be easily overlooked. Eggs and second-stage juveniles of the nematodes are able to survive desiccation (Jatala and Kaltenbach, 1979) (Anthoine et al., 2006b); this fact is particularly important for soil related pathways.

Pathways:

- Plants for planting, including potato tubers (seed and ware potatoes) but excluding seeds. Potato tubers and other plants of Solanaceae are closed pathways. Some other plants, e. g. Cactaceae, are open pathways (Table 4).
- Soil and growing media as such from areas where the nematode occurs (including dry soil). This pathway is closed because of Annex III, Part A, No. 14 of EU 2000/29.
- Soil and growing media attached to plants (host or non-host plants) from areas where the nematode occurs. This pathway is very difficult to control as plants may be imported with soil or growing media attached to keep them alive.
- Soil and growing media attached to (agricultural) machinery, tools, packaging materials including containers. Although this pathway is not considered the most important pathway for entry, this pathway needs to be considered due to the fact that the nematode survives in dried soil.

Until 24 November 2017, there were no records of interceptions of *N. aberrans* in the Europhyt database.

Table 4: Import of live indoors plants and cacti (code CN8: 06029099) to EU 28 in 2012–2016 (in 100 kg) (accessed 24.11.2017)

Country of origin	2012	2013	2014	2015	2016
Chile	0	No data	50	190	88
Mexico	1,526	1,821	1,959	713	233
Peru	3	0	0	2	4
United States	2,942	3,004	3,074	2,858	2,516

3.4.3. Establishment

Is the pest able to become established in the EU territory? (Yes or No)

Yes, the pest is able to become established in the EU as major host plants (potatoes, sugar beet and beans) are present and environmental conditions are suitable.

3.4.3.1. EU distribution of main host plants

The host plants of the potato and sugar beet groups of *N. aberrans* are present throughout the EU territory (Appendices B and C). Beans, which are susceptible to the populations assigned to the bean group, are also present throughout the EU (Appendix D). Tomato as a universal host for all groups is an important crop widely cultivated in the EU (Appendix E). Due to its wide host range, which includes many commercial crop and weed species, the nematode once it is introduced into the EU, will find suitable host plants (Manzanilla-Lopez et al., 2002).

3.4.3.2. Climatic conditions affecting establishment

Nacobbus aberrans is adapted to different climatic conditions and has been found in its area of origin in the Andean highlands as well as lower altitudes (Manzanilla-Lopez et al., 2002). South American populations of *N. aberrans* were able to develop at temperatures of 10–25°C with an optimum at 20°C (Anthoine et al., 2006a). In the Andes, *N. aberrans* is associated with potatoes at temperatures of 15–18°C (Mai et al., 1981). There appears to be a wide range of adaptation to temperature and the temperature requirements vary among populations. Even when considering this variation, climatic conditions for establishment of *N. aberrans* in the EU are suitable.

The pest could establish in all areas of the EU where host plants are grown under field conditions. *N. aberrans* is well adapted to survive extended periods of dry and cold weather conditions. Periods of soil cooling and desiccation aid in revival of nematode activity during spring, causing subsequent root infection (Jatala and Kaltenbach, 1979). The nematode will survive freezing temperatures as has been demonstrated by Jatala and Kaltenbach (1979) who reported that the nematode survived temperatures of −13°C.

In glasshouses, e.g. tomato production, the pest will be also able to establish. This is also supported by the fact that the nematode (then *N. serendipiticus*) was detected in glasshouses in the UK and the Netherlands (Franklin, 1959; Clark, 1967; de Bruijn and Stemerding, 1968).

3.4.4. Spread

Is the pest able to spread within the EU territory following establishment? (Yes or No) How?

Yes, the pest is able to spread within the EU territory on plants, including potato tubers, but excluding seeds, with or without soil attached, and with soil as such or soil associated with tools and machinery.

RNQPs: Is spread mainly via specific plants for planting, rather than via natural spread or via movement of plant products or other objects?

No, although it can be spread with different plant species, it can also spread via soil and growing media.

Plants for planting are not the main pathway, although it may be an important pathway for potatoes. As is the case with all soil-borne plant-parasitic nematodes, active spread is limited to short distances (in the range of ca. 1m). Spread over longer distances, within fields or regions, is in general human assisted. Pathways have been described in the Entry section (see Section 3.4.2). Although soil and growing media attached to (agricultural) machinery, tools, packaging materials including containers are not considered an important pathway for entry, it is important for spread.

3.5. Impacts

Would the pests' introduction have an economic or environmental impact on the EU territory?

Yes, the pest affects the production of several economically important crops including potato, sugar beet, tomato and beans.

Nacobbus aberrans is an important pest of crops outside the EU and similar impact is expected should it be introduced in the EU. Environmental impacts are not expected. The pest reduces the yield of potatoes (Mai et al., 1981; Franco et al., 1999; Manzanilla-Lopez et al., 2002; Lax et al., 2011). Yield losses depend on initial density, climatic conditions, soil type and potato cultivar and may reach 60% (Franco et al., 1992). The pest is considered the most important constraint to potato production in southern Peru and Bolivia (Mai et al., 1981). Franco et al. (1999) consider this pest more important than potato cyst nematodes (*Globodera* spp.).

In the USA, *N. aberrans* affects sugar beet and field vegetables, but not potato (Inserra et al., 1983). The yield losses reported on sugar beet are in the range of 10–20%.

Yield losses have been reported in tomato (Cristobal-Alejo et al., 2006) and bean (Manzanilla-Lopez et al., 2002). In Mexico, yield losses of 55% and 36% for tomato and bean, respectively, have been reported (Manzanilla-Lopez et al., 2002).

3.6. Availability and limits of mitigation measures

Are there measures available to prevent the entry into, establishment within or spread of the pest within the EU such that the risk becomes mitigated?

Yes, the ban on the import of soil and growing media and host plants (including tubers but excluding seeds) from areas where the nematode is present would prevent entry into and establishment or spread of this pest within the PRA area.

RNQPs: Are there measures available to prevent pest presence on plants for planting such that the risk becomes mitigated?

Yes, but these measures are limited by the fact that all (host and non-host) plants for planting need to be addressed.

3.6.1. Phytosanitary measures

- Import ban on host plants for planting (including tubers but excluding seeds) and soil
- Pest-free area, pest-free places of production
- Certification schemes

The effectiveness of phytosanitary measures or certification schemes addressing plants for planting may be limited by the fact that soil (attached to plants or machinery) as a relevant pathway may not be covered by these measures.

3.6.2. Biological or technical factors limiting the feasibility and effectiveness of measures to prevent the entry, establishment and spread of the pest

- Detection and identification: the absence of symptoms (galls) in certain plants, including potato tubers, is possible (Anthoine et al., 2006b); the presence of *N. aberrans* can, therefore, be overlooked. Dormant stages of *N. aberrans* are difficult to detect (Anthoine et al., 2006b); detection may be improved if direct DNA-extraction techniques are used (Atkins et al., 2005).
- Once the pest is introduced into the EU, establishment is difficult to prevent because environmental conditions in the pest risk analysis (PRA) area are suitable, the nematode can survive adverse environmental conditions and has a wide host range (including weeds) (Manzanilla-Lopez et al., 2002).
- False root-knot nematode has a wide host range – not all plants for planting with soil attached are addressed within the current legislation.

3.6.3. Control methods

- Cultural control: Although *N. aberrans* has a wide host range, crop rotation is an important control method for its control. *N. aberrans* populations declined in the absence of suitable host plants for 3 years (Manzanilla-Lopez et al., 2002). Eradication of the nematode under field conditions has not been demonstrated. Eradication from greenhouses was reported from UK (EPPO, 2017). Limited control can be achieved by trap cropping (oats) or by using antagonistic crops such as *Chrysanthemum cinerariaefolium* or *Tagetes erecta* (Manzanilla-Lopez et al., 2002). Some resistant cultivars exist for some field and vegetable crops. Cid del Prado (2016) reported that some bean cultivars are resistant to *N. aberrans*. Gómez-Rodriguez et al. (2017) found resistance in some pepper (*C. annuum*) lines but not in commercial cultivars.

- Biological control: To manage *N. aberrans* populations, biological control agents have been reported as a potential alternative to nematicides. The use of biological control agents including *Paecilomyces lilacinus, Arthrobotrys conoides* and *Pochonia chlamydosporia* have been found to affect *N. aberrans* populations (Main et al., 1999; Manzanilla-Lopez et al., 2002; Perez-Rodriguez et al., 2007; Franco-Navarro et al., 2016). *Pseudomonas protegens* has been reported to reduce infection and reproduction of *N. aberrans* on tomato roots in greenhouse experiments (Lax et al., 2013).
- Chemical control: Nematicides alone do not effectively reduce nematode populations (Manzanilla-Lopez et al., 2002).
- IPM methods: Use of *P. chlamydosporia* in combination with nematicide application and environmentally friendly crop protection techniques that include incorporation of cabbage residues and composted manures has been recognised as a successful IPM tool for reducing *N. aberrans* populations (Franco-Navarro et al., 2016).

3.7. Uncertainty

The unclear taxonomic position of *N. aberrans*, based on physiological, morphological, molecular and ecological differences between various populations, presents some uncertainty. *N. aberrans* may be separated into distinct species in the future. Considering the currently known host ranges of *N. aberrans*, all populations will affect major commercial crops in the PRA area: potato, sugar beet, tomato and bean. The consideration of *N. aberrans* sensu lato as a harmful organism bears no uncertainty.

4. Conclusions

Nacobbus aberrans meets the criteria assessed by EFSA for consideration as a potential Union quarantine pest (Table 5).

Table 5: The Panel's conclusions on the pest categorisation criteria defined in Regulation (EU) 2016/2031 on protective measures against pests of plants (the number of the relevant sections of the pest categorisation is shown in brackets in the first column)

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest	Key uncertainties
Identity of the pest (Section 3.1)	The identity of the pest is established: *Nacobbus aberrans* (Thorne) Thorne and Allen. Taxonomic keys and molecular tools are available to identify the pest	The identity of the pest is established: *Nacobbus aberrans* (Thorne) Thorne and Allen. Taxonomic keys and molecular tools are available to identify the pest	*N. aberrans* may be a species complex. The unclear taxonomic position of *N. aberrans*, based on physiological, morphological, molecular and ecological differences between various populations, presents some uncertainty
Absence/ presence of the pest in the EU territory (Section 3.2)	The pest has been described earlier from greenhouses in the UK and NL. Eradication has been reported as successful in the UK and NL. The pest is not known to occur in the EU	The pest has been described earlier from greenhouses in the UK and NL. Eradication has been reported as successful in the UK and NL. The pest is not known to occur in the EU	No uncertainties

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest	Key uncertainties
Regulatory status (Section 3.3)	*Nacobbus aberrans* is currently regulated by Council Directive 2000/29/EC as a harmful organism whose introduction into and spread within all member states shall be banned	*Nacobbus aberrans* is currently regulated by Council Directive 2000/29/EC as a harmful organism whose introduction into and spread within all member states shall be banned	No uncertainties
Pest potential for entry, establishment and spread in the EU territory (Section 3.4)	*Nacobbus aberrans* is able to enter and spread with plants (including potato tubers but excluding seeds), soil, soil attached to plants for planting or to machinery, tools etc. Natural (active) spread is only over short distances. The pest survives low temperatures and desiccation	*Nacobbus aberrans* is able to enter and spread with plants (including potato tubers but excluding seeds) but plants are not the only pathway	No uncertainties
Potential for consequences in the EU territory (Section 3.5)	*Nacobbus aberrans* would have severe direct impact on important crops such as potatoes, sugar beet, tomato and beans	The presence of the pest on plants for planting would have an economic impact	Host preferences of nematode populations belonging to different groups or races
Available measures (Section 3.6)	Measures are available to inhibit entry via traded commodities (e.g. prohibition on the importation of host plants for planting, soil and the introduction of plants for planting with soil or growing media attached)	Pest-free area and pest-free places/sites of production reduce the risk of the pest being present on plants for planting	No uncertainties
Conclusion on pest categorisation (Section 4)	*Nacobbus aberrans* does satisfy all the criteria that are within the remit of EFSA to assess to be regarded as a Union quarantine pest	*Nacobbus aberrans* does not meet the criteria of (a) occurring in the EU territory, and (b) plants for planting being the only means of spread	No uncertainties
Aspects of assessment to focus on/ scenarios to address in future if appropriate	All populations of *Nacobbus aberrans* (sensu lato) are harmful and from a phytosanitary point further delimitation of species or specification of host ranges is not necessary		

References

Anthoine G and Mugniéry D, 2005. Variability of the ITS rDNA and identification of *Nacobbus aberrans* (Thorne, 1935) Thorne & Allen, 1944 (Nematoda : Pratylenchidae) by rDNA amplification. Nematology, 7, 503–516.

Anthoine G and Mugniéry D, 2006. Crossing experiments with South American populations of *Nacobbus aberrans* (Thorne, 1935) Thorne and Allen, 1944 (Nematoda : Pratylenchidae). Nematropica, 36, 67–77.

Anthoine G, Buisson A, Gauthier JP and Mugniéry D, 2006a. Aspects of the biology of *Nacobbus aberrans* (Thorn, 1935) Thorne & Allen, 1944 (Nematoda : Pratylenchidae): 2 - Capacities of development on hosts under in vivo and in vitro conditions. Bulletin OEPP, 36, 365–372.

Anthoine G, Gauthier JP and Mugniéry D, 2006b. Aspects of the biology of *Nacobbus aberrans* (Thorn, 1935) Thorne & Allen, 1944 (Nematoda : Pratylenchidae): 1 - Capacities of quiescence and diapause. Bulletin OEPP, 36, 359–364.

Atkins SD, Manzanilla-Lopez RH, Franco J, Peteira B and Kerry BR, 2005. A molecular diagnostic method for detecting *Nacobbus* in soil and in potato tubers. Nematology, 7, 193–202.

de Bruijn N and Stemerding S, 1968. *Nacobbus serendipiticus*, a plant parasitic nematode new to the Netherlands Journal of Plant Pathology, 74, 227–228.

del Carmen Tordable M, Lax P, Edmundo Doucet M, Bima P, Ramos D and Vargas L, 2010. Response of roots of different plants to the presence of the false root-knot nematode *Nacobbus aberrans*. Russian Journal of Nematology, 18, 31–39.

Cid del Prado VI, 2016. *Nacobbus aberrans* in horticultural crops and its management in Mexico. Journal of Nematology, 48, 311.

Clark SA, 1967. The development and life history of the false root-knot nematode, *Nacobbus serendipiticus*. Nematologica, 13, 91–101.

Cristobal-Alejo J, Mora-Aguilera G, Manzanilla-Lopez RH, Marban-Mendoza N, Sanchez-Garcia P, Cid Del Prado-Vera I and Evans K, 2006. Epidemiology and integrated control of *Nacobbus aberrans* on tomato in Mexico. Nematology, 8, 727–737.

EFSA PLH Panel (EFSA Panel on Plant Health), 2010. PLH Guidance on a harmonised framework for pest risk assessment and the identification and evaluation of pest risk management options by EFSA. EFSA Journal 2010;8(2):1495, 66 pp. https://doi.org/10.2903/j.efsa.2010.1495

EPPO (European and Mediterranean Plant Protection Organization), 2009. *Nacobbus aberrans* sensu lato. Bulletin OEPP/EPPO, 39, 376–381.

EPPO (European and Mediterranean Plant Protection Organization), 2017. EPPO Global Database (available online). Available online: https://gd.eppo.int

Eves-van den Akker S, Lilley CJ, Jones JT and Urwin PE, 2015. Plant-parasitic nematode feeding tubes and plugs: new perspectives on function. Nematology, 17, 1–9.

FAO (Food and Agriculture Organization of the United Nations), 2004. ISPM (International Standards for Phytosanitary Measures) 21—Pest risk analysis of regulated non-quarantine pests. FAO, Rome, 30 pp. Available online: https://www.ippc.int/sites/default/files/documents//1323945746_ISPM_21_2004_En_2011-11-29_Refor.pdf

FAO (Food and Agriculture Organization of the United Nations), 2013. ISPM (International Standards for Phytosanitary Measures) 11—Pest risk analysis for quarantine pests. FAO, Rome, 36 pp. Available online: https://www.ippc.int/sites/default/files/documents/20140512/ispm_11_2013_en_2014-04-30_201405121523-494.65%20KB.pdf

Franco J, Montecinos R and Ortuno N, 1992. Management strategies of *Nacobbus aberrans*. In: Gommers FJ and Maas PWT (eds.).

Franco J, Ramos J, Oros R, Main G and Ortuno N, 1999. Perdidas Economicas Causadas por *Nacobbus abberans* y *Globodera* spp. en el Cultivo de la Papa en Bolivia. Revista Latinoamericana de la Papa, 11, 40–66.

Franco-Navarro F, Velasco-Azorsa R and Cid del Prado-Vera I, 2016. *Pochonia chlamydosporia* vs *Nacobbus aberrans*: experiences in the control of the false root-knot nematode in Mexico. Journal of Nematology, 48, 322.

Franklin MT, 1959. *Nacobbus serendipiticus* n. sp., a root-galling nematode from tomatoes in England. Nematologica, 4, 286–293.

Gómez-Rodriguez O, Corona-Torres T and Heber Aguilar-Rincon V, 2017. Differential response of pepper (Capsicum annuum L.) lines to *Phytophthora capsici* and root-knot nematodes. Crop Protection, 92, 148–152.

Inserra RN, Vovlas N, Griffin GD and Anderson JL, 1983. Development of the false root-knot nematode, *Nacobbus-aberrans*, on sugarbeet. Journal of Nematology, 15, 288–296.

Inserra RN, Chitambar JJ, Chitwood DJ and Handoo Z, 2004. The potato pathotype of the false-root knot nematode, Nacobbus aberrans. Working Group of the SON Exotic Nematode Plant Pest List.

Jatala P, 1991. Reniform and false root-knot nematodes, *Rotylenchulus* and *Nacobbus* spp. In: Nickle WR (ed.). *Manual of agricultural nematology*. Marcel Dekker, New York. pp. 509–528.

Jatala P and de Scurrah MM, 1975. Mode of dissemination of *Nacobbus* spp. in certain potato-growing areas of Peru and Bilivia. Journal of Nematology, 7, 324–325.

Jatala P and Golden AM, 1977. Taxonomic status of *Nacobbus* species attacking potatoes in South America. Nematropica, 7, 9–10.

Jatala P and Kaltenbach R, 1979. Survival of *Nacobbus aberrans* in adverse conditions. Journal of Nematology, 11, 303.

Lax P, Doucet ME, Gallardo C, De l'Argentier SM and Bautista R, 2008. Presence of soil nematodes in andean tubers. Nematropica, 38, 87–94.

Lax P, Duenas JCR, Coronel NB, Gardenal CN, Bima P and Doucet ME, 2011. Host range study of Argentine *Nacobbus aberrans* sensu Sher populations and comments on the differential host test. Crop Protection, 30, 1414–1420.

Lax P, del Carmen Tordable M, Macagno J, Bima P and Edmundo Doucet M, 2013. Response of different potato cultivars to the presence of *Nacobbus aberrans*. Nematropica, 43, 83–90.

Luc M, 1987. A reappraisal of *Tylenchina* (Nemata). 7. The family Pratylenchidae Thorne, 1949. Revue de Nematologie, 10, 203–218.

Mai WF, Brodie BB, Harrison MB and Jatala P, 1981. Nematodes. In: Hooker WJ (ed.). Compendium of Potato Diseases. American Phytopathological Society, St. Paul, USA. pp. 93–101.

Main G, Franco J and Ortuno N, 1999. Trap crops as an alternative to reduce populations of *Nacobbus aberrans* and *Globodera* spp. on potato. Fitopatologia, 34, 35–41.

Manzanilla-Lopez RH, Costilla MA, Doucet M, Inserra RN, Lehman PS, del Prado-Vera IC, Souza RM and Evans K, 2002. The genus *Nacobbus* Thorne & Allen, 1944 (Nematoda : Pratylenchidae): Systematics, distribution, biology and management. Nematropica, 32, 149–227.

Nemaplex. Available online: http://nemaplex.ucdavis.edu/Nemabase2010/NematodePageHostRangeResults.aspx?NgenusNspec=Xiphinema%20californicum [Accessed: 26.1.2018]

Perez-Rodriguez I, Doroteo-Mendoza A, Franco-Navarro F, Santiago-Santiago V and Montero-Pineda A, 2007. Isolates of *Pochonia chlamydosporia* var. *chlamydosporia* from Mexico as potential biological control agents of *Nacobbus aberrans*. Nematropica, 37.

Reid A, Manzanilla-Lopez RH and Hunt D, 2003. *Nacobbus aberrans* (Thorne, 1935) Thorne & Allen 1944 (Nematoda: Pratylenchidae); a nascent species complex revealed by RFLP analysis and sequencing of the ITS-rDNA region. Nematology, 5, 441–451.

Rojas F, Franco J and Ortuño N, 1997. Las Ferias Agrícolas: Fuente de Diseminación de Nacobbus aberrans. Revista Latinoamericana de la Papa, 9, 35–48.

Sher SA, 1970. Revision of the genus *Nacobbus* Thorne and Allen, 1944 (Nematoda: Tylenchoidea). Journal of Nematology, 2, 228–235.

Siddiqi MR, 2000. *Tylenchida: Parasites of plants and insects*, 2nd Edition. CABI Publishing, Wallingford, UK.

Thorne G, 1935. The sugar beet nematode and other indigenous nemic parasites of schadscale. Journal of Agricultural Research, 51, 509–514.

Thorne G, 1961. *Principles of Nematology*. McGraw Hill Book Company, 553 pp.

Vovlas N, Nico AI, De Luca F, Di Giorgi C and Castillo P, 2007. Diagnosis and molecular variability of an Argentinean population of *Nacobbus aberrans* with some observations on histopathology in tomato. Journal of Nematology, 39, 17–26.

Abbreviations

EPPO	European and Mediterranean Plant Protection Organization
FAO	Food and Agriculture Organization
IPPC	International Plant Protection Convention
MS	Member State
PLH	EFSA Panel on Plant Health
PRA	Pest risk analysis
TFEU	Treaty on the Functioning of the European Union
ToR	Terms of Reference

Appendix A – Host plants of *Nacobbus aberrans* (sensu lato)

Family	Species	References used		
		Manzanilla-Lopez et al. (2002)	Nemaplex	EPPO GD
Amaranthaceae	*Amaranthus* sp.	✓		
	A. hybridus L.	✓		
	A. hypochondriacus L.	✓		
	A. quitensis H.B. & K.	✓		
	A. retroflexus L.	✓		
	A. spinosus L.	✓		
	Bassia (=*Kochia*) *scoparia* (L.) Voss	✓		
	Beta vulgaris L.	✓	✓	✓
Apiaceae	*Daucus carota* L.	✓	✓	✓
Asteraceae	*Eupatorium azangaroense* Sch. Bip.	✓		
	Baccharis salicifolia (Ruiz and Pavón) Pers.	✓		
	Gaillardia pulchella Fouger	✓	✓	
	Lactuca sativa L.	✓	✓	✓
	Simsia amplexicaulis Pers.	✓		
	Tagetes mandonii Sch. Bip.	✓		
	Taraxacum officinale L.	✓		
	Tragopogon porrifolius L.	✓	✓	
Basellaceae	*Ullucus tuberosus* Caldas	✓		
Brassicaceae	*Brassica campestris* L.	✓		
	B. juncea (L.) Czern. & Cass. (=*B. japonica*)	✓		
	B. napus (L.) Rchb. Napobrassica Group	✓	✓	
	B. nigra (L.) Koch	✓	✓	
	B. oleracea L.	✓	✓	✓
	B. rapa L.	✓		
	Calandria albis Kunth.	✓		
	Capsella bursa-pastoris (L.) Medic.	✓		
	Matthiola sp.	✓	✓	
	Raphanus sativus L.	✓	✓	
	Sisymbrium irio L.	✓		
Cactaceae	*Coryphantha vivipara* Britt. and Rose		✓	
	Escobaria (=*Mammillaria*) *vivipara* (Nutt.) F. Buxb	✓		
	Mamillaria vivipara (Nutt.) Haw.	✓		
	Opuntia fragilis Haw.	✓	✓	✓
	O. macrorhiza Engelm. (= *tortispina* Nutt.)	✓	✓	
Caryophyllaceae	*Spergula arvensis* L.	✓		
	Stellaria media (L.) Vill.	✓	✓	
Chenopodiaceae	*Atriplex confertifolia* (Torr. and Frém.) S. Wats	✓	✓	
	Chenopodium album L.	✓	✓	
	Chenopodium ambrosioides L.	✓		
	Ch. murale L.	✓		
	Ch. nuttalliae Saff.	✓		
	Ch. quinoa Willd.	✓		
	Salsola kali L. var *tenuifolia* Tausch	✓	✓	
	Spinacia oleracea L.	✓	✓	
Convolvulaceae	*Ipomoea batatas* Lam.	✓		

Family	Species	References used		
		Manzanilla-Lopez et al. (2002)	**Nemaplex**	**EPPO GD**
Cucurbitaceae	*Cucumis sativus* L.	✓	✓	✓
	Cucurbita maxima Duchesne	✓		
	C. pepo L.	✓	✓	
Fabaceae	*Phaseolus vulgaris* L.	✓		
	Physalis spp.	✓		
	Pisum sativum L.	✓	✓	
	Trifolium sp.	✓		
Lamiaceae	*Origanum vulgare* L.	✓		
Malvaceae	*Abelmoschus* (=*Hibiscus*) *esculentus* Moench	✓		
	Alcea rosea L.	✓		
	Anoda cristata (L.) Schlecht.	✓		
	Malva parviflora L.	✓		
Nyctaginaceae	*Mirabilis jalapa* L.	✓		
Oxalidaceae	*Oxalis tuberosa* Molina	✓		
Plantaginaceae	*Plantago lanceolata* L.	✓		
Polygonaceae	*Fagopyrum esculentum* Moench.	✓		
Portulaceae	*Portulaca oleracea* L.	✓		
Solanaceae	*Solanum* sp.	✓	✓	✓
	Capsicum annuum L.	✓	✓	✓
	C. annuum L. var. *glabriusculum* (Dunal) Heiser & Pickersgill (=*C. baccatum* L.)	✓		
	C. frutescens L.	✓		
	C. pendulum Willd.	✓		
	C. pubescens Ruiz & Pav.	✓		
	Cestrum roseum H.B. & K.	✓		
	Cyphomandra betacea Sendt.	✓		
	Datura ferox L.	✓		
	D. stramonium L.	✓		
	Nicotiana tabacum L.	✓		
	Solanum acaule		✓	
	S. andigena Juz. and Buk.	✓	✓	
	S. chacoense Bitter	✓		
	Solanum chmielewskii (C.M.Rick, Kesicki, Fobes & M.Holle) D.M.Spooner, G.J.Anderson & R.K.Jansen		✓	
	Solanum hirsutum		✓	
	Solanum hybrids		✓	
	Solanum infundibuliforme		✓	
	Solanum lycopersicum L.	✓	✓	✓
	Solanum megistacrolobum		✓	
	S. melongena L.	✓	✓	
	S. nigrum L.	✓	✓	
	Solanum peruvianum Mill.	✓	✓	
	Solanum pimpinellifolium Mill.		✓	
	S. rostratum Dun.	✓		
	S. triquetrum Cav.	✓		

Family	Species	References used		
		Manzanilla-Lopez et al. (2002)	Nemaplex	EPPO GD
	S. tuberosum L.	✓	✓	✓
	Solanum sparsipilum		✓	
Tropaeolaceae	*Tropaeolum tuberosum* Ruíz. et Pav.	✓		
Zygophyllaceae	*Tribulus terrestris* L.	✓	✓	

Appendix B – EU area of potato production 2012–2016 (thousands of hectares)

Country	2012	2013	2014	2015	2016
EU 28	21.78	21.13	21.38	20.37	21.22
Austria	67.00	75.40	80.37	78.69	89.21
Belgium	14.90	12.77	10.20	11.02	8.38
Bulgaria	10.23	10.23	10.31	10.05	9.87
Croatia	4.55	4.64	4.91	4.74	5.04
Cyprus	23.65	23.21	23.99	22.68	23.41
Czech Republic	39.50	39.60	19.60	42.00	46.10
Denmark	5.50	4.60	4.40	3.80	3.71
Estonia	20.70	22.10	22.00	21.90	21.70
Finland	154.09	160.96	168.02	167.26	179.00
France	238.30	242.80	244.80	236.70	242.50
Germany	24.16	24.69	23.83	20.75	18.03
Greece	25.08	20.95	20.98	18.74	16.41
Hungary	8.99	10.74	9.46	8.52	9.04
Ireland	58.65	50.39	52.35	50.42	48.14
Italy	12.20	12.40	11.10	10.20	10.90
Latvia	31.70	28.30	26.80	23.03	21.64
Lithuania	0.64	0.59	0.61	0.57	0.62
Luxembourg	0.70	0.69	0.69	0.69	0.77
Malta	373.00	337.00	267.12	292.50	300.74
Poland	25.05	26.76	27.21	24.62	23.30
Portugal	229.27	207.61	202.67	196.07	186.24
Romania	8.93	8.98	9.11	8.07	8.26
Slovak Republic	3.39	3.31	3.60	3.32	3.16
Slovenia	72.02	72.43	75.96	71.68	72.14
Spain	24.70	23.88	23.78	23.11	24.21
Sweden	150.00	156.00	156.00	155.66	155.59
The Netherlands	149.00	139.00	141.00	129.00	139.00
United Kingdom	21.78	21.13	21.38	20.37	21.22

Appendix C – EU area of sugar beet production 2012–2016 (thousands of hectares)

Country	2012	2013	2014	2015	2016
EU 28	1,661.20	1,578.20	1,632.44	1,420.33	1,498.64
Austria	49.26	50.85	50.60	45.44	43.50
Belgium	61.20	59.80	58.60	52.35	55.54
Croatia	23.50	20.25	21.90	13.88	15.49
Czech Republic	61.16	62.40	62.96	57.61	60.74
Denmark	40.80	38.00	38.00	36.00	33.10
Finland	11.50	12.00	13.70	12.40	11.60
France	389.79	393.63	406.74	385.05	405.23
Germany	402.10	357.40	372.50	312.80	334.50
Greece	8.05	5.81	7.87	5.18	5.42
Hungary	18.72	18.82	15.42	15.51	16.00
Italy	45.55	40.71	51.99	38.12	32.30
Lithuania	19.20	17.70	17.00	12.24	15.15
Poland	212.00	193.70	197.64	180.10	203.39
Portugal	0.37	0.38	0.35	0.10	0.10
Romania	27.30	28.14	31.28	26.60	24.92
Slovak Republic	19.74	20.33	22.21	21.52	21.48
Spain	38.95	32.05	38.41	37.61	32.87
Sweden	39.00	36.23	34.26	19.38	30.60
The Netherlands	73.00	73.00	75.00	58.43	70.72
United Kingdom	120.00	117.00	116.00	90.00	86.00

Appendix D – EU area of fresh bean production 2012–2016 (thousands of hectares)

Country	2012	2013	2014	2015	2016
EU 28	106.57	106.68	100.01	94.10	97.83
Austria	1.02	0.89	0.86	1.01	1.15
Belgium	8.88	9.31	8.90	8.80	9.00
Bulgaria	0.00	0.30	0.34	0.36	0.71
Croatia	0.29	0.27	0.19	0.37	0.57
Cyprus	0.18	0.15	0.13	0.03	0.03
Finland	0.02	0.03	0.04	0.04	0.05
France	26.72	26.45	28.53	25.77	26.70
Germany	4.69	5.20	4.56	4.60	4.61
Greece	6.21	6.10	6.31	6.19	5.76
Hungary	1.93	1.51	1.65	2.10	1.80
Italy	16.54	18.71	17.26	17.06	18.69
Lithuania	0.22	0.23	0.20	0.16	0.20
Poland	7.10	5.10	6.20	6.40	6.94
Portugal	0.63	0.56	0.83	0.57	0.51
Romania	5.76	5.50	5.36	5.44	5.03
Slovak Republic	0.00	0.00	0.00	0.03	0.00
Slovenia	0.63	0.64	0.69	0.51	0.53
Spain	9.69	10.04	10.17	9.45	9.45
Sweden	0.01	0.01	0.02	0.02	0.02
The Netherlands	4.67	4.19	3.79	3.61	3.08
United Kingdom	11.37	11.52	4.00	1.60	3.00

Appendix E – EU area of tomato production 2012–2016 (thousands of hectares)

Country	2012	2013	2014	2015	2016
EU 28	229.83	230.45	248.08	256.54	249.70
Austria	0.18	0.18	0.19	0.19	0.18
Belgium	0.48	0.52	0.51	0.51	0.51
Bulgaria	3.40	3.80	3.59	3.28	4.20
Croatia	0.45	0.45	0.32	0.42	0.36
Cyprus	0.20	0.21	0.21	0.27	0.22
Czech Republic	0.38	0.31	0.28	0.20	0.34
Denmark	0.04	0.04	0.04	0.03	0.03
Estonia	0.01	0.00	0.00	0.00	0.01
Finland	0.11	0.12	0.11	0.11	0.11
France	5.23	5.92	5.83	5.69	5.68
Germany	0.32	0.33	0.33	0.33	0.34
Greece	15.98	16.66	17.25	17.36	16.84
Hungary	1.28	1.74	1.88	2.26	1.93
Ireland	0.01	0.01	0.01	0.01	0.01
Italy	91.85	95.19	103.11	107.18	96.78
Lithuania	0.58	0.59	0.54	0.49	0.57
Poland	13.10	11.80	13.50	13.80	12.42
Portugal	15.41	15.63	18.46	18.66	20.85
Romania	29.75	28.07	24.43	24.84	22.71
Slovak Republic	0.51	0.44	0.51	0.57	0.68
Slovenia	0.22	0.00	0.23	0.19	0.21
Spain	48.61	46.62	54.75	58.13	62.72
Sweden	0.04	0.04	0.04	0.04	0.04
The Netherlands	1.69	1.77	1.78	1.76	1.78
United Kingdom	0.00	0.00	0.20	0.23	0.20