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## Commodity risk assessment of *Ullucus tuberosus* tubers from Peru

EFSA Panel on Plant Health (PLH),

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### Abstract

The European Commission requested the EFSA Panel on Plant Health to prepare and deliver risk assessments for commodities listed in Commission Implementing Regulation (EU) 2018/2019 as 'High risk plants, plant products and other objects'. This Scientific Opinion covers plant health risks posed by tubers of *Ullucus tuberosus* imported from Peru, taking into account the available scientific information, including the technical information provided by Peru. The relevance of an EU quarantine pest for this opinion was based on evidence that: (i) the pest is present in Peru, (ii) *U. tuberosus* is a host of the pest and (iii) the pest can be associated with the commodity. The relevance of any other pest, not regulated in the EU, was based on evidence that: (i) the pest is present in Peru (ii) the pest is absent in the EU; (iii) *U. tuberosus* is a host of the pest; (iv) the pest can be associated with the commodity and (v) the pest may have an impact and can pose a potential risk for the EU territory. There are five pests i.e. one insect (*Amathynetoides nitidiventris*), two nematodes (*Atalodera andina* and *Nacobbus aberrans*) and two viruses (the Andean potato latent virus (APLV) and the potato virus T (PVT)) that fulfilled all relevant criteria were selected for further evaluation. For the five pests, the risk mitigation measures proposed in the technical dossier from Peru were evaluated taking into account the possible limiting factors. For each of the five pests, an expert judgement is given on the likelihood of pest freedom taking into consideration the risk mitigation measures acting on the pest, including uncertainties associated with the assessment. The degree of pest freedom varies among the pests evaluated, with PVT being the pest most frequently expected on the imported commodities. The Expert Knowledge Elicitation indicated, with 95% certainty, that between 9,157 and 10,000 tubers out of 10,000 would be free of PVT.

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Figures 2, 3 and 5



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## Table of contents

Abstract.....	1
1. Introduction.....	4
1.1. Background and Terms of Reference as provided by European Commission.....	4
1.1.1. Background.....	4
1.1.2. Terms of reference.....	4
1.2. Interpretation of the Terms of Reference.....	4
2. Data and methodologies.....	5
2.1. Data provided by SENASA, Peru.....	5
2.2. Literature searches performed by EFSA.....	9
2.3. Methodology.....	10
2.3.1. Commodity data.....	10
2.3.2. Identification of pests potentially associated with the commodity.....	10
2.3.3. Listing and evaluation of risk mitigation measures.....	11
3. Commodity data.....	11
3.1. Description of the commodity.....	11
3.2. Description of the production areas.....	12
3.3. Production and handling processes.....	15
3.3.1. Source of planting material.....	15
3.3.2. Production cycle.....	15
Phenology.....	15
3.3.3. Pest monitoring during production.....	17
3.3.4. Post-harvest processes and export procedure.....	17
4. Identification of pests potentially associated with the commodity.....	17
4.1. Selection of relevant EU-quarantine pests associated with the commodity.....	18
4.2. Selection of other relevant pests (non-quarantine in the EU) associated with the commodity.....	20
4.3. Overview of interceptions.....	20
4.4. List of potential pests not further assessed.....	20
4.5. Summary of pests selected for further evaluation.....	21
5. Risk mitigation measures.....	21
5.1. Possibility of pest presence in the production places.....	21
5.2. Risk mitigation measures applied in Peru.....	21
5.3. Evaluation of the current measures for the selected relevant pests including uncertainties.....	23
5.3.1. Overview of the evaluation of <i>Nacobbus aberrans</i> .....	23
5.3.2. Overview of the evaluation of <i>Atalodera andina</i> .....	24
5.3.3. Overview of the evaluation of Andean potato latent virus (APLV).....	25
5.3.4. Overview of the evaluation of potato virus T (PVT).....	26
5.3.5. Overview of the evaluation of <i>Amathynetoides nitidiventris</i> .....	27
5.3.6. Outcome of Expert Knowledge Elicitation.....	28
6. Conclusions.....	31
References.....	32
Glossary.....	32
Abbreviations.....	33
Appendix A – Datasheets of pests selected for further evaluation via Expert Knowledge Elicitation.....	34
Appendix B – Web of Science All Databases Search String.....	73
Appendix C – List of pests that can potentially cause an effect not further assessed.....	74
Appendix D – Excel file with the pest list of <i>U. tuberosus</i> from Peru.....	75

## 1. Introduction

### 1.1. Background and Terms of Reference as provided by European Commission

#### 1.1.1. Background

The new Plant Health Regulation (EU) 2016/2031<sup>1</sup>, on the protective measures against pests of plants, has been applied from December 2019. Provisions within the above Regulation are in place for the listing of 'high risk plants, plant products and other objects' (Article 42) on the basis of a preliminary assessment, and to be followed by a commodity risk assessment. A list of 'high risk plants, plant products and other objects' has been published in Regulation (EU) 2018/2019<sup>2</sup>. Scientific opinions are therefore needed to support the European Commission and the Member States in the work connected to Article 42 of Regulation (EU) 2016/2031, as stipulated in the terms of reference.

#### 1.1.2. Terms of reference

In view of the above and in accordance with Article 29 of Regulation (EC) No. 178/2002<sup>3</sup>, the Commission asks EFSA to provide scientific opinions in the field of plant health.

In particular, EFSA is expected to prepare and deliver risk assessments for commodities listed in the relevant Implementing Act as "High risk plants, plant products and other objects". Article 42, paragraphs 4 and 5, establishes that a risk assessment is needed as a follow-up to evaluate whether the commodities will remain prohibited, removed from the list and additional measures will be applied or removed from the list without any additional measures. This task is expected to be on-going, with a regular flow of dossiers being sent by the applicant required for the risk assessment.

Therefore, to facilitate the correct handling of the dossiers and the acquisition of the required data for the commodity risk assessment, a format for the submission of the required data for each dossier is needed.

Furthermore, a standard methodology for the performance of "commodity risk assessment" based on the work already done by Member States and other international organizations needs to be set.

In view of the above and in accordance with Article 29 of Regulation (EC) No. 178/2002, the Commission asks EFSA to provide scientific opinion in the field of plant health for *Ullucus tuberosus* from Peru taking into account the available scientific information, including the technical dossier provided by Peru.

### 1.2. Interpretation of the Terms of Reference

The EFSA Panel on Plant Health (hereafter referred to as 'the Panel') was requested to conduct a commodity risk assessment of *Ullucus tuberosus* from Peru (PE) following the Guidance on commodity risk assessment for the evaluation of high-risk plant dossiers (EFSA PLH Panel, 2019a).

The EU quarantine pests that are regulated as a group in the Commission Implementing Regulation (EU) 2019/2072 were considered and evaluated separately at species level. The references to 'non-European' refer to all territories with exception of the Union territories as defined in Article 1 point 3 of Regulation (EU) 2016/2031.

Pests listed as 'Regulated Non-Quarantine Pest' (RNQP) in Commission Implementing Regulation (EU) 2019/2072 were not considered for further evaluation, in line with a letter from European Commission from 24 October 2019, Ref. Ares (2019)6579768 – 24/10/2019, on Clarification on EFSA mandate on High Risk Plants.

<sup>1</sup> Regulation (EU) 2016/2031 of the European Parliament and of the Council of 26 October 2016 on protective measures against pests of plants, amending Regulations (EU) 228/2013, (EU) 652/2014 and (EU) 1143/2014 of the European Parliament and of the Council and repealing Council Directives 69/464/EEC, 74/647/EEC, 93/85/EEC, 98/57/EC, 2000/29/EC, 2006/91/EC and 2007/33/EC. OJ L 317, 23.11.2016, pp. 4–104.

<sup>2</sup> Commission Implementing Regulation (EU) 2018/2019 of 18 December 2018 establishing a provisional list of high risk plants, plant products or other objects, within the meaning of Article 42 of Regulation (EU) 2016/2031 and a list of plants for which phytosanitary certificates are not required for introduction into the Union, within the meaning of Article 73 of that Regulation C/2018/8877. OJ L 323, 19.12.2018, pp. 10–15.

<sup>3</sup> 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, 1.2.2002, pp. 1–24.



In its evaluation the Panel:

- Checked whether the provided information in the technical dossier (hereafter referred to as 'the Dossier') provided by Peru (PE) was sufficient to conduct a commodity risk assessment. When necessary, additional information was requested to the Peruvian NPPO.
- Selected the relevant union EU-regulated quarantine pests and protected zone quarantine pests (as specified in Commission Implementing Regulation (EU) 2019/2072<sup>4</sup>, hereafter referred to as 'EU quarantine pests') and other relevant pests, absent and not regulated in the EU, present in Peru and associated with the commodity.
- For those Union quarantine pests for which specific measures are in place for the import of the commodity from the specific country in Commission Implementing Regulation (EU) 2019/2072, the assessment was restricted to whether or not the applicant country applies those measures. The effectiveness of those measures was not assessed.
- For those Union quarantine pests for which no specific measures are in place for the import of the commodity from the specific applicant country and other relevant pests present in applicant country and associated with the commodity, the effectiveness of the measures described by the applicant in the dossier was assessed.

Risk management decisions are not within EFSA's remit. Therefore, the Panel provided a rating based on expert judgement regarding the likelihood of pest freedom for each relevant pest given the risk mitigation measures proposed by Servicio Nacional de Sanidad Agraria del Perú (hereafter SENASA).

## 2. Data and methodologies

### 2.1. Data provided by SENASA, Peru

The Panel considered all the data and information in the Dossier provided by SENASA on 20 January 2020, including the additional information provided by SENASA on 07 July 2020, after EFSA's request. The Dossier is managed by EFSA.

The structure and overview of the Dossier is shown in Table 1. The number of the relevant section is indicated in the opinion when referring to a specific part of the Dossier.

**Table 1:** Structure and overview of the Dossier

Dossier section	Overview of contents	Filename
1	Technical Dossier on <i>Ullucus tuberosus</i> (complete document)	REF2 CARTA N 0031-2020-DSV (IMP.TUBERCULOS OLLUCO-UE).pdf
2	Additional information provided by SENASA on 07 July 2020	ADJ CARTA-0329-2020-DSV ( <i>Ullucus tuberosus</i> ).pdf

The data and supporting information provided by SENASA formed the basis of the commodity risk assessment.

Data sources used by SENASA to compile the Dossier (details on literature searches can be found in the Dossier Section 1) (Table 2).

<sup>4</sup> 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. OJ L 319, 10.12.2019, p. 1–279.

**Table 2:** Database sources used in the literature searches by SENASA

Database name and service provider	URL of database	Justification for choosing database
CABI Crop Protection Compendium Provider: CAB International	<a href="https://www.cabi.org/cpc/">https://www.cabi.org/cpc/</a>	A database compiling scientific information on all aspects of crop protection, including extensive global coverage of pests, diseases, weeds and their natural enemies, the crops that are their hosts and the countries in which they occur
EPPO Global Database Provider: European and Mediterranean Plant Protection Organization	<a href="https://gd.eppo.int/">https://gd.eppo.int/</a>	Provides all pest-specific information that has been produced or collected by EPPO
Alcázar J., Gonzalo A. y S. Mayta. 2004. Capítulo V - Plagas y su Control. p. 59–71. "El cultivo del Olluco en la Sierra Central del Perú" editado por Glicerio López y Michael Hermann. 133 pp.	<a href="https://books.google.com.pe/">https://books.google.com.pe/</a>	Scientific publication about ulluco in Peru
Avalos, C. 2008. Olluco: Sabrosa raíz andina. Revista Generación, Lima – Perú. Volumen 78: p. 42–47. "Estabilidad genética de germoplasma de olluco ( <i>Ullucus tuberosus</i> Caldas) conservado ex situ", Tesis para optar el grado de Magister Scientiae en Mejoramiento Genético de Plantas.	<a href="http://repositorio.lamolina.edu.pe">http://repositorio.lamolina.edu.pe</a>	Website (of the University of La Molina, Lima, Peru) that includes scientific and academic production on Andean crops and agricultural production
Brücher, H. 1967. <i>Ullucus aborigineus</i> spec. nov., die Wildform einer andinen Kulturpflanze. Ber Deutsch. Bot. Ges. 80(4): p. 376–381. "Estabilidad genética de germoplasma de olluco ( <i>Ullucus tuberosus</i> Caldas) conservado ex situ", Tesis para optar el grado de magister scientiae en mejoramiento genético de plantas.	<a href="http://repositorio.lamolina.edu.pe/">http://repositorio.lamolina.edu.pe/</a>	
Cadima, X., G. Valdivia, V. Guzmán. 1997. Caracterización morfológica y bioquímica (pruebas preliminares). En: Informe anual 1996-97 IBTA PROINPA. Technical information on Ulluco ( <i>Ulluco tuberosus</i> ) to export European Union 26 Cochabamba, Bolivia. p. 934–936. El cultivo del Olluco en la Sierra Central del Perú" editado por Glicerio López y Michael Hermann. 133 pp.	<a href="https://books.google.com.pe/">https://books.google.com.pe/</a>	Website holding several scientific publications about ulluco in Peru
Calzada, J.; C. Mantari. 1954. Cultivo y variedades del olluco en Puno. Perú, La Vida Agrícola 31(363): p. 139–144. "El cultivo del Olluco en la Sierra Central del Perú" editado por Glicerio López y Michael Hermann. 133 pp.	<a href="https://books.google.com.pe/">https://books.google.com.pe/</a>	
Cárdenas, M. 1969. Manual de plantas económicas de Bolivia. Cochabamba, Imprenta Ichus, p. 54–60. "Estabilidad genética de germoplasma de olluco ( <i>Ullucus tuberosus</i> Caldas) conservado ex situ". Tesis para optar el grado de magister scientiae en mejoramiento genético de plantas.	<a href="http://repositorio.lamolina.edu.pe/">http://repositorio.lamolina.edu.pe/</a>	Website of the University of La Molina, (Lima, Peru) including academic publications on Andean crops and agricultural production

Database name and service provider	URL of database	Justification for choosing database
Chuquillanqui C., Fuentes S. y Holle M. 2004. Capítulo III – Las Enfermedades causadas por virus y su control. p. 20–38 “El cultivo del Olluco en la Sierra Central del Perú” editado por Glicerio López y Michael Hermann. 133 pp.	<a href="https://books.google.com.pe/">https://books.google.com.pe/</a>	Website holding several scientific publications about ulluco in Peru
Farfán, A. 1998. Comparativo ecofisiológico preliminar de oca, ulluco y ñu en diferentes altitudes de la C.C. Pícol, Taray, Calca. Universidad Nacional de San Antonio Abad del Cusco, Perú. 172 p. “Composición nutricional y de mucílago de tres variedades de olluco ( <i>Ullucus tuberosus</i> Loz.) para la obtención de chuño de olluco en el distrito de santotomás – cusco”. Tesis para optar al título profesional de ingeniero agropecuario.	<a href="http://repositorio.unsaac.edu.pe/">http://repositorio.unsaac.edu.pe/</a>	
Frere, M.; J. Rea; J. Rijks. 1977. <i>Ullucus tuberosus</i> . En: M. Frere; J. Rea; J. Rijks (eds.). Estudio agroclimatológico de la zona andina. Organización de las NU para la Agricultura y la Alimentación (FAO), Roma, Italia. p. 331–337. “El cultivo del Olluco en la Sierra Central del Perú” editado por Glicerio López y Michael Hermann. 133 pp.	<a href="https://books.google.com.pe/">https://books.google.com.pe/</a>	
IPGRI/CIP, 2003. Descriptores del Ulluco ( <i>Ullucus tuberosus</i> ). Instituto Internacional de Recursos Fitogenéticos, Roma, Italia; Centro Internacional de la Papa, Lima Perú.	<a href="https://books.google.com.pe/">https://books.google.com.pe/</a>	
Jeffries CJ, 1998. FAO/IPGRI technical guidelines for the safe movement of germplasm. No. 19: Potato. FAO/IPGRI Technical Guidelines for the Safe Movement of Germplasm. No. 19. Potato, No. 19:177 pp.; many ref.	<a href="https://www.cabi.org/cpc/datasheet/42783">https://www.cabi.org/cpc/datasheet/42783</a>	A database compiling scientific information on all aspects of crop protection, including extensive global coverage of pests, diseases, weeds and their natural enemies, the crops that are their hosts and the countries in which they occur
Jones RAC; Fribourg CE, 1977. Beetle, contact and potato true seed transmission of Andean potato latent virus. <i>Annals of Applied Biology</i> , 86(1):123-128	<a href="https://www.cabi.org/cpc/datasheet/42518">https://www.cabi.org/cpc/datasheet/42518</a>	
Jones RAC; Fribourg CE, 1981. Andean potato latent virus. In: Hooker WJ, ed. <i>Compendium of Potato Diseases</i> . St Paul, MN, USA: APS Press, 78.	<a href="https://www.cabi.org/cpc/datasheet/42518">https://www.cabi.org/cpc/datasheet/42518</a>	
King, SR. 1988. Economic Botany of the Andean Tuber Crop Complex: <i>Lepidium Meyenii</i> , <i>Oxalis tuberosa</i> , <i>Tropaeolum Tuberosum</i> and <i>Ullucus tuberosus</i> . Ph. D. Thesis, The City University, New York, 282 p. <b>Name of the resource:</b> “El cultivo del Olluco en la Sierra Central del Perú” editado por Glicerio López y Michael Hermann. 133 pp.	<a href="https://books.google.com.pe/">https://books.google.com.pe/</a>	Website giving access to scientific publications about ulluco in Peru
León, J. 1964. Plantas alimenticias andinas. Instituto Interamericano de Ciencias Agrícolas, Zona Andina, Lima, Perú. 112 p. “El cultivo del Olluco en la Sierra Central del Perú” editado por Glicerio López y Michael Hermann. 133 pp.	<a href="https://books.google.com.pe/">https://books.google.com.pe/</a>	
Lizarraga C; Santa Cruz M; Salazar LF, 1996. First report of potato leafroll luteovirus in ulluco ( <i>Ullucus tuberosus</i> Caldas). <i>Plant Disease</i> , 80(3):344. “El cultivo del Olluco en la Sierra Central del Perú” editado por Glicerio López y Michael Hermann. 133 pp.	<a href="https://books.google.com.pe/">https://books.google.com.pe/</a>	
Montaldo, A. 1972. Cultivo de raíces y tubérculos tropicales. Organización de Estados Americanos. Instituto Interamericano de Ciencias Agrícolas, Perú. p. 210–211.	<a href="https://books.google.com.pe/">https://books.google.com.pe/</a>	

Database name and service provider	URL of database	Justification for choosing database
Missouri Botanical Garden, 2008. "Trópicos". <a href="http://www.tropicos.org">www.tropicos.org</a> , Saint Louis, Missouri - EEUU. "Estabilidad genética de germoplasma de olluco ( <i>Ullucus tuberosus</i> Caldas) conservado ex situ", Tesis para optar el grado de magister scientiae en mejoramiento genético de plantas.	<a href="http://repositorio.lamolina.edu.pe/">http://repositorio.lamolina.edu.pe/</a>	Website of the University of La Molina, (Lima, Peru) including academic publications on Andean crops and agricultural production
National Research Council. 1989. Lost Crops of the Incas: Little-Known Plants of the Andes with Promise for Worldwide Cultivation. National Academy Press. Washington D.C., USA. p. 106. "Estabilidad genética de germoplasma de olluco ( <i>Ullucus tuberosus</i> Caldas) conservado ex situ", Tesis para optar el grado de magister scientiae en mejoramiento genético de plantas.	<a href="http://repositorio.lamolina.edu.pe/">http://repositorio.lamolina.edu.pe/</a>	
Pietilä, L; Tapia, M. 1991. Investigaciones sobre ulluku. Universidad de Turku, Finlandia, 67 p. "Estabilidad genética de germoplasma de olluco ( <i>Ullucus tuberosus</i> Caldas) conservado ex situ", tesis para optar el grado de magister scientiae en mejoramiento genético de plantas.	<a href="http://repositorio.lamolina.edu.pe/">http://repositorio.lamolina.edu.pe/</a>	
Rousi, A; Jokela, P; Kalliola, R; Pietilä, L; Salo, J; Yli-Rekola, M. (1989). Morphological variation among clones of ulluco ( <i>Ullucus tuberosus</i> , Basellaceae) collected in southern Peru. Economic Bot. 43 (1): 58-72. <b>Name of the resource:</b> "Estabilidad genética de germoplasma de olluco ( <i>Ullucus tuberosus</i> Caldas) conservado ex situ", Tesis para optar el grado de magister scientiae en mejoramiento genético de plantas.	<a href="http://repositorio.lamolina.edu.pe/">http://repositorio.lamolina.edu.pe/</a>	
SIEA, 2012. Boletín del Sistema Integrado de Estadísticas Agrarias (SIEA). Oficina de Estudios Económicos y Estadísticos. Ministerio de Agricultura, Lima, Perú. <b>Name of the resource:</b> "Estabilidad genética de germoplasma de olluco ( <i>Ullucus tuberosus</i> Caldas) conservado ex situ", tesis para optar el grado de magister scientiae en mejoramiento genético de plantas.	<a href="http://repositorio.lamolina.edu.pe/">http://repositorio.lamolina.edu.pe/</a>	
Tapia, M; Arbizu, C. 1991. Los sistemas de rotación de los cultivos andinos subexplotados en los Andes del Perú. En: VII Congreso Internacional sobre Cultivos Andinos. Centro Internacional de la papa. Lima, Perú. "Estabilidad genética de germoplasma de olluco ( <i>Ullucus tuberosus</i> Caldas) conservado ex situ". Tesis para optar el grado de magister scientiae en mejoramiento genético de plantas.	<a href="http://repositorio.lamolina.edu.pe/">http://repositorio.lamolina.edu.pe/</a>	Academic repository of the University of San Antonio Abad (Cusco, Peru) containing publications about ulluco in Peru.
Tapia, M. y Fries, A. 2007. Guía de campo de los cultivos andinos (En línea). Consultado 18 de junio. 2019. FAO y ANPE. Lima. "Composición nutricional y de mucílago de tres variedades de olluco ( <i>Ullucus tuberosus</i> Loz.) para la obtención de chuño de olluco en el distrito de santo tomas – cusco". Tesis para optar al título profesional de ingeniero agropecuario.	<a href="http://repositorio.unsaac.edu.pe/">http://repositorio.unsaac.edu.pe/</a>	

## 2.2. Literature searches performed by EFSA

Literature searches were undertaken by EFSA to compile a list of pests potentially associated with *U. tuberosus*. Two searches were combined: (i) a general search to identify pests of *U. tuberosus* in different databases and (ii) a tailored search to identify whether these pests are present or not in Peru and the EU. The searches were run between 23 March and 3 April 2020. No language, date or document type restrictions were applied in the search strategy.

The Panel used several databases (Table 3) to compile the list of pests associated with the *U. tuberosus*. As for Web of Science, the literature search was performed using a specific, ad hoc established search string (see Appendix B). The string was run in 'All Databases' with no range limits for time or language filters (Section 2.3.2 and Appendix D).

**Table 3:** Databases used by EFSA for the compilation of the pest list associated with *U. tuberosus*

Database	Platform/Link
A catalog of the Cecidomyiidae (Diptera) of the world	<a href="https://www.ars.usda.gov/ARUserFiles/80420580/Gagne_2014_World_Cecidomyiidae_Catalog_3rd_Edition.pdf">https://www.ars.usda.gov/ARUserFiles/80420580/Gagne_2014_World_Cecidomyiidae_Catalog_3rd_Edition.pdf</a>
A Catalog of the Eriophoridae (Acarina: Prostigmata) of the world	<a href="https://www.cabi.org/isc/abstract/19951100613">https://www.cabi.org/isc/abstract/19951100613</a>
Aphids on World Plants	<a href="http://www.aphidsonworldsplants.info/C_HOSTS_AAIntro.htm">http://www.aphidsonworldsplants.info/C_HOSTS_AAIntro.htm</a>
CABI Crop Protection Compendium	<a href="https://www.cabi.org/cpc/">https://www.cabi.org/cpc/</a>
Database of Insects and their Food Plants	<a href="http://www.brc.ac.uk/dbif/hosts.aspx">http://www.brc.ac.uk/dbif/hosts.aspx</a>
Database of the World's Lepidopteran Hostplants	<a href="https://www.nhm.ac.uk/our-science/data/hostplants/search/index.dsmi">https://www.nhm.ac.uk/our-science/data/hostplants/search/index.dsmi</a>
EPPO Global Database	<a href="https://gd.eppo.int/">https://gd.eppo.int/</a>
EUROPHYT	<a href="https://webgate.ec.europa.eu/europhyt/">https://webgate.ec.europa.eu/europhyt/</a>
TRACES NT	<a href="https://webgate.ec.europa.eu/tracesnt/">https://webgate.ec.europa.eu/tracesnt/</a>
Leaf-miners	<a href="http://www.leafmines.co.uk/html/plants.htm">http://www.leafmines.co.uk/html/plants.htm</a>
Nemaplex	<a href="http://nemaplex.ucdavis.edu/Nemabase2010/PlantNematodeHostStatusDDQuery.aspx">http://nemaplex.ucdavis.edu/Nemabase2010/PlantNematodeHostStatusDDQuery.aspx</a>
New Zealand Fungi	<a href="https://nzfungi2.landcareresearch.co.nz/default.aspx?NavControl=search&amp;selected=NameSearch">https://nzfungi2.landcareresearch.co.nz/default.aspx?NavControl=search&amp;selected=NameSearch</a>
NZFUNGI - New Zealand Fungi (and Bacteria)	<a href="https://nzfungi.landcareresearch.co.nz/html/mycology.asp?ID=">https://nzfungi.landcareresearch.co.nz/html/mycology.asp?ID=</a>
Plant Pest Information Network	<a href="https://www.mpi.govt.nz/news-and-resources/resources/registers-and-lists/plant-pest-information-network/">https://www.mpi.govt.nz/news-and-resources/resources/registers-and-lists/plant-pest-information-network/</a>
Plant Viruses Online	<a href="http://bio-mirror.im.ac.cn/mirrors/pvo/vide/famindex.htm">http://bio-mirror.im.ac.cn/mirrors/pvo/vide/famindex.htm</a>
Scalenet	<a href="http://scalenet.info/associates/">http://scalenet.info/associates/</a>
Spider Mites Web	<a href="https://www1.montpellier.inra.fr/CBGP/spmweb/advanced.php">https://www1.montpellier.inra.fr/CBGP/spmweb/advanced.php</a>
USDA ARS Fungi Database	<a href="https://nt.ars-grin.gov/fungalatabases/fungushost/fungushost.cfm">https://nt.ars-grin.gov/fungalatabases/fungushost/fungushost.cfm</a>
Web of Science: All Databases (Web of Science Core Collection, CABI: CAB Abstracts, BIOSIS Citation Index, Chinese Science Citation Database, Current Contents Connect, Data Citation Index, FSTA, KCI-Korean Journal Database, Russian Science Citation Index, MEDLINE, SciELO Citation Index, Zoological Record)	Web of Science <a href="https://www.webofknowledge.com">https://www.webofknowledge.com</a>
World Agroforestry	<a href="http://www.worldagroforestry.org/treedb2/speciesprofile.php?Spid=1749">http://www.worldagroforestry.org/treedb2/speciesprofile.php?Spid=1749</a>

Additional searches, limited to retrieve documents, were run when developing the opinion. The available scientific information, including previous EFSA opinions on the relevant pests and diseases (see pest data sheets in Appendix A) and the relevant literature and legislation (e.g. Regulation

(EU) 2016/2031; Commission Implementing Regulations (EU) 2018/2019; (EU) 2018/2018 and (EU) 2019/2072) were taken into account.

## 2.3. Methodology

When developing the opinion, the Panel followed the EFSA Guidance on commodity risk assessment for the evaluation of high-risk plant dossiers (EFSA PLH Panel, 2019a).

In the first step, pests associated with the commodity in the country of origin (EU-regulated pests and other pests) that may require risk mitigation measures were identified.

In this opinion, relevant EU non-quarantine pests were selected based on evidence for their potential impact for the EU. After the first step, all the relevant pests that may need risk mitigation measures were identified.

In the second step, the overall efficacy of the proposed risk mitigation measures for each pest was evaluated. A conclusion on the pest freedom status of the commodity for each of the relevant pests was achieved and uncertainties were identified.

### 2.3.1. Commodity data

Based on the information provided by the SENASA, the characteristics of the commodity were summarised.

### 2.3.2. Identification of pests potentially associated with the commodity

To identify which pests could potentially enter the EU with the import of ulluco tubers from Peru a pest list was compiled. The pest list is a compilation of all identified plant pests associated with *U. tuberosus* based on information provided in the Dossier Section 1 and on searches performed by the Panel. The search strategy and search syntax were adapted to each of the databases listed in Table 3, according to the options and functionalities of the different databases and CABI keyword thesaurus.

The scientific names of the host plants (i.e. *Ullucus tuberosus*) were used when searching in the EPPO Global database and CABI Crop Protection Compendium. The same strategy was applied to the other databases excluding EUROPHYT and Web of Science.

EUROPHYT and TRACES NT was consulted by searching for the interceptions associated with commodities imported from Peru, at species and genus level, from 1995 to present.

The search strategy used for Web of Science Databases was designed combining common names for pests and diseases, terms describing symptoms of plant diseases and the scientific and common names of the commodity. All of the pests already retrieved using the other databases were removed from the search terms in order to be able to reduce the number of records to be screened. The established search string is detailed in Appendix B, and was run on 27 March 2020.

The titles and abstracts of the scientific papers retrieved were screened and the pests associated with *U. tuberosus* were included in the pest list. The pest list was eventually further supplemented with other relevant information (e.g. EPPO code per pest, taxonomic information, categorisation, distribution) useful for the selection of the pests relevant for the purposes of this opinion.

Finally, the list was also completed by including the pests listed in the Dossier provided by the applicant country, if they were not found using the other sources of information listed above.

The compiled pest list (see Microsoft Excel<sup>®</sup> in Appendix D) includes all identified pests that use as host the *U. tuberosus*.

According to the Interpretation of Terms of Reference, the EU quarantine pests that are regulated as a group in the Commission Implementing Regulation (EU) 2019/2072 were considered and evaluated separately at species level.

The evaluation of the compiled pest list was done in two steps: first, the relevance of the EU-quarantine pests was evaluated (Section 4.1); second, the relevance of any other plant pest was evaluated (Section 4.2).

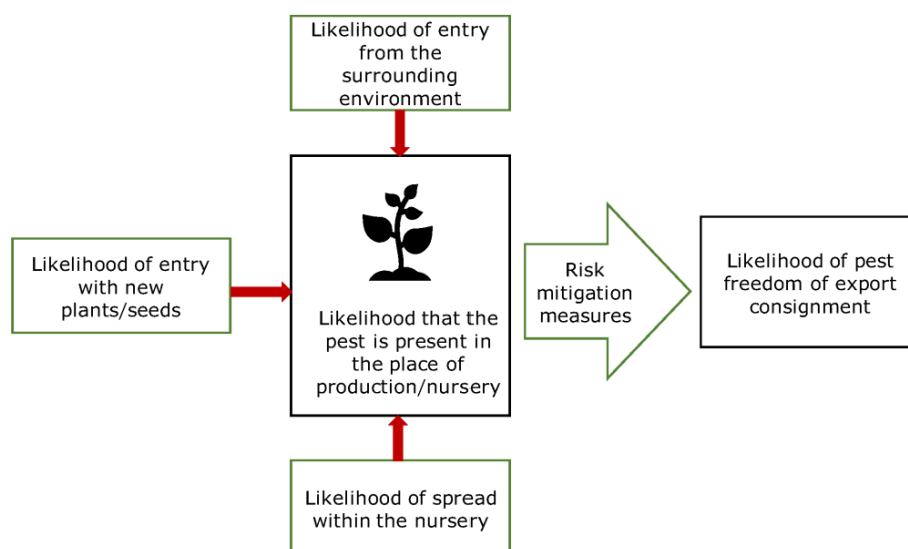
Pests for which limited information was available on one or more criteria used to identify them as relevant for this opinion, e.g. on potential impact, are listed in Appendix C (List of pests that can potentially cause an effect not further assessed).



### 2.3.3. Listing and evaluation of risk mitigation measures

All currently used risk mitigation measures were listed and evaluated. When evaluating the likelihood of pest freedom at origin, the following types of potential infection sources for *U. tuberosus* in production places were considered (see also Figure 1):

- pest entry from surrounding areas,
- pest entry with new plants/seeds,
- pest spread within the place of production.



**Figure 1:** Conceptual framework to assess likelihood that plants are exported free from relevant pests. Source: EFSA PLH Panel (2019b)

The risk mitigation measures adopted in the production places (as communicated by SENASA, Peru) were evaluated with Expert Knowledge Elicitation (EKE) according to the Guidance on uncertainty analysis in scientific assessment (EFSA Scientific Committee, 2018).

Information on the biology, estimates of likelihood of entry of the pest to the production places and spread within the production places and the effect of the measures on a specific pest were summarised in pest data sheets compiled for each pest selected for further evaluation (see Appendix A).

To estimate the level of pest freedom of the commodities, a semi-formal expert knowledge elicitation (EKE) was performed following Annex B.8 on semi-formal EKE of the EFSA opinion on the principles and methods behind EFSA's Guidance on Uncertainty Analysis in Scientific Assessment (EFSA Scientific Committee, 2018). The specific question for the semi-formal EKE was defined as follows: 'Taking into account (i) the risk mitigation measures in place in the export production place, and (ii) other relevant information, how many of 10,000 *U. tuberosus* tubers will be infested with the relevant pest/pathogen when arriving in the EU?'. The EKE question was common for all the pests that were assessed.

The uncertainties associated with the EKE were taken into account and quantified in the probability distribution applying the semi-formal method described in section 3.5.2 of the EFSA-PLH Guidance on quantitative pest risk assessment (EFSA PLH Panel, 2018). Finally, the results were reported in terms of the likelihood of pest freedom. The lower 5% percentile of the uncertainty distribution reflects the opinion that pest freedom is with 95% certainty above this limit.

## 3. Commodity data

### 3.1. Description of the commodity

The commodity to be imported are tubers of *U. tuberosus* (common name: ulluco; family: Basellaceae).



According to Fries and Tapia (2007), *U. tuberosus* plants can be differentiated in two major groups according to size:

- Plants of crawling type: with stems slightly red-coloured, small leaves and elongated red-purple tubers, typical of the northern Andes and Colombia.
- Erect plants: with large base and intense green-coloured leaves and tubers of different colours, common in Peru and Bolivia.

In Peru according to the information provided in the dossier (Section 1), farmers cultivate a number of varieties, such as:

- Chuqchan smooth: elongated shape and superior quality.
- Q'ello chuqcha: yellow tubers.
- Muru lisa: pink tubers and early growth.
- Yuraq lisa: white tubers.
- Bela api chuqcha: yellow–reddish tubers.
- Puka smooth: reddish tubers.
- *Papa lisa*: orange tubers of round shape.
- K'ita lisa, ataq lisa and k'ipa ullucu: wild varieties.

Ulluco is a crop of the Andean region and is managed mainly by subsistence farmers. The reproduction is asexual meaning that the producers select the 'seed' tubers from the best plants of the previous crop/harvest to be used as propagation materials. Sowing is direct and nurseries are not required.

The part of the plant used is the tuber which has a cylindrical, oval, falcate and fusiform shape at both ends. They develop at the end of the adventitious roots and their shape varies from spherical to cylindrical. They have attractive colours such as white, yellow, light green, pink, orange, violet or purple.

According to the standard morphological descriptors of the IPGRI/CIP (2003) regarding the shape of the tubers, there are only four forms in ulluco i.e. round, cylindrical, semi-sickle like and twisted. However, it is common to see in other germplasm collections (Ecuador, Bolivia and Peru) also ovoid tubers. The standard descriptors do not refer to the eyes, probably because they are not parameters of description of the species variability, however, the ulluco eyes are characterised because they are very superficial and without bracts (Cadima et al., 1996).

Exported tubers are intended to be distributed and reach the final consumer and international food market facilities and not as planting material. However, the tubers are viable and could theoretically be planted. It has been reported that Andean potato latent virus (APLV) (an EU quarantine pathogen) was detected in ulluco plantings in the UK which originated from an 'unregulated internet purchase' (Fox et al., 2019).

### 3.2. Description of the production areas

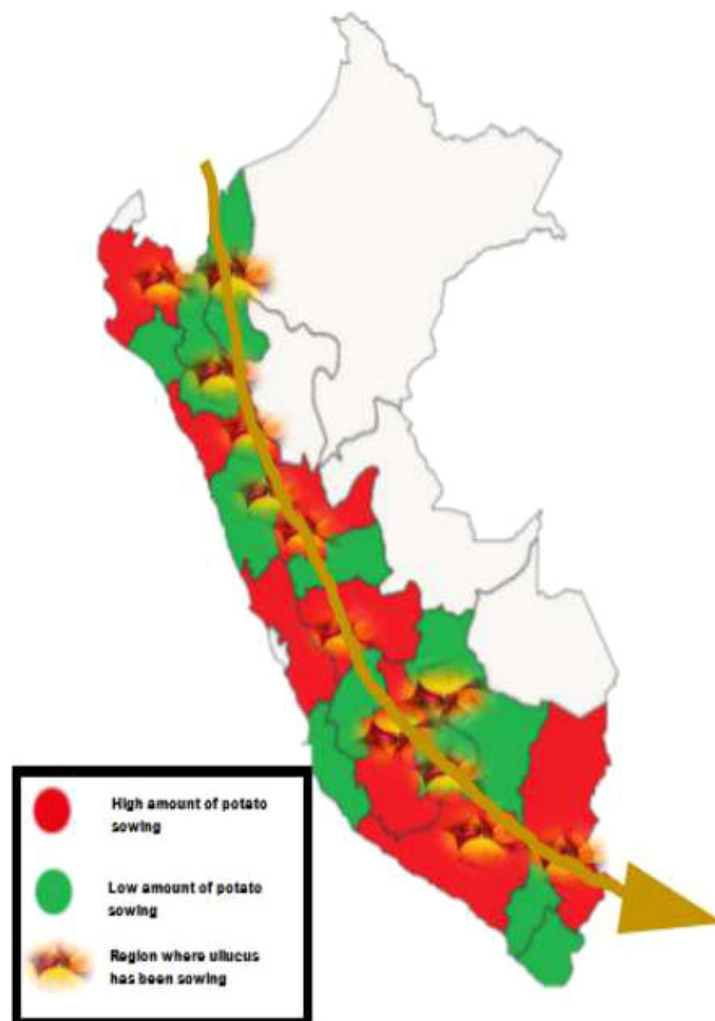
The crop is grown in almost all South America, especially in the Andean regions from Venezuela to Bolivia at an altitudinal range that reaches 4,000 metres above sea level (a.s.l.). Ulluco is a highly relevant crop from the social and economic perspectives in the high Andean region (King, 1988), so it is the most important and consumed crop after *S. tuberosum* (hereafter referred to as potato) in all Andean countries (León, 1964; Cárdenas, 1969; Pietila and Tapia, 1991). It is adapted to extreme cold (it is a frost resistant crop) and drought conditions, typical of the high mountains. In Peru, ulluco is cultivated in marginal soils with an average yearly yield of ca. 6–7 metric tons (mt) per ha under traditional conditions (National Research Council, 1989; SIEA, 2012). Ulluco is a crop managed mainly by subsistence farmers, in plots ranging between 100 and 2,000 m<sup>2</sup> although in some sites lots of up to 2 ha have been observed.

In Peru, the main export production areas are located in the regions of Apurímac, Arequipa, Cajamarca, Cusco, Huancavelica, Huánuco, Junín, Pasco and Puno (Figure 2), covering 21,559 ha (in 2018). Production also takes place in Ayacucho and La Libertad. In Peru, the ulluco cultivation area is conducted between 2,600 and 3,800 m.a.s.l., but its optimum area can be found between 3,000 and 3,600 m, with temperatures ranging between 8 and 14 °C, and water requirements of 600–1,000 mm.

Ulluco is often grown in rotation or in combination with potato as well as other crops e.g. *Chenopodium quinoa* (quinoa), *Oxalis tuberosum* (oca), *Tropaeolum tuberosum* (mashua), *Phaseolus* spp. (beans) and/or *Hordeum vulgare* (barley) and some of the pests are shared among these crops. Areas of potato production are widespread in Peru (Figure 3), and in many of these areas, ulluco is also grown. According to the dossier, the area where ulluco is grown covers 27,846 hectares in the Peruvian highlands and these represent 9% of the total potato-growing area in Peru (Table 4).



**Figure 2:** Export production areas in Peru are the regions of Apurímac, Arequipa, Cajamarca, Cusco, Huancavelica, Huánuco, Junín, Pasco and Puno (highlighted in pink) as provided in the dossier



**Figure 3:** Potato and ulluco production areas in Peru (areas of high potato production in red, low potato production in green, and ulluco in yellow) as specified in the dossier

**Table 4:** Production area (ha) of ulluco and potato in Peru

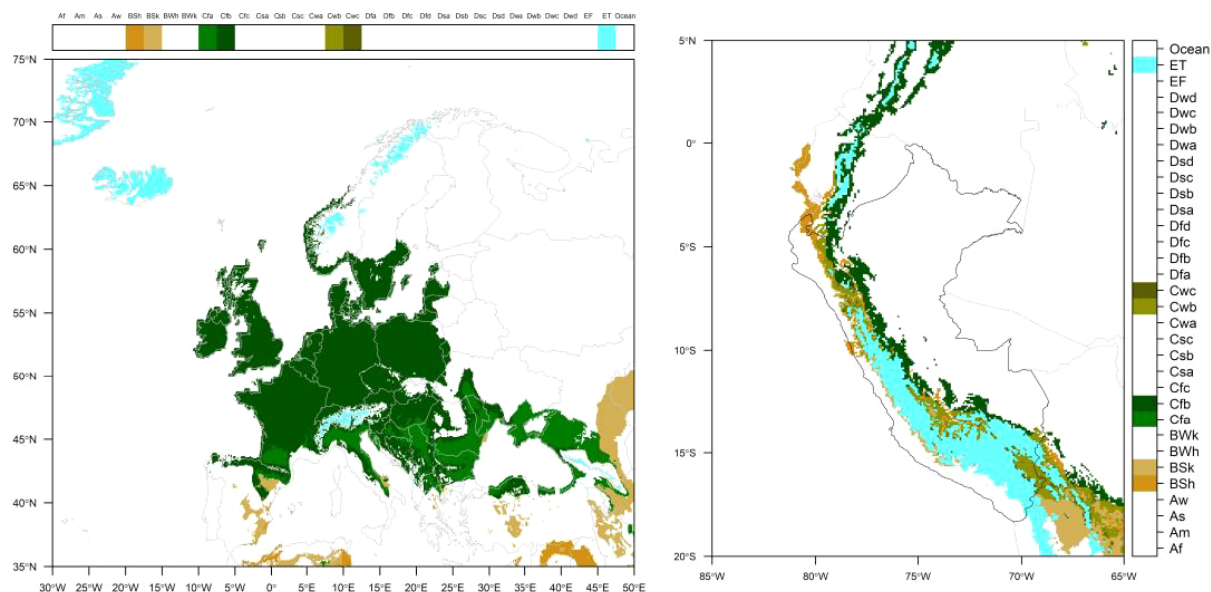
Peruvian Region	Potato area	Ulluco area
Puno	59,469	2,772
Huanuco	43,210	2,186
Cuzco	30,901	4,251
Cajamarca	28,496	3,516
Huancavelica	28,240	2,797
Apurimac	24,941	2,686
La Libertad	23,864	1,581
Junin	23,837	2,549
Ayacucho	22,991	2,853
Ancash	9,813	676
Arequipa	9,604	31
Pasco	9,208	802
Lima	4,947	167
Amazonas	4,002	193
Piura	1,990	446
Lambayeque	746	340
Total	326,259	27,846

There is no distinction of the phytosanitary conditions of ulluco from one region to another and between production areas within the same region.

Based on the global Köppen–Geiger climate zone classification (Kottek et al., 2006), the climate of the production areas of *U. tuberosus* in Peru are classified as: Cwb, Cwc, Cfb, Bsh, Bsk and ET (Table 5); Cwb: main climate (C):warm temperature; precipitation (w): *winter dry*; temperature (b): warm summer, Cwc: main climate, (C):warm temperature; precipitation (w): *winter dry*; temperature (c): *cool summer*, Cfb: main climate, (C):warm temperature; precipitation (f): *fully humid*; temperature (b): *warm summer*, Bsh: main climate, (B): arid; precipitation (s): *summer dry*; temperature (h): *hot arid*, Bsk: main climate, (B): arid; precipitation (s): *summer dry*; temperature (k): *cold arid*, ET: main climate, (E): polar; temperature (T): *polar tundra*.

**Table 5:** Climatic classification, according to Köppen–Geiger, of ulluco production regions as provided by SENASA (Dossier, Section 2)

Region	Climate according to Köppen–Geiger
Cajamarca	Cwb
Huánuco	BSh
Pasco	Cfb and ET
Junín	Cfb and ET
Huancavelica	Cfb, ET and Bsk
Ayacucho	Bsk
Apurímac	Cfb, ET, Cwb and Cwc
Cusco	Cwb
Puno	ET, Cfb and Cwc



**Figure 4:** Distribution of Köppen–Geiger climate subgroups: Cwb, Cwc, Cfb, Bsh, Bsk and ET in ulluco production areas in Peru (right); and distribution of Köppen–Geiger of climate subgroups in EU27 similar to those in Peru (left). The Köppen–Geiger map is based on Kottek et al., 2006, downscaled after Rubel et al. (2017), it is representative for the period 1986–2010 and provided at a resolution of 5 arc min (Source: <http://koeppen-geiger.vu-wien.ac.at/present.htm>)

In 1948, ulluco was introduced to Europe as a potential alternative crop (King, 1988); but according to Rousi et al. (1989), interest in the crop was lost due to its low yields. Cultivation has been reported from other countries such as Finland, France and New Zealand (Avalos, 2008), but supporting data are scarce. Extensive cultivation in a high-latitude, temperate region without a long autumn, such as Finland, is unlikely due to day length requirements for tuberisation.

### 3.3. Production and handling processes

#### 3.3.1. Source of planting material

Tubers from previous harvest season are used for planting. The farmer selects the tubers for planting based on visual inspection.

#### 3.3.2. Production cycle

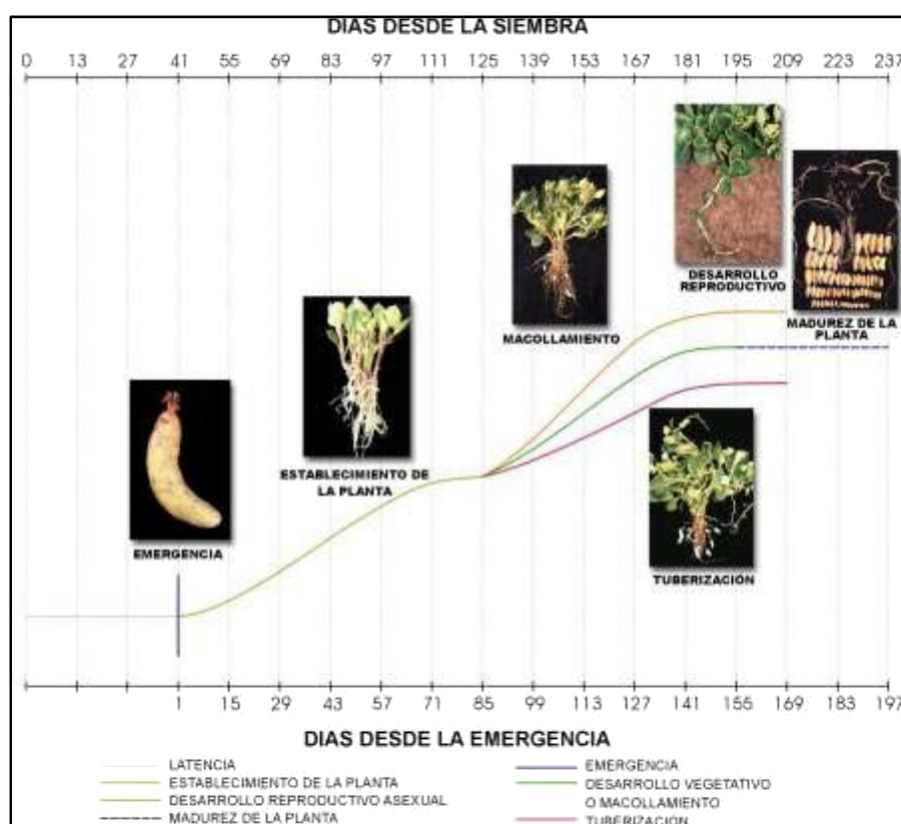
Ulluco is usually cultivated by planting tubers commonly selected from the best plants of the previous season or taken from plants at high altitudes where the incidence of pests and diseases is lower (section 1 of the dossier). These germinate and grow easily at temperatures above 18°C, but withstand temperatures below 0°C. The cultivation period may vary from 5 to 8 months, depending on the variety, requiring 9 months in the highest areas. Ulluco may be harvested from January to April. Tuberisation requires short days i.e. less than 12 h daylight (McMoran and Gauthier, 2014).

### Phenology

The following phenological phases for commercial varieties of ulluco have been experimentally defined as reported in the Dossier (Figure 5, Table 6):

- 1) Emerging – It occurs between 36 and 51 days after sowing and is influenced by precipitation, humidity, temperature, seed tuber maturity and physical properties of the soil as water retention.
- 2) Plant establishment – This period comprises from the emergence of the plant until 85 days later; it is characterised by a rapid root growth, plant height and young leaves. The presence of mature leaves marks the end of this phase.

- 3) Stolon initiation – It starts at 85 days after the emergence and lasts until 155 days later, being characterised by the slow increase of young leaves, the rapid increase of mature leaves and the constant and rapid increase in the number of main and secondary stems/main stem. This phase ends when the plant begins reducing its young and mature leaves, close to the 155 days.
- 4) Reproductive Development – It occurs between 85 and 169 days after the emergence and is characterised by the rapid increase in number of mature leaves, inflorescences and underground and aerial stolons.
- 5) Flowering – It starts at 43 days after emergence
- 6) Tuber filling – It occurs simultaneously phase to the previous two phases. It occurs between 85 and 169 days after the emergence and is characterised by a rapid increase in the number, dimensions and weight of the tubers. Tuber formation begins at 43 days after the emergence. Average tuber weight is approx. 87.4 g and size 9.7 cm length and a 3.4 cm diameter.
- 7) Maturity – It occurs between 155 and 183 days and is characterised by the fall of young and mature leaves, flowering cessation, development of aerial stolons and leaves becoming yellowish.



**Figure 5:** Phases of ulluco growth as provided in the dossier where the top x-axis corresponds with the number of days after sowing (i.e. dias desde siembra in Spanish) and the bottom x-axis corresponds with number of days after emergence (i.e. dias desde la emergencia in Spanish)

**Table 6:** Ulluco phenology based on the information provided in the dossier

Development phases	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Emerging												
Plant establishment												
Stolon initiation												
Reproductive development												
Flowering												
Tuber filling												
Maturity												

Ulluco can be harvested after 180–220 days of growth, depending on the altitude of the plot and the variety.

### 3.3.3. Pest monitoring during production

Main ulluco production areas are under Integrated Pest Management (IPM) mainly combining cultural, mechanical measures and biological control measures. The low temperatures and the seasonality in ulluco production areas result in some pests showing diapause; therefore, crop rotation and fallow are put in practice as basic strategies for pest management. Mechanical control is also used to prevent and manage pest damage (e.g. manual collection of pests). In many cases, the naturally occurring biodiversity (e.g. natural enemies) and intercropping/mixcropping decreases pest occurrence.

SENASA has a Phytosanitary Surveillance System in place that comprises a set of official activities, including the inspection and monitoring of some pests associated with the crop in ulluco production areas (Table 7).

**Table 7:** Pests monitoring by SENASA in ulluco cultivation areas in Peru as reported in the dossier

Plant species	Region	Sample	Specialty	Pest species
<i>Ullucus tuberosus</i>	Ayacucho	Plant	Virology	Ullucus mild mottle virus
	Ayacucho	Leaf	Mycology	<i>Peromospora</i> sp.
	Ayacucho	Leaf	Virology	Tomato mosaic virus
	Apurimac	Leaf	Mycology	<i>Aecidium</i> sp.
	Puno	Leaf	Mycology	<i>Rhizoctonia solani</i>
	Puno	Leaf	Mycology	<i>Phoma</i> sp.
	Ancash	Leaf	Virology	Andean potato latent virus
	Ancash	Leaf	Virology	Potato virus T
	Ancash	Leaf	Virology	Potato leaf roll virus
	Ancash	Leaf	Virology	Papaya mosaic virus

### 3.3.4. Post-harvest processes and export procedure

After an initial selection in the field (discarding small or diseased tubers), harvested ulluco tubers are transported by truck from the place of production to the packinghouse. Each truck is clean, has its security seal and enters to packinghouse that has Sanitary Authorization, issued by SENASA.

In the packing house, a rigorous selection is made, checking and dry cleaning each of the tubers. The cleaning of the tubers is carried out in two stages. The first is mechanical and the second stage is carried out by staff who clean tuber after tuber, and at the same time carry out a selection process to remove ulluco tubers that are found to be damaged or with pest symptoms. The process of inspection and phytosanitary certification developed by SENASA involves sampling of 2% of the tubers. This sample is visually inspected and if there is any suspicion of the presence of a pest, further investigation is done on the tuber by a laboratory analysis.

The tubers are packed in cardboard and plastic boxes authorised for export to the European Union. The weight of packaging can be 3 kg, 5 kg, 10 kg, and 18 kg. Tubers are kept in boxes, organised in pallets maintained at 2°C and 90–95% of relative humidity. The final export product is also controlled and certified by SENASA prior to airborne shipment (Dossier section 1 and 2).



## 4. Identification of pests potentially associated with the commodity

The search for potential pests associated with *U. tuberosus* rendered 85 species (see Microsoft Excel<sup>®</sup> file in Appendix D).

### 4.1. Selection of relevant EU-quarantine pests associated with the commodity

The EU listing of union quarantine pests and protected zone quarantine pests (Commission Implementing Regulation (EU) 2019/2072) is based on assessments concluding that the pests can enter, establish, spread and have potential impact in the EU.

Four EU-quarantine species that are reported to use *U. tuberosus* as a host plant were evaluated (Table 8) for their relevance of being included in this opinion.

The relevance of an EU-quarantine pest for this opinion was based on evidence that:

- a) the pest is present in Peru;
- b) *U. tuberosus* is host of the pest;
- c) one or more life stages of the pest can be associated with the specified commodity.

Pests that fulfilled all three criteria were selected for further evaluation.

Table 8 presents an overview of the evaluation of the four EU-quarantine pest species known to be present in Peru and for which *U. tuberosus* is reported as a host. Three species (i.e. *Nacobbus aberrans*, Andean potato latent virus (APLV) and potato virus T (PVT)) can be associated with the commodity and were selected for further evaluation.



**Table 8:** Overview of the evaluation of the four EU-quarantine pest species known to use *U. tuberosus* as a host plant for their relevance for this opinion

No.	Pest name according to EU legislation <sup>(a)</sup>	EPPO Code	Group	Pest present in Peru	<i>U. tuberosus</i> confirmed as a host (reference)	Pest can be associated with the commodity	Pest relevant for the opinion
1	<i>Nacobbus aberrans</i>	NACOB	Nematodes	Yes	Yes (CABI, online)	Yes	Yes
2	Andean potato latent virus (APLV)	APLV00	Virus and Viroids	Yes	Yes (CABI, online)	Yes	Yes
3	Potato virus T (PVT)	PVT000	Virus and Viroids	Yes	Yes (CABI, online)	Yes	Yes
4	Potato virus Y (PVY) <sup>(b)</sup>	PVY0	Virus and Viroids	Yes	Yes (Fox et al., 2019)	No <sup>(c)</sup>	No

(a): Commission Implementing Regulation (EU) 2019/2072.

(b): By using NGS, this virus was detected in bulked leaf samples.

(c): Confirmation of presence in tubers was not performed.

## 4.2. Selection of other relevant pests (non-quarantine in the EU) associated with the commodity

The information provided by Peru, integrated with the search EFSA performed, was evaluated in order to assess whether there are other potentially relevant pests of *U. tuberosus* present in the country of export. For these potential pests that are not quarantine in the EU, pest risk assessment information on the probability of introduction, establishment, spread and impact is usually lacking. Therefore, these pests that are potentially associated with *U. tuberosus* were also evaluated to determine their relevance for this opinion based on evidence that:

- a) the pest is present in Peru;
- b) the pest is absent or has a limited distribution in the EU;
- c) *U. tuberosus* is a host of the pest;
- d) one or more life stages of the pest can be associated with the specified commodity;
- e) the pest may have an impact in the EU.

Pests that fulfilled all five criteria were selected for further evaluation.

Based on the information collected, 85 potential pests known to be associated with *U. tuberosus* were evaluated for their relevance to this opinion. Species were excluded from further evaluation when at least one of the conditions listed above (a-e) was not met. Details can be found in the Appendix D (Microsoft Excel<sup>®</sup> file). Of the evaluated EU non-quarantine pests, two pests (*Amathynetoides nitidiventris* and *Atalodera andina*) were selected for further evaluation because they met all of the selection criteria. More information on these two species can be found in the pest datasheets (Appendix A).

## 4.3. Overview of interceptions

Data on the interception of harmful organisms on tubers of *U. tuberosus* can provide information on some of the organisms that can be present on *U. tuberosus* despite the current measures taken. According to EUROPHYT/Traces NT online (accessed on 17/09/20), there were no interceptions of tubers of *U. tuberosus* from Peru destined to the EU Member States due to the presence of harmful organisms between the years 1995 and 17/09/20. *Ullucus tuberosus* was not regulated by previous PH Directive (2000/29 EC), and therefore, there was no obligation to inspect incoming shipments. Thus, the lack of interceptions may not reflect the pest status in previous years.

In the UK, screening of plantings originating from unregulated internet purchases of ulluco tubers has revealed the presence of quarantine pests (Fox et al., 2019, see pest sheet for further details).

According to the Dossier (Table 9), Peru has exported 59,790 kg of ulluco tubers to the EU in 2018, while in 2019, the exported volume was 59,983 kg.

**Table 9:** Exported volume of ulluco tubers (in kg) from Peru into EU countries in 2018 and 2019 (Table 9, data presented in Dossier)

Destination	Net weight (kg)	
	2018	2019
Spain	34,438	45,002
Italy	19,504	8,659
France	530	4,146
Netherlands	5,214	2,094
Germany	83	82
Belgium	15	0
United Kingdom	6	0

## 4.4. List of potential pests not further assessed

From the list of pests not selected for further evaluation, the Panel highlighted two species (see Appendix C) for which the currently available evidence provides no reason to select these species for further evaluation in this opinion. A specific justification of the inclusion in this list is provided for each species in Appendix C.

#### 4.5. Summary of pests selected for further evaluation

The five pests identified to be present in Peru while having potential for association with *U. tuberosus* tubers destined for export are listed in Table 10. The effectiveness of the risk mitigation measures applied to the commodity was evaluated for these selected pests.

**Table 10:** List of relevant pests selected for further evaluation

Number	Current scientific name	EPPO code	Name used in the EU legislation	Taxonomic information	Group	Regulatory status
1	<i>Amathynetoides nitidiventris</i>	–	–	Coleoptera Curculionidae	Insects	Not regulated in the EU
2	<i>Atalodera andina</i>	ATADAN	–	Chromadorea Heteroderidae	Nematodes	Not regulated in the EU
3	<i>Nacobbus aberrans</i>	NACOBAB	<i>Nacobbus aberrans</i> (Thorne) Thorne and Allen	Chromadorea Pratylenchidae	Nematodes	EU Quarantine Pest according to Commission Implementing Regulation (EU) 2019/2072
4	Andean potato latent virus (APLV)	APLV00	Andean potato latent virus	Tymovirales Tymoviridae	Virus and Viroids	EU Quarantine Pest according to Commission Implementing Regulation (EU) 2019/2072
5	Potato virus T (PVT)	PVT000	Potato virus T	Tymovirales Betaflexiviridae	Virus and Viroids	EU Quarantine Pest according to Commission Implementing Regulation (EU) 2019/2072

### 5. Risk mitigation measures

For each selected pest (Table 10), the Panel assessed the possibility that it could be present in an *U. tuberosus* production place and assessed the probability that pest freedom of a consignment is achieved by the proposed risk mitigation measures acting on the pest under evaluation.

The information used in the evaluation of the effectiveness of the risk mitigation measures is summarised in a pest data sheet (see Appendix A).

#### 5.1. Possibility of pest presence in the production places

For each pest (Table 10), the Panel evaluated the likelihood that the pest could be present in an *U. tuberosus* production place by evaluating the possibility that *U. tuberosus* in the export production place are infested either by:

- introduction of the pest from the environment surrounding the production place;
- introduction of the pest with new plants/seeds;
- spread of the pest within the production place.

#### 5.2. Risk mitigation measures applied in Peru

With the information provided by SENASA, Peru (Dossier sections 1 and 2), the Panel summarised the risk mitigation measures that are currently applied in the production places (Table 11).

**Table 11:** Overview of currently applied risk mitigation measures for *U. tuberosus* tubers designated for export to the EU from Peru

Number	Risk mitigation measure	Implementation in Peru
1	Surveillance and monitoring	Personnel trained in SENASA regional offices travel daily to the highland's areas (crop-producing areas) for the identification of anomalies in the ulluco growth, plant symptoms related to the presence of virus or other pests in order to support the producer for pest prevention and management, and also collect samples to the laboratory. Specific details on sampling intensity and protocols applied were not provided in the dossier.
2	Sampling and laboratory testing	The samples are registered in the database 'Integrated System of Plant Health Management' (SIGSVE) and sent the Unit of Diagnostic Center of Plant Health of SENASA, under adequate conditions of protection. The analyses are performed by the SENASA Plant Health Diagnostic Centers Unit, which has diagnostic methods based on pest morphology, ELISA and molecular biology (conventional PCR, real time and sequencing). If a pest is detected, SENASA headquarters and producers are informed and also corrective measures are applied. However, the details of these corrective measures are not specified.
3	Crop rotation	Ulluco production can be part of a rotation scheme with different crops e.g. oca, beans, barley
4	Selection of production sites	Ulluco is produced in sites at high altitudes with potentially temperate environmental conditions
5	Use of healthy propagation and production material	The use of ulluco as a vegetative seed is mainly based on an ocular selection of the harvested tubers. This selection allows farmers to obtain free of any pest or symptomatology that may be counterproductive in the crop. Seed tubers are produced in areas with low incidence of aphids (lower chances of virus transmission) and in these areas, symptomatic plants if present are discarded and not taken for production.
6	Elimination of volunteer plants and crop residues	Volunteer plants can be removed when they are small or their presence is avoided by making a good harvest and eliminating their residues. Damaged, rotten and small tubers left in the fields after harvest allowed weevil larvae and other pests to develop inside and complete their life cycle. These tubers instead must be collected and destroyed. A practical way to eliminate this waste is to introduce animals, such as pigs and sheep, to feed and thus get rid of these tubers
7	Mechanical measures	Manual capture of weevils Use of plastic barriers under stored ulluco tubers
8	Ash application	Application of ash to the neck of the plant during plant emergence and prior to hilling
9	Hilling ( <i>sic</i> 'stubble tillage')	Hilling to support and protect plant growth
10	Application of plant extracts/repellent	Extracts of <i>Lupinus mutabilis</i> and <i>Foeniculum vulgare</i> are applied to prevent infestations of aphids and other insect pests
11	Timely harvest	Timely harvest to reduce the level of insect pest (e.g. weevils) infestation in tubers
12	Winter plough in harvested fields	Fields are ploughed between July and August to destroy weevils by exposing them to the sun and wild birds
13	Poultry use	During the selection of ulluco tubers and after soil removal chickens are used in the field (after harvest) as predators of larvae, pupae and wintering adults.
14	Sorting/grading/tuber selection	Only first category tubers (those for export) are selected in the field Tubers are individually and visually inspected
15	Brushing and cleaning of tubers	Brushing/cleaning of the tubers is carried out. Damaged ulluco tubers and tubers with symptoms of the pests are removed.
16	Pre-consignment inspection	According to SENASA, 2% of tubers are visually inspected; tubers with symptoms are sent for laboratory testing.

Number	Risk mitigation measure	Implementation in Peru
17	Application of vegetal extracts/oils	Use <i>Minthostachis mollis</i> oil extracts/repellents to protect stored products
18	Storage temperature	Export tubers are shipped in containers with a temperature and relative humidity of 2°C, 90%–95% humidity.

### 5.3. Evaluation of the current measures for the selected relevant pests including uncertainties

For each evaluated pest, the relevant risk mitigation measures acting on the pest were identified. Any limiting factors on the effectiveness of the measures were documented. Therefore, the Panel assumes that applications are effective in removing the pest to an acceptable level. If there are serious uncertainties or evidence of pest presence despite application of the pesticide (e.g. reports of interception at import), this will be considered in the EKE on the effectiveness of the measures.

All the relevant information including the related uncertainties deriving from the limiting factors used in the evaluation are summarised in a pest data sheet provided in Appendix A. Based on this information, for each selected relevant pest, an expert judgement is given for the likelihood of pest freedom taking into consideration the risk mitigation measures and their combination acting on the pest.

An overview of the evaluation of each relevant pest is given in the sections below (Sections 5.3.1–5.3.5). The outcome of the EKE regarding pest freedom after the evaluation of the currently proposed risk mitigation measures is summarised in Section 5.3.6.

#### 5.3.1. Overview of the evaluation of *Nacobbus aberrans*

Rating of the likelihood of pest freedom	<b>Very frequently pest free</b> (based on the median)				
Percentile of the distribution	5%	25%	Median	75%	95%
Proportion of pest-free tubers	<b>9,549</b> out of 10,000 tubers	<b>9,714</b> out of 10,000 tubers	<b>9,856</b> out of 10,000 tubers	<b>9,953</b> out of 10,000 tubers	<b>9,996</b> out of 10,000 tubers
Proportion of infested tubers	<b>4</b> out of 10,000 tubers	<b>47</b> out of 10,000 tubers	<b>144</b> out of 10,000 tubers	<b>286</b> out of 10,000 tubers	<b>451</b> out of 10,000 tubers
Summary of the information used for the evaluation	<p><b>Possibility that the pest could become associate with the commodity</b></p> <p><i>N. aberrans</i> is a currently regulated plant parasitic quarantine nematode that poses a high risk to EU agriculture when introduced either with infested plants (plants for planting) or with soil attached to plants. The nematode is widespread in oca and ulluco production areas (Bridge et al., 2005) and is considered the most common pest of potato and other Andean crops, including ulluco in the temperate Andean highlands (Manzanilla-Lopez et al., 2002; Franco and Main, 2008). In the Andes it is associated with potatoes at temperatures of 15–18°C (Mai et al., 1981). Although ulluco roots can be severely attacked, information on the economic impact of <i>N. aberrans</i> as a limiting factor of ulluco production is poorly understood (Bridge et al., 2005). It is reported that <i>N. aberrans</i> causes damage to potatoes in Peru, but reports of such attacks are rare. It is uncertain how many fields in the potato-, ulluco- and oka-growing areas in Peru are affected by <i>N. aberrans</i>.</p> <p>The main pathways of this nematode are plants for planting, including tubers, water, soil and growing media attached to agricultural machinery, tools and shoes. This nematode may be present on ulluco plants or other host plants (e.g. oca) occurring in the environment and may infest the commodity mainly by human-assisted dispersal.</p>				

**Measures taken against the pest and their efficacy**

The relevant proposed measures are: (i) Surveillance and monitoring, (ii) Sampling and laboratory testing, (iii) Use of healthy propagation and production material, (iv) Sorting/grading/tuber selection, (v) Removal of soil from tubers (brushing/washing) and vi) Pre-consignment inspection.

**Interception records**

There are no records of interceptions from Peru, but see Section 4.3 above for details.

**Shortcomings of current measures/procedures**

Peru's answers to the questions raised by the working group state that the production areas of ulluco are located at high altitudes and therefore at low temperatures, which in their opinion means that the nematodes do not pose significant phytosanitary problems. The producers do not perceive the problems caused by pests and therefore do not apply specific phytosanitary measures against nematodes.

In view of the process of inspection and phytosanitary certification developed by SENASA, a sample of 2% of the total quantity of ulluco tubers intended for export is taken. This sample is visually inspected and, if pests are suspected, it is destroyed at the laboratory analysis level. However, as there may be mobile stages of *N. aberrans* in the tubers, the visual inspection may not be sufficient for inspectors to identify infected tubers and send them for laboratory analysis. It is therefore uncertain to what extent this procedure is able to ensure the absence of *N. aberrans* in asymptomatic tubers. The undetected presence of this nematode during inspections may contribute to the spread of infection with *N. aberrans*.

**Main uncertainties**

No details are given on the distribution of *N. aberrans* and its frequency in the area of ulluco production. There is some uncertainty regarding the lack of data from official surveillance surveys and reports of problems caused by this nematode in the production of ulluco in Peru.

There are uncertainties about the possible infestation with common weeds in the area, which is a good host for this nematode.

The absence of nematode-induced symptoms (bile) is possible in certain plants, so that the presence of *N. aberrans* in the ulluco tubers cannot be detected by visual inspection.

**5.3.2. Overview of the evaluation of *Atalodera andina***

<b>Rating of the likelihood of pest freedom</b>	<b>Pest free with exceptional cases</b> (based on the median)				
<b>Percentile of the distribution</b>	5%	25%	Median	75%	95%
<b>Proportion of pest-free tubers</b>	<b>9,938</b> out of 10,000 tubers	<b>9,966</b> out of 10,000 tubers	<b>9,980</b> out of 10,000 tubers	<b>9,990</b> out of 10,000 tubers	<b>9,997</b> out of 10,000 tubers
<b>Proportion of infested tubers</b>	<b>3</b> out of 10,000 tubers	<b>10</b> out of 10,000 tubers	<b>20</b> out of 10,000 tubers	<b>34</b> out of 10,000 tubers	<b>62</b> out of 10,000 tubers
<b>Summary of the information used for the evaluation</b>	<p><b>Possibility that the pest could become associated with the commodity</b></p> <p><i>A. andina</i> (= <i>T. andinus</i>) is a non-cyst-forming heteroderid nematode belonging to the subfamily Ataloderinae. The species is a native to South America, where it infests some important Andean crops. <i>A. andina</i> was first described on oca plants collected in Peru at Lake Titicaca (Golden et al. 1983). It has a wide host range and has been reported from more than 30 plant species in 12 botanical families. Among them, oca, ulluco, potato, quinoa, wild quinoa, lupine, shepherd's purse, wild turnip (<i>B. campestris</i>), ragwort (<i>S. vulgaris</i>) and wild tobacco (<i>N. paniculata</i>) are considered effective hosts of <i>A. andina</i> (Franco and Mosquera, 1993). Although the roots of ulluco plants can be heavily infested by this species, information on its economic importance is lacking (Bridge et al., 2005). On the roots of ulluco plants, <i>A. andina</i> is often found in association with the root-knot nematodes <i>Meloidogyne</i> spp. and the false root-knot nematode <i>N. aberrans</i>. According to Jatala, <i>A. andina</i> is considered an important nematode species on potatoes in some Andean regions of Peru, but the crop losses it causes on potatoes and other tuber crops have not been adequately quantified (Scurrah et al., 2005). Although ulluco can be attacked by <i>A. andina</i>,</p>				

(chemical) control of this nematode is rarely practiced because ulluco is mainly grown on economically less important small farms (Bridge et al., 2005). *A. andina* is therefore not considered a major problem in the production of these crops. The main pathways of this nematode are plants for planting, including tubers, water, soil and growing media attached to farm machinery, tools and footwear. *A. andina* may be present on ulluco plants or other host plants in the environment (e.g. oca) and may infest the commodity primarily by human-assisted dispersal.

#### Measures taken against the pest and their efficacy

The relevant proposed measures are: (i) Surveillance and monitoring, (ii) Sampling and laboratory testing, (iii) Use of healthy propagation and production material, (iv) Sorting/grading/tuber selection, (v) Removal of soil from tubers (brushing/washing) and (vi) Pre-consignment inspection.

#### Interception records

There are no records of interceptions from Peru, but see Section 4.3 above for details

#### Shortcomings of current measures/procedures

Peru's answers to the questions raised by the working group state that the production areas of ulluco are located at high altitudes and therefore at low temperatures, which in their opinion means that the nematodes do not pose significant phytosanitary problems. The producers do not perceive the problems caused by pests and therefore do not apply specific phytosanitary measures against nematodes.

In view of the process of inspection and phytosanitary certification developed by SENASA, a sample of 2% of the total quantity of ulluco tubers intended for export is taken. This sample is visually inspected and, if pests are suspected, it is destroyed at the laboratory analysis level. However, as there may be mobile stages of *A. andina* in the tubers, the visual inspection may not be sufficient for inspectors to identify infected tubers and send them for laboratory analysis. It is therefore uncertain to what extent this procedure is able to ensure the absence of *A. andina* in asymptomatic tubers. The undetected presence of this nematode during inspections may contribute to the spread of infection with *A. andina*.

#### Main uncertainties

- No details are given on the distribution of *A. andina* and its frequency in the area of ulluco production.
- There is some uncertainty regarding the lack of data from official surveillance surveys and reports of problems caused by this nematode in the production of ulluco in Peru.
- There are uncertainties about the possible infestation with common weeds in the area, which is a good host for this nematode.
- The absence of nematode-induced symptoms is possible in certain plants, so that the presence of *A. andina* in the ulluco tubers cannot be detected by visual inspection.

### 5.3.3. Overview of the evaluation of Andean potato latent virus (APLV)

<b>Rating of the likelihood of pest freedom</b>	<b>Very frequently pest free</b> (based on the median)				
<b>Percentile of the distribution</b>	5%	25%	Median	75%	95%
<b>Proportion of pest-free tubers</b>	<b>9,259</b> out of 10,000 tubers	<b>9,452</b> out of 10,000 tubers	<b>9,647</b> out of 10,000 tubers	<b>9,821</b> out of 10,000 tubers	<b>9,955</b> out of 10,000 tubers
<b>Proportion of infested tubers</b>	<b>45</b> out of 10,000 tubers	<b>179</b> out of 10,000 tubers	<b>353</b> out of 10,000 tubers	<b>548</b> out of 10,000 tubers	<b>741</b> out of 10,000 tubers



<b>Summary of the information used for the evaluation</b>	<p><b>Possibility that the pest could become associated with the commodity</b>          APLV is widespread in Peru. Potato and ulluco are natural hosts. The possible pathways for spread of APLV is vegetative propagation material. No symptoms are observed on ulluco plants. There are no phytosanitary regulations on viruses and plants are grown from non-certified seeds. APLV is readily transmitted by contact plant to plant, seeds, and its transmission from the foliage to tubers is erratic. It can be also transmitted by a flea beetle with low efficiency in experimental conditions. It has been detected in a high incidence level in two areas La Libertad and Ancash, in addition to plants from certified material in Junin and Huancavelica provinces. Potential vectors have a low abundance because of the higher altitude. It has been considered that field inspection cannot detect asymptomatic infections, and also that the virus can remain stable during transport conditions.</p> <p><b>Measures proposed against the pest and their efficacy</b>          The relevant proposed measures are (i) Surveillance and monitoring; (ii) Sampling and laboratory testing; (iii) Prevention by the use of healthy propagation material (Table 11).</p> <p><b>Interception records</b>          There has been one record of interceptions in potato from Peru. There were no interceptions on ulluco but see section 4.3 above for details.</p> <p><b>Shortcomings of the proposed measures/procedures</b>          The propagation material is selected to prevent potential infections, however visual inspection will fail to detect latent infections. Also, production areas are located with low temperatures and potential minimal occurrence of pests. The inspections activities of the ulluco producing-areas are accordingly addressed by SENASA following the ISPM.</p> <p><b>Main uncertainties</b></p> <ul style="list-style-type: none"> <li>• It is uncertain to what extent the true seeds that are used to produce ulluco are virus-free</li> <li>• Information on the biology of APLV in ulluco is lacking.</li> <li>• It is uncertain to what extent other cultivated host plants (potato) could be potential source of APLV inoculum.</li> <li>• It is uncertain to what extent the detection and sampling strategies are effective to detect asymptomatic plants.</li> <li>• It is uncertain the transmission rate to tubers.</li> <li>• The transmission efficiency by <i>Epitrix</i> spp. is unknown, as well as which species are able to transmit APLV in ulluco. In addition, there are no known control measures for <i>Epitrix</i> spp. in this crop.</li> </ul>
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#### 5.3.4. Overview of the evaluation of potato virus T (PVT)

<b>Rating of the likelihood of pest freedom</b>	<b>Very frequently pest free</b> (based on the median)				
<b>Percentile of the distribution</b>	5%	25%	Median	75%	95%
<b>Proportion of pest-free tubers</b>	<b>9,157</b> out of 10,000 tubers	<b>9,372</b> out of 10,000 tubers	<b>9,597</b> out of 10,000 tubers	<b>9,801</b> out of 10,000 tubers	<b>9,952</b> out of 10,000 tubers
<b>Proportion of infested tubers</b>	<b>48</b> out of 10,000 tubers	<b>199</b> out of 10,000 tubers	<b>403</b> out of 10,000 tubers	<b>628</b> out of 10,000 tubers	<b>843</b> out of 10,000 tubers

<b>Summary of the information used for the evaluation</b>	<p><b>Possibility that the pest could become associated with the commodity</b> PVT is widespread in Peru. Potato and ulluco are natural hosts. PVT is readily transmitted through vegetative propagation (true potato seeds) and pollen, in addition to be readily transmitted by sap inoculation to potato, as well as to tubers produced by infected plants. There are no phytosanitary regulations on viruses and plants are grown from non-certificated seeds. It has been detected in a high incidence level in Ayacucho Cusco, Ancash and Puno areas. It has been considered that field inspection cannot detect asymptomatic infections, and also that the virus can remain stable during transport conditions.</p> <p><b>Measures proposed against the pest and their efficacy</b> The relevant proposed measures are (i) Surveillance and monitoring; (ii) Sampling and laboratory testing; (iii) Prevention by the use of healthy propagation material (Table 11).</p> <p><b>Interception records</b> There were no interceptions on ulluco but see section 4.3 above for details.</p> <p><b>Shortcomings of the proposed measures/procedures</b> The propagation material is selected to prevent potential infections, however visual inspection will fail to detect latent infections. Also, production areas are located with low temperatures and potential minimal occurrence of pests. The inspections activities of the ulluco producing-areas are accordingly addressed by SENASA following the ISPM.</p> <p><b>Main uncertainties</b></p> <ul style="list-style-type: none"> <li>• It is uncertain to what extent the true seeds that are used to produce ulluco are virus-free.</li> <li>• Lack of information on the biology of PVT in ulluco.</li> <li>• It is uncertain to what extent the detection and sampling strategies are effective to detect asymptomatic plants.</li> <li>• Lack of information on whether potential alternative host plants, such as mashua, potato or oca could be potential source of PVT inoculum.</li> <li>• It is uncertain the potential PVT transmission by true seeds and pollen in ulluco.</li> </ul>
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### 5.3.5. Overview of the evaluation of *Amathynetoides nitidiventris*

<b>Rating of the likelihood of pest freedom</b>	<b>Extremely frequently pest free</b> (based on the median)					
<b>Percentile of the distribution</b>	5%	25%	Median	75%	95%	
<b>Proportion of pest-free tubers</b>	<b>9,812</b> out of 10,000 tubers	<b>9,863</b> out of 10,000 tubers	<b>9,916</b> out of 10,000 tubers	<b>9,962</b> out of 10,000 tubers	<b>9,994</b> out of 10,000 tubers	
<b>Proportion of infested tubers</b>	<b>6</b> out of 10,000 tubers	<b>38</b> out of 10,000 tubers	<b>84</b> out of 10,000 tubers	<b>137</b> out of 10,000 tubers	<b>188</b> out of 10,000 tubers	
<b>Summary of the information used for the evaluation</b>	<p><b>Possibility that the pest could become associated with the commodity</b> The pest is present in Peru where it is considered one of the most important pests of ulluco causing at harvest between 2.5% and 50% of damage to tubers. This weevil is prevalent in ulluco-producing areas throughout the year, and can complete the life cycle in other crops common in the ulluco producing areas such as oca and beans. Adults can fly and move both within the production field or from the surroundings. During storage infested tubers can also be a source of infestation for healthy ones. The main pathway is represented by infested tubers.</p>					

**Measures taken against the pest and their efficacy**

Crop rotation has been observed to reduce weevil damage to the crop. Use of healthy seed tubers may lower pest presence and pressure. Ash application to the neck of each plant to the emergency and before the stubble tillage reduces the weevil damage. Elimination of volunteer plants when they are small or avoiding their presence by making a good harvest and eliminating crop residues may lower pest pressure. High and timely stubble tillage may prevent the larvae from reaching the tubers. Timely harvest may decrease pest pressure. Elimination of crop residues (damaged, rotten and small tubers) introducing animals in the field after harvest, reduces pest pressure. Plough the soil of infested fields to destroy weevils by exposing them to the sun and wild birds. Poultry use during the selection of ulluco tubers and after soil removal to reduce pest populations. Manual capture of weevils can contribute to reduce the amount of weevils present. Tuber storage at 2°C and 90–95% humidity.

**Interception records**

There were no interceptions on ulluco, but see Section 4.3 above for details.

**Shortcomings of current measures/procedures**

From the dossier, it seems that the seed tubers come from the previous production cycle; therefore, the inspection is visual and the health status uncertain. Although crop rotation has been seen to be effective in controlling the pest, in some cases the crops rotating are also hosts of the pest. Limited scientific data on efficacy of ash applications, volunteer plants elimination, high stubble tillage, timely harvest and efficacy of animals in eliminating crop residues are available. Mechanical measures might not be effective enough. Storage conditions (2°C and 90–95% humidity) may only slow down the insect cycle and not kill it.

**Main uncertainties**

- Other host plants cultivated jointly or in the proximity of ulluco fields can serve as a source of infestation.
- Although visually inspected, seed tubers with very small entry wounds are difficult to be detected and discarded and can therefore be a source of infestation.

**5.3.6. Outcome of Expert Knowledge Elicitation**

Table 12 and Figure 6 show the outcome of the EKE regarding pest freedom after the evaluation of the currently proposed risk mitigation measures for all the evaluated pests.

Figure 6 provides an explanation of the descending distribution function describing the likelihood of pest freedom after the evaluation of the currently proposed risk mitigation measures for *U. tuberosus* tubers designated for export to the EU for potato virus T (PVT).

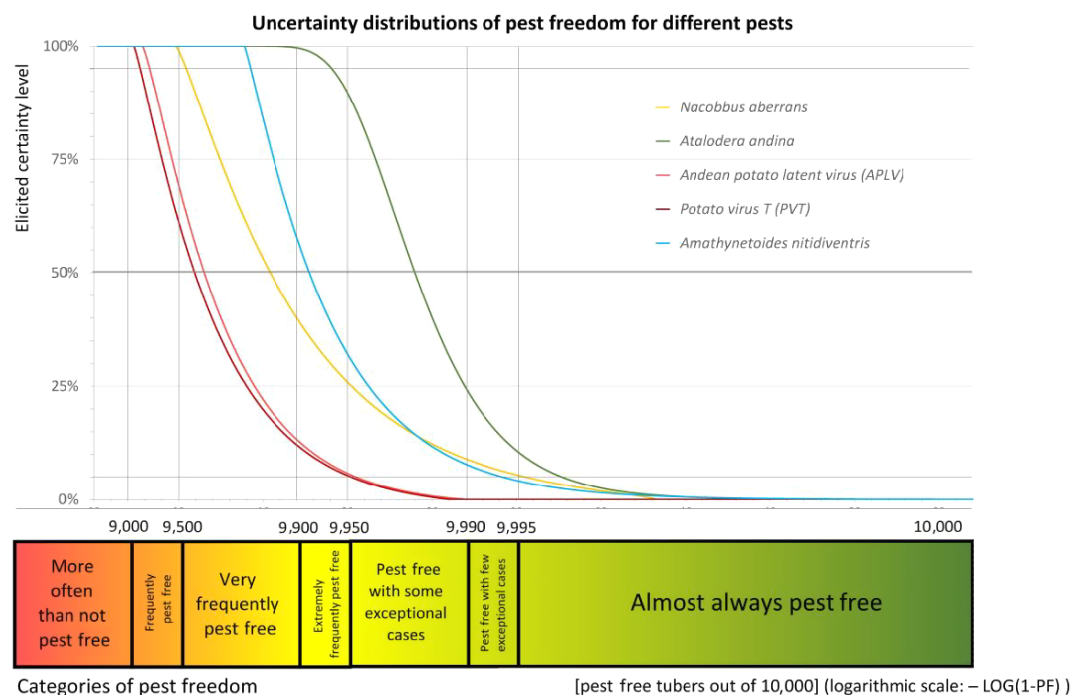
**Table 12:** Assessment of the likelihood of pest freedom following evaluation of current risk mitigation measures against *Nacobbus aberrans*, *Atalodera andina*, Andean potato latent virus (APLV), potato virus T (PVT) and *Amathynetoides nitidiventris* on *Ullucus tuberosus* tubers designated for export to the EU. In panel A, the median value for the assessed level of pest freedom for each pest is indicated by 'M', the 5% percentile is indicated by L, and the 95% percentile is indicated by U. The percentiles together span the 90% uncertainty range regarding pest freedom. The pest freedom categories are defined in panel B of the table

Number	Group	Pest species	Sometimes pest free	More often than not pest free	Frequently pest free	Very frequently pest free	Extremely frequently pest free	Pest free with some exceptional cases	Pest free with few exceptional cases	Almost always pest free
1	Nematode	<i>Nacobbus aberrans</i>				LM				U
2	Nematode	<i>Atalodera andina</i>					L	M		U
3	Virus	Andean potato latent virus (APLV)			L	M		U		
4	Virus	Potato virus T (PVT)			L	M		U		
5	Insect	<i>Amathynetoides nitidiventris</i>				L	M		U	

PANEL A

Pest freedom category	Pest-free tubers out of 10,000	Legend of pest freedom categories	
Sometimes pest free	≤ 5,000	L	Pest freedom category includes the elicited lower bound of the 90% uncertainty range
More often than not pest free	5,000–≤ 9,000	M	Pest freedom category includes the elicited median
Frequently pest free	9,000–≤ 9,500	U	Pest freedom category includes the elicited upper bound of the 90% uncertainty range
Very frequently pest free	9,500–≤ 9,900		
Extremely frequently pest free	9,900–≤ 9,950		
Pest free with some exceptional cases	9,950–≤ 9,990		
Pest free with few exceptional cases	9,990–≤ 9,995		
Almost always pest free	9,995–≤ 10,000		

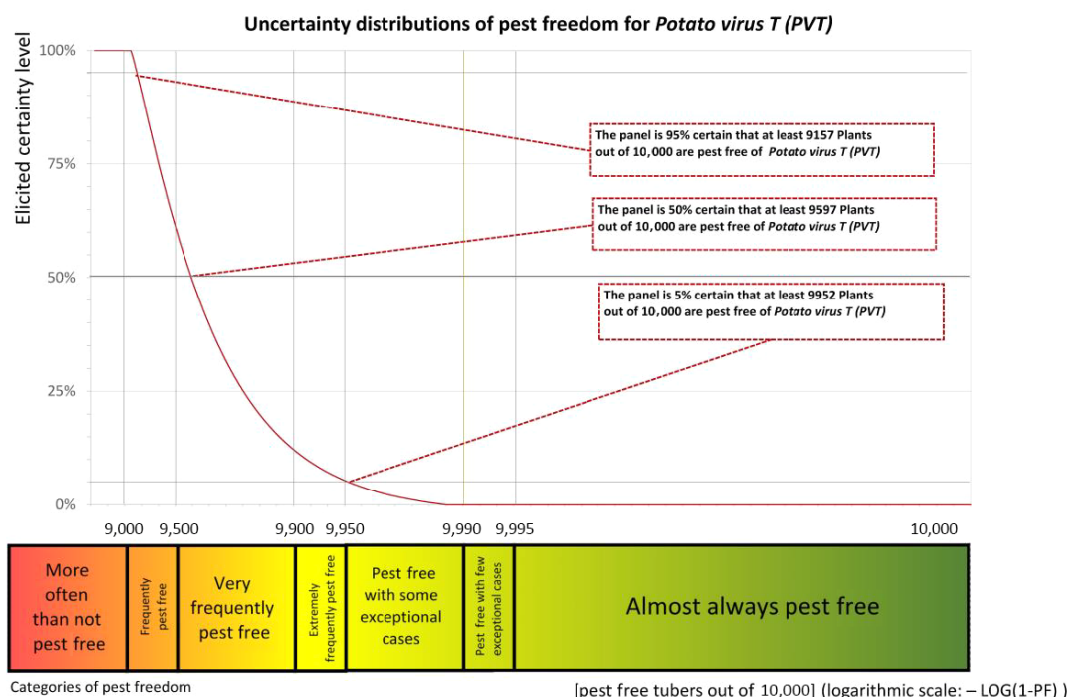
PANEL B



**Figure 6:** Elicited certainty (y-axis) of the number of pest-free *Ullucus tuberosus* tubers (x-axis; log-scaled) out of 10,000 tubers designated for export to the EU introduced from Peru for all evaluated pests visualised as descending distribution function. Horizontal lines indicate the percentiles (starting from the bottom 5%, 25%, 50%, 75%, 95%). The Panel is 95% sure that 9,549, 9,938, 9,259, 9,157 and 9,812 or more tubers per 10,000 will be free from *Nacobbus aberrans*, *Atalodera andina*, Andean potato latent virus (APLV), potato virus T (PVT) and *Amathynetoides nitidiventris*, respectively

The Panel is 95% sure that:

- 9,157 or more tubers per 10,000 will be free from potato virus T.
- 9,259 or more tubers per 10,000 will be free from Andean potato latent virus.
- 9,549 or more tubers per 10,000 will be free from *Nacobbus aberrans*.
- 9,812 or more tubers per 10,000 will be free from *Amathynetoides nitidiventris*.
- 9,938 or more tubers per 10,000 will be free from *Atalodera andina*.



**Figure 7:** Explanation of the descending distribution function describing the likelihood of pest freedom after the evaluation of the currently proposed risk mitigation measures for *Ullucus tuberosus* tubers designated for export to the EU based on the example of potato virus T (PVT)

## 6. Conclusions

There are five pests i.e. one insect (*Amathynetoides nitidiventris*), two nematodes (*Atalodera andina* and *Nacobbus aberrans*) and two viruses (the Andean potato latent virus (APLV) and the potato virus T (PVT)) identified to be present in Peru and potentially associated with tubers of *U. tuberosus* imported from Peru and relevant for the EU.

For these pests, the likelihood of the pest freedom after the evaluation of the currently proposed risk mitigation measures for *U. tuberosus* designated for export to the EU was estimated.

For *Amathynetoides nitidiventris*, the likelihood of pest freedom following evaluation of proposed risk mitigation measures was estimated as 'extremely frequently pest free' with the 90% uncertainty range reaching from 'very frequently pest free' to 'pest free with few exceptional cases'. The Expert Knowledge Elicitation indicated, with the 95% certainty, that between 9,812 and 10,000 tubers per 10,000 will be free from *A. nitidiventris*.

For *Atalodera andina*, the likelihood of pest freedom following evaluation of proposed risk mitigation measures was estimated as 'pest free with some exceptional cases' with the 90% uncertainty range reaching from 'extremely frequently pest free' to 'almost always pest free'. The Expert Knowledge Elicitation indicated, with the 95% certainty, that between 9,938 and 10,000 tubers per 10,000 will be free from *A. andina*.

For *Nacobbus aberrans*, the likelihood of pest freedom following evaluation of proposed risk mitigation measures was estimated as 'very frequently pest free' with the 90% uncertainty range reaching from 'very frequently pest free' to 'almost always pest free'. The Expert Knowledge Elicitation indicated, with the 95% certainty, that between 9,549 and 10,000 tubers per 10,000 will be free from *N. aberrans*.

For Andean potato latent virus (APLV), the likelihood of pest freedom following evaluation of proposed risk mitigation measures was estimated as 'very frequently pest free' with the 90% uncertainty range reaching from 'frequently pest free' to 'pest free with some exceptional cases'. The Expert Knowledge Elicitation indicated, with the 95% certainty, that between 9,259 and 10,000 tubers per 10,000 will be free from APLV.

For potato virus T (PVT), the likelihood of pest freedom following evaluation of proposed risk mitigation measures was estimated as 'very frequently pest free' with the 90% uncertainty range reaching from 'frequently pest free' to 'pest free with some exceptional cases'. The Expert Knowledge



Elicitation indicated, with the 95% certainty, that between 9,157 and 10,000 tubers per 10,000 will be free from PVT.

## References

- Avalos C, 2008. Olluco: Sabrosa raíz andina. Revista Generación, Lima-Perú, 78, 42–47.
- CABI (Centre for Agriculture and Bioscience International), online. CABI Crop Protection Compendium. Available online: <https://www.cabi.org/cpc/>
- Cadima X, Valdivia G and Guzmán V, 1996. Caracterización morfológica y bioquímica (pruebas preliminares). Informe anual, 97, 934–936.
- Cárdenas M, 1969. Manual de plantas económicas de Bolivia (No. QK262 C3).
- EFSA PLH Panel (EFSA Panel on Plant Health), 2019b. Commodity risk assessment of black pine (*Pinus thunbergii* Parl.) bonsai from Japan. EFSA Journal 2019; 17(5):5667, 184 pp. <https://doi.org/10.2903/j.efsa.2019.5668>
- EFSA PLH Panel (EFSA Panel on Plant Health), 2018. Guidance on quantitative pest risk assessment. EFSA Journal 2018;16(8):5350, 86 pp. <https://doi.org/10.2903/j.efsa.2018.5350>
- EFSA PLH Panel (EFSA Panel on Plant Health), 2019a. Guidance on commodity risk assessment for the evaluation of high risk plants dossiers. EFSA Journal 2019; 17(4):5668, 20 pp. <https://doi.org/10.2903/j.efsa.2019.5668>
- EFSA Scientific Committee, 2018. Scientific Opinion on the principles and methods behind EFSA's Guidance on Uncertainty Analysis in Scientific Assessment. EFSA Journal 2018;16(1):5122, 235 pp. <https://doi.org/10.2903/j.efsa.2018.5122> ISSN:1831-4732
- EPPO (European and Mediterranean Plant Protection Organization), online. EPPO Global Database. Available online: <https://www.eppo.int> [Accessed: 20 April 2020].
- EUROPHYT, online. European Union Notification System for Plant Health Interceptions - EUROPHYT. Available online: [http://ec.europa.eu/food/plant/plant\\_health\\_biosafety/europhyt/index\\_en.htm](http://ec.europa.eu/food/plant/plant_health_biosafety/europhyt/index_en.htm) [Accessed: 17 September 2020].
- FAO (Food and Agriculture Organization of the United Nations), 1995. ISPM (International standards for phytosanitary measures) No 4. Requirements for the establishment of pest free areas. Available online: <https://www.ippc.int/en/publications/614/>
- FAO (Food and Agriculture Organization of the United Nations), 2017. ISPM (International standards for phytosanitary measures) No. 5. Glossary of phytosanitary terms. FAO, Rome. Available online: <https://www.ippc.int/en/publications/622/>
- Fox A, Fowkes AR, Skelton A, Harju V, Buxton-Kirk A, Kelly M, Forde SMD, Pufal H, Conyers C, Ward R, Weekes R, Boonham N and Adams IP, 2019. Using high-throughput sequencing in support of a plant health outbreak reveals novel viruses in *Ullucus tuberosus* (Basellaceae). Plant Pathology, 68, 576–587.
- Fries AM and Tapia ME, 2007. Guía de campo de los cultivos andinos. FAO, ANPE-PERÚ.
- IPGRI/CIP, 2003. Descriptores del Ulluco (*Ullucus tuberosus*). Instituto Internacional de Recursos Fitogenéticos, Roma, Italia; Centro Internacional de la Papa, Lima Perú.
- León J, 1964. Boletín Técnico: Plantas alimenticias andinas.
- King SR, 1988. Economic Botany of the Andean Tuber crop complex *Lepidium meyenii*, *Oxalis tuberosa*, *Tropaeolum tuberosum* and *Ullucus tuberosus* (Doctoral dissertation, City University of New York).
- Kottek M, Grieser J, Beck C, Rudolf B and Rubel F, 2006. World map of Köppen- Geiger climate classification updated. Meteorologische Zeitschrift, 15, 259–263.
- McMoran D and Gauthier J, 2014. Experimenting with growing ulluco as a niche crop for fun and profit. Journal of Horticulture, 1–2.
- National Research Council, 1989. Lost crops of the Incas: little-known plants of the Andes with promise for worldwide cultivation. National Academies Press.
- Pietila L and Tapia M, 1991. Investigaciones sobre ulluku (No. 635.1 P625). Abo Akademis Kopieringscentral.
- Rousi A, Jokela P, Kalliola R, Pietilä L, Salo J and Yli-Rekola M, 1989. Morphological variation among clones of ulluco (*Ullucus tuberosus*, Basellaceae) collected in southern Peru. Economic Botany, 43, 58–72.
- Rubel F, Brugger K, Haslinger K and Auer I, 2017. The climate of the European Alps: Shift of very high resolution Köppen-Geiger climate zones 1800–2100. Meteorologische Zeitschrift, 26, 115–125.
- SIEA, 2012. Boletín del Sistema Integrado de Estadísticas Agrarias (SIEA). Oficina de Estudios Económicos y Estadísticos. Ministerio de Agricultura, Lima, Perú.
- TRACES NT, online. Trade Control and Expert System. Available online: <https://webgate.ec.europa.eu/tracesnt/login> [Accessed: 7 January 2021].

## Glossary

Control (of a pest)	Suppression, containment or eradication of a pest population (FAO, 1995, 2017)
Entry (of a pest)	Movement of a pest into an area where it is not yet present, or present but not widely distributed and being officially controlled (FAO, 2017)



Establishment (of a pest)	Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO, 2017)
Impact (of a pest)	The impact of the pest on the crop output and quality and on the environment in the occupied spatial units
Introduction (of a pest)	The entry of a pest resulting in its establishment (FAO, 2017)
Measures	Control (of a pest) is defined in ISPM 5 (FAO 2017) as 'Suppression, containment or eradication of a pest population' (FAO, 1995). Control measures are measures that have a direct effect on pest abundance. Supporting measures are organisational measures or procedures supporting the choice of appropriate risk mitigation measures that do not directly affect pest abundance.
Pathway	Any means that allows the entry or spread of a pest (FAO, 2017)
Phytosanitary measures	Any legislation, regulation or official procedure having the purpose to prevent the introduction or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests (FAO, 2017)
Protected zone	A Protected zone is an area recognised at EU level to be free from a harmful organism, which is established in one or more other parts of the Union.
Quarantine pest	A pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled (FAO, 2017)
Regulated non-quarantine pest	A non-quarantine pest whose presence in plants for planting affects the intended use of those plants with an economically unacceptable impact and which is therefore regulated within the territory of the importing contracting party (FAO, 2017)
Risk mitigation measure	A measure acting on pest introduction and/or pest spread and/or the magnitude of the biological impact of the pest should the pest be present. A risk mitigation measure may become a phytosanitary measure, action or procedure according to the decision of the risk manager
Spread (of a pest)	Expansion of the geographical distribution of a pest within an area (FAO 2017)

## Abbreviations

CABI	Centre for Agriculture and Bioscience International
EKE	Expert Knowledge Elicitation
EPPO	European and Mediterranean Plant Protection Organization
FAO	Food and Agriculture Organization
FUN	Fungi
INS	Insect
ISPM	International Standards for Phytosanitary Measures
NEM	Nematode
NPPO	National Plant Protection Organisation
PLH	Plant Health
PRA	Pest Risk Assessment
RNQPs	Regulated Non-Quarantine Pests

## Appendix A – Datasheets of pests selected for further evaluation via Expert Knowledge Elicitation

### A.1. *Amathynetoides nitidiventris* (Hustache)

#### A.1.1. Organism information

<b>Taxonomic information</b>	<p>Current valid scientific name: <i>Amathynetoides nitidiventris</i> (Hustache 1938)</p> <p>Synonyms: <i>Adioristus nitidiventris</i> Hustache, 1938; <i>Amathynetes nitidiventris</i> Kuschel, 1949; <i>Puranius nitidiventris</i> Kuschel, 1955; <i>Macrostyphlus nitidiventris</i> Kuschel, 1986</p> <p>Name used in the EU legislation: N/A</p> <p>Order: Coleoptera</p> <p>Family: Curculionidae</p> <p>Common name: gorgojo del ulluco; ulluco weevil</p> <p>Name used in the Dossier: <i>Amathynetoides nitidiventris</i></p>
<b>Group</b>	Insects
<b>EPPO code</b>	N/A
<b>Regulated status</b>	The pest is not regulated in the EU, neither is listed by EPPO.
<b>Pest status in Peru</b>	Present. As a result of a diagnostic study carried out in the community of La Libertad, one of the main producing centres of ulluco in the central highlands, it was found that 96% of farmers consider the 'ulluco weevil' as the main pest of the culture, followed by the earthworms. The literature checked also points out that this species is one of the most important pests of ulluco (Alcazar et al., 2004; McCaffrey and Walker, 2012). The weevil causes at harvest between 2.5% and 50% of damage to tubers. The pest is also reported for Concepción and Junín.
<b>Pest status in the EU</b>	Absent (CABI CPC, online; EPPO online, Fauna Europaea, online).
<b>Host status on <i>U. tuberosus</i></b>	<i>U. tuberosus</i> is reported as the main host plant of <i>A. nitidiventris</i> (Alcazar et al., 2004; McCaffrey and Walker, 2012).
<b>PRA information</b>	N/A
<b>Other relevant information for the assessment</b>	
Biology	<p>The life cycle of <i>A. nitidiventris</i> reared in the laboratory at 17 °C and 78% relative humidity has an egg-adult life span of 243 days and the total cycle, including adult longevity, is 459 days (Aldana, 2003). Adult longevity averages 218.0 and 214.9 days for males and females respectively (Alcazar et al., 2004).</p> <p>The species has a pre-oviposition phase lasting 18 days on average. Oviposition occurs during the months of October and November (lat 12°04'S 75°13'W), it lasts on average 155 days, during which the female lays a total of 373 eggs (Alcazar et al., 2004). Incubation lasts 28.8 days after which the larva emerges. The larval period has a duration of 102 days, going through 4 stages. The larvae feed on the tubers. After the larval period the species pupates passing through a pre-pupal stage which lasts 31 days on average. During this period the larva stops feeding and exits or falls down the tuber to pupate in a pupal chamber made with soil at a depth of 16-20 cm. Under laboratory conditions pupation can occur inside the tuber. The pupal stage lasts 32.3 days. It overwinters as adult between July and August (lat 12°04'S 75°13'W) in the soil inside the pupal chamber or inside the tubers in the field or in the warehouse. This phase ends when the adult emerges from the tuber or from the ground after the first rains in September-October. To exit the tubers, the adults dig a hole both in storage and in the field. After emergence the adult weevils move looking for ulluco plants, being volunteer, the first option followed by migration to new fields. Adults feed on young leaves, rootlets, stolons and tubers close to the surface; very rarely they have been found feeding on stems. Females lay their eggs on the ground under soil clods in groups and in humid places near the plant.</p> <p>At harvest, almost 90% of the larvae remain in the soil representing the most important re-infestation source for the next campaign, especially if ulluco is replanted. The remaining part of the larvae either fall from the tubers during storage or complete their development in the tubers (4%), being able to spread the pest to new growing areas.</p>

<b>Symptoms</b>	<b>Main type of symptoms</b>	The larval stage causes greater damage in the field, feeding on the tubers producing holes, and subtracting quality. The adults are present in the field from September to July. The adult density in the field increases from the emergence of ulluco plants to reach its maximum in mid-January, when the plant starts flowering, providing adults with food and shelter. Then the adult population begins to decline until July.  The larvae of this weevil, cause holes on the tubers especially in the late stages of cultivation.
	<b>Presence of asymptomatic tubers</b>	It has been found that 4% of the larval weevil population infesting tubers in the field manage to complete their cycle within the tuber in warehouse. So, it is important to carefully select the ulluco seed tubers, avoiding planting damaged and infested tubers with weevil larvae.  The holes made by the larvae can be of various size and although the selection process tries to eliminate the tubers with wounds, there are always tubers with small wounds that cannot be eliminated with the naked eye.
	<b>Confusion with other pests</b>	<i>Premnotypes</i> spp., which attack potato, have been erroneously identified as ulluco weevil (Alcazar et al., 2004).
<b>Host plant range</b>	Although <i>U. tuberosus</i> is reported as the main host plant of <i>A. nitidiventris</i> , the species also attacks tubers and roots of oca, mashua, maca, carrot, fava bean and corn (Alcazar et al., 2004; McCaffrey and Walker, 2012).	
<b>Pathways</b>	Infested tubers	
<b>Surveillance information</b>	<p>The applicant country declares to perform surveillance in accordance with the 'Pest Prospecting Instructions' and 'Sampling and Handling Manual' developed by SENASA to carry out the prospecting actions on ulluco, as well as the procedures for sampling and remission of samples to the laboratory of plant parts and/or pests. Personnel trained in SENASA regional offices travel daily to the crop-producing areas for the identification of anomalies in their growth, which may be related to the presence of virus or other disease as well as the presence of insects which can be collected with vacuum cleaners, entomological meshes or plant parts. Specific details on sampling intensity and protocols applied were not provided in the Dossier.</p> <p>The samples collected in the field are registered in the database 'Integrated System of Plant Health Management' (SIGSVE) and sent to the Unit of Diagnostic Center of Plant Health of SENASA, under adequate conditions of protection. Laboratory analyses are performed by the SENASA Plant Health Diagnostic Centers Unit, which has diagnostic methods based on pest morphology, ELISA and molecular biology (conventional PCR, real time and sequencing).</p>	

## A.1.2. Possibility of pest presence in production places

### A.1.2.1. Possibility of entry from the surrounding environment

This weevil is prevalent in ulluco-producing areas throughout the year, and therefore, it cannot be excluded that some of the production sites are infested with this pest. The weevil attacks and can complete the life cycle in other crops common in the ulluco-producing areas such as oca and beans. Adult females ready for oviposition can lay eggs in ulluco plants and soil and may be coming from the surrounding environment and crops.

#### Uncertainties:

As ulluco is often cultivated together or in the proximity of many other crops such as corn, lupins, pumpkin, quinoa, oats, barley, wheat, beans etc., this biodiversity can be both positive or not. Indeed, it can decrease the pest pressure providing natural enemies, or increase it serving as a source of alternative host plants.

Taking into consideration the above evidence and uncertainties, the Panel considers that it is possible for the pest to enter the production place from the surrounding environment.

### A.1.2.2. Possibility of entry with new plants/seeds

Ulluco as potato and other tubers is cultivated using seed tubers. Therefore, if seed tubers are infested with this pest, there could be a possibility for entry with planting material to the production sites. Tubers with very small entry wounds are difficult to be detected and discarded. Ulluco is often cultivated in open fields in rotation and/or combination with other tuber crops, so given the long life cycle and that some stages may stay in the soil between growing periods, there is also a possibility of cultivating ulluco in a previously infested field.

#### Uncertainties:

Although visually inspected, seed tubers with very small entry wounds are difficult to be detected and discarded.

Taking into consideration the above evidence and uncertainties, the Panel considers it possible that the pest could enter the production place with seed tubers.

### A.1.2.3. Possibility of spread within the production place and storage

As mentioned above, adult females can fly and can move within the production field or come from the surroundings, given the prevalence of the pest the potential for spread within production sites cannot be neglected. Also, during storage infested tubers can be a problem for healthy ones, so if storage periods are long there can be secondary infestation taking place.

#### Uncertainties:

- The intended use of plastic barriers under ulluco tubers during storage and their efficacy in preventing infestations is uncertain.

Taking into consideration the above evidence and uncertainties, the Panel considers that the transfer of the pest within the production place is possible either by movement of adults in the field or by larvae in storage facilities.

### A.1.3. Information from interceptions

Considering imports of *U. tuberosum* and any other crop coming from Peru to the EU, between 1995 and 2020, there are no records of *A. nitidiventris* on ulluco or other commodities (EUROPHYT, online, Accessed: 21/10/2020 - TRACES NT), but see Section 4.3 in the main body of the opinion for details.

### A.1.4. Evaluation of the risk mitigation measures

The description of all the risk mitigation measures currently applied in Peru is provided in Table 11. In the table below, those relevant for *A. nitidiventris* are listed along with an indication of their effectiveness.

No.	Risk mitigation measure	Effect on the pest	Evaluation and uncertainties
3	Crop rotation	Yes	<p><u>Evaluation:</u> It has been observed that in ulluco fields where crop rotation is applied there is no weevil damage to the crop. Pest pressure can be lowered.</p> <p><u>Uncertainties:</u> In some cases, the crops rotating are also hosts of the pest.</p>
5	Use of healthy seed tubers	Yes	<p><u>Evaluation:</u> Avoiding sowing tubers damaged and infested with weevils. Pest pressure can be lowered.</p> <p><u>Uncertainties:</u> It seems that the seeds come from the previous production cycle; therefore, the inspection is visual and the health status uncertain.</p>

No.	Risk mitigation measure	Effect on the pest	Evaluation and uncertainties
6	Elimination of volunteer plants	Yes	<p><u>Evaluation:</u> Volunteer plants can be removed when they are small, or their presence can be avoided by making a good harvest and eliminating their residues. These plants are the first to emerge and provide adult weevils with food, shelter and place to oviposit. Pest pressure can be lowered.</p> <p><u>Uncertainties:</u> No scientific data on efficacy.</p>
	Elimination of crop residues	Yes	<p><u>Evaluation:</u> Damaged, rotten and small tubers left in the fields after harvest allow weevil larvae and other pests to develop inside and complete their life cycle. These tubers instead must be collected and destroyed. A practical way to eliminate this waste is to introduce animals, such as pigs and sheep, to feed and thus get rid of these tubers. Pest pressure can be lowered.</p> <p><u>Uncertainties:</u></p> <ul style="list-style-type: none"> <li>• Their strategy might not be the most effective to remove crop residues,</li> <li>• No scientific data on efficacy.</li> </ul>
7	Mechanical measures	Yes	<p><u>Evaluation:</u> Manual capture of weevils can contribute to reduce the amount of weevils present.</p> <p><u>Uncertainties:</u> Might not be effective enough.</p>
8	Ash application	Yes	<p><u>Evaluation:</u> The application of 10 g of ash to the neck of the plant to the emergency and before the stubble tillage reduces by 37% the damage by weevil. It can lower infestation.</p> <p><u>Uncertainties:</u> Limited scientific data on efficacy.</p>
9	Hilling	Yes	<p><u>Evaluation:</u> It is important to hill properly in order to prevent the larvae from reaching the tubers. Pest pressure can be lowered.</p> <p><u>Uncertainties:</u> No scientific data on efficacy.</p>
11	Timely harvest	Yes	<p><u>Evaluation:</u> The damage increases when ulluco is left in the field for longer than needed. Pest pressure can be lowered.</p> <p><u>Uncertainties:</u> No scientific data on efficacy.</p>
12	Winter plough in harvested fields	Yes	<p><u>Evaluation:</u> Plough the soil of infested fields between July and August to destroy weevils by exposing them to the sun and wild birds. Pest pressure can be lowered.</p> <p><u>Uncertainties:</u> No scientific data on efficacy.</p>
13	Poultry use	Yes	<p><u>Evaluation:</u> During the selection of ulluco tubers and after soil removal chickens are used such as predators of larvae, pupae and overwintering adults. Pest pressure can be lowered.</p> <p><u>Uncertainties:</u> No scientific data on efficacy.</p>
18	Storage temperature	No	<p><u>Evaluation:</u> The tubers are shipped in containers with a temperature and relative humidity of 2°C, 90%–95% humidity. The life cycle can be slowed down.</p> <p><u>Uncertainties:</u> The temperature inside the tubers could be different from the one in the environment.</p>

### A.1.5. Overall likelihood of pest freedom

#### A.1.5.1. Reasoning for a scenario which would lead to a reasonably low number of infested consignments

- Low proportion of larvae complete life cycle in tubers.
- Pest only present in the three reported sites.
- Prevalence in other regions is lower.

- Visual selection of tubers for planting results in a low spread rate because of effective detection of infested material.
- Regular inspections by phytosanitary authorities are effective.
- Few hosts in the surroundings.
- Crop rotation is effective to reduce the pest.
- Ash treatment is effective to reduce the pest.
- Cleaning fields with animals (e.g. chickens) after harvest is effective to reduce the pest.

#### **A.1.5.2. Reasoning for a scenario which would lead to a reasonably high number of infested consignments**

- Larvae complete life cycle in tubers.
- Pest present also in other areas of Peru.
- Prevalence in other regions is similar to reported regions.
- Visual selection of tubers for planting is not effective and results in a high spread.
- Regular inspections by phytosanitary authorities are not effective due to unspecific symptoms or inadequate sampling scheme.
- Many alternative hosts are present in the surroundings of ulluco fields.
- Crop rotation is not effective to reduce the pest.
- Ash treatment is not effective to reduce the pest.
- Cleaning fields with animals (e.g. chickens) after harvest is not effective to reduce the pest.

#### **A.1.5.3. Reasoning for a central scenario equally likely to over- or underestimate the number of infested consignments (median)**

- Reports of up to 86% tubers attacked, but only 4% of larvae remain inside tubers.
- Ulluco is a main host, other Andean tubers are potential hosts but not potato.
- The weevil is not a main pest in the export producing areas.
- Polyphagous, attacks also other plant species.
- Spread via larvae in soil and adult movements.
- Reinfestations possible via infested tubers in the field and also during storage (warehouses).
- Identification of larval exit holes in tubers leads to detection and discard of infested tubers, but recent or latent infestations may not be easily detected.
- No data on distribution in Peru other than three locations: La Libertad, Junín, Concepción.

#### **A.1.5.4. Reasoning for the precision of the judgement describing the remaining uncertainties (1st and 3rd quartile/interquartile range)**

- Uncertain about pest pressure and distribution in Peru.
- Data on efficacy of inspections are not provided.
- Uncertainty about control measure efficacy.



#### A.1.5.5. Elicitation outcomes of the assessment of the pest freedom for *A. nitidiventr*

The following tables show the elicited and fitted values for pest infestation/infection (Table A.1) and pest freedom (Table A.2).

**Table A.1:** Elicited and fitted values of the uncertainty distribution of pest infestation by *A. nitidiventr* per 10,000 tubers

Percentile	1%	2.5%	5%	10%	17%	25%	33%	50%	67%	75%	83%	90%	95%	97.5%	99%
Elicited values	1.00					40.00		80.00		140.00					200.00
EKE	0.98	2.76	6.03	13.23	23.70	37.59	52.30	84.08	118.79	137.33	157.01	174.09	187.99	195.66	200.78

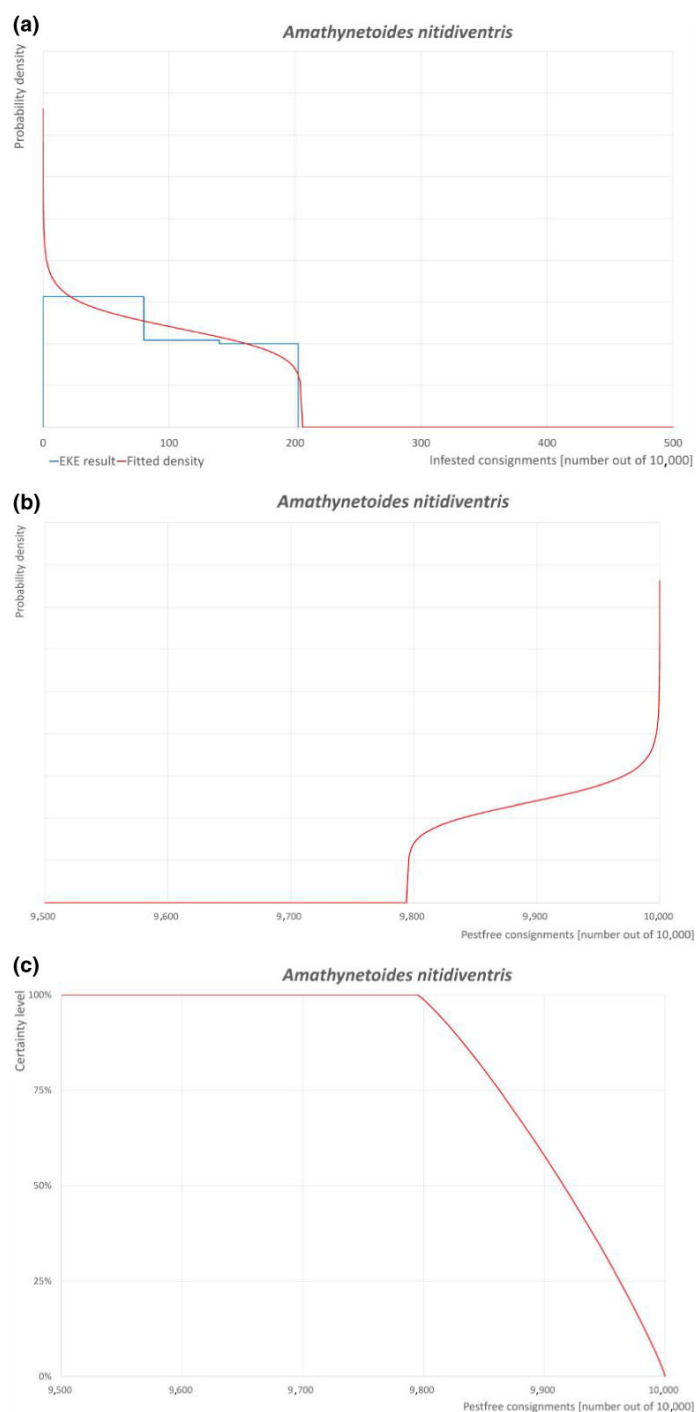
The EKE results are BetaGeneral (0.88624, 1.1525, 0, 205) fitted with @Risk version 7.6.

Based on the numbers of estimated infested plants, the pest freedom was calculated (i.e. = 10,000 – the number of infested tubers per 10,000). The fitted values of the uncertainty distribution of the pest freedom are shown in Table A.2.

**Table A.2:** The uncertainty distribution of plants free of *A. nitidiventr* per 10,000 tubers calculated by Table A.1

Percentile	1%	2.5%	5%	10%	17%	25%	33%	50%	67%	75%	83%	90%	95%	97.5%	99%
Values	9,800.00					9,860.00		9,920.00		9,960.00					9,999.00
EKE results	9,799.22	9,804.34	9,812.01	9,825.91	9,842.99	9,862.67	9,881.21	9,915.92	9,947.70	9,962.41	9,976.30	9,986.77	9,993.97	9,997.24	9,999.02

The EKE results are the fitted values.



**Figure A.1:** (a) Comparison of judged values for the uncertainty distribution of pest infestation per 10,000 tubers (histogram in blue) and fitted distribution (red line); (b) density function to describe the uncertainties of the likelihood of pest freedom; (c) descending distribution function of the likelihood of pest freedom

## A.1.6. References

- Alcázar J, Aldana G and Mayta S, 2004. Plagas y su control. El cultivo del ulluco en la sierra central del Perú. Capítulo V. Serie: Conservación y uso de la biodiversidad de raíces y tubérculos andinos: Una década de investigación para el desarrollo (1993–2003), 3.
- Aldana Yurivilca GS, 2003. Biología y medidas de control del gorgojo del ulluco *Amathynetoides nitidiventris* Hustache (Coleoptera: Curculionidae) en el departamento de Junín. Huancayo (Peru), Thesis of the Universidad Nacional del Centro del Perú: 132 pp.
- McCaffrey S and Walker K, 2012. Ulluco weevil (*Amathynetoides nitidiventris*) Updated on 4/16/2012 12:00:17 PM. Available online: PaDIL - <http://www.padil.gov.au>

## A.2. Potato virus T (PVT)

### A.2.1. Organism information

<b>Taxonomic information</b>	Current valid scientific name: potato virus T Synonyms: Potato T capillovirus, Potato T trichovirus Name used in the EU legislation: <i>Potato virus T</i> [PVT000]; Order: Tymovirales Family: <i>Betaflexiviridae</i> Common name: – Name used in the Dossier: <i>Potato virus T</i> (PVT)
<b>Group</b>	Virus
<b>EPPO code</b>	PVT000
<b>Regulated status</b>	Annex II: List of Union quarantine pests, Part A: Pests not known to occur in the Union territory  Quarantine pest: Morocco (2018), Canada (2019), Mexico (2018), USA (1994), Israel (2009), Norway (2012), New Zealand (2000),  A1 list: Argentina (2019), Brazil (2018), Jordan (2013), Kazakhstan (2017), Russia (2014), Turkey (2016), EAEU (2016), EPPO (1978)
<b>Pest status in Peru</b>	Present: widespread (EPPO, CABI CPC)
<b>Pest status in the EU</b>	Absent (EPPO, CABI CPC)
<b>Host status on <i>Ullucus tuberosus</i></b>	According to CABI CPC, <i>Ullucus tuberosus</i> (ulluco) is one of the hosts of PVT.
<b>PRA information</b>	PRA on EU internal movement of true potato seed (TPS) of registered TPS varieties: probability of association of regulated pests and analysis of risk reduction options (Netherlands Food and Consumer Product Safety Authority, 2015)  Assessment of Quarantine Pest Dispersal from Norwegian Potato and Root Vegetable Packing Plants with Evaluation of Risk Reducing Options, Opinion of the Panel on Plant Health of the Norwegian Scientific Committee for Food and Environment (2018)
<b>Other relevant information for the assessment</b>	
<b>Biology</b>	The potato virus T (PVT) is an RNA virus with flexuous filamentous particles that belong to the related genus <i>Tepovirus</i> (Martelli et al., 1994). It is seed-borne in some <i>solanaceous</i> species and is readily transmitted through vegetative propagation (true potato seeds) and pollen (Jones, 1982), in addition to be readily transmitted by sap inoculation to potato, as well as to tubers produced by infected plants. Vectors responsible for spreading PVT in potato crops are not known (Salazar and Harrison, 1978).

<b>Symptoms</b>	<b>Main type of symptoms</b>	PVT can be asymptomatic in potato and ullucus plant species. Some experimental plant species are used for PVT diagnosis: <i>Chenopodium amaranticolor</i> ; Systemic necrosis in leaves. <i>C. quinoa</i> ; Chlorotic spots in inoculated leaves, and mosaics in systemically infected leaves. <i>Datura stramonium</i> ; mild mosaics in systemically infected leaves. <i>Nicotiana debneyi</i> ; mottling in systemically infected leaves. <i>Phaseolus vulgaris</i> ; necrosis in systemically infected leaves and recovery of plants.
	<b>Presence of asymptomatic plants</b>	PVT is symptomless in potato and ulluco.
	<b>Confusion with other pests</b>	N/A
<b>Host plant range</b>	Natural hosts include Mashua ( <i>Tropaeolum tuberosum</i> ), oca ( <i>Oxalis tuberosa</i> ), potato ( <i>Solanum tuberosum</i> ) and ulluco ( <i>Ullucus tuberosus</i> ). It has been transmitted mechanically to 46 species from 8 dicotyledonous families, including Amaranthaceae, Chenopodiaceae, Leguminosae and Solanaceae (Salazar and Harrison, 1978). Wild <i>Solanum</i> species are also susceptible.	
<b>Pathways</b>	<ul style="list-style-type: none"> <li>– Vegetative propagation material (tubers and true seeds)</li> <li>– Mechanically by sap and plant-to-plant contact</li> <li>– Pollen</li> </ul>	
<b>Surveillance information</b>	<p>Following the Peruvian NPPO Dossier, there are no phytosanitary regulations on viruses that affect ulluco, but SENASA carries out permanent phytosanitary surveillance of crop fields, which includes sampling for laboratory analysis and supporting the producer for pest prevention and management. These activities are carried out in accordance with the 'Pest Prospecting Instructions' and 'Sampling and Handling Manual' developed by SENASA to carry out the prospecting actions on crops, including ulluco, as well as the procedures for sampling and remission of samples to the laboratory of plant parts and/or pests.</p> <p>Personnel trained in SENASA regional offices travel daily to the crop-producing areas for the identification of symptoms or damage due to pests and the transfer of samples to the laboratory. In the case of ulluco, this crop is managed in the highland's areas, the fields are travelled in order to identify anomalies in their growth, which may be related to the presence of virus or other disease.</p> <p>The samples collected in the field are registered in the database 'Integrated System of Plant Health Management' (SIGSVE) and sent to the Unit of Diagnostic Center of Plant Health of SENASA, under adequate conditions of protection. Laboratory analyses are performed by the SENASA Plant Health Diagnostic Centers Unit, which has diagnostic methods based on pest morphology, ELISA and molecular biology (conventional PCR, real time and sequencing).</p> <p>According to the Dossier and geographical distribution of PVT in Peru, it has been reported in the Ayacucho Cusco, Ancash and Puno areas.</p>	

## A.2.2. Possibility of pest presence in the production places

### A.2.2.1. Possibility of entry from the surrounding environment

Ulluco production sites are located in areas with low average temperatures, and therefore, the potential occurrence of pests is comparatively lower than other regions in Peru. There are no phytosanitary regulations on viruses.

PVT is widespread in Peru. Its natural host is potato, but it is also able to infect some other plant species in the Amaranthaceae, Chenopodiaceae, Fabaceae and Solanaceae families that may act as a source of PVT inoculum. The ulluco-producing area may be surrounded by other cultivated (potato or oca) or wild potential alternative hosts of PVT. Traditional cropping systems can favour the PVT dispersal in crops, as ulluco may be overlapping in mixed cropping with potato, ulluco may be beside potato fields or ulluco may be planted in fields where potato was previously grown. Also, the asymptomatic infection of PVT in potato and ulluco is a major issue, as it can be unnoticed and

contribute to the propagation of diseased material. According to EFSA Pest Categorisation on non-EU viruses and viroids on potato, the main pathway of PVT are plants for planting, including tubers or true seeds and microplants. Therefore, the use of diseased propagative material (tuber seeds) is the main factor that could be contributing to the entry and dispersal of PVT to the ulluco production areas from the surrounding environment. Additional pathways include mechanical transmission by plant to plant contact, as PVT has been reported to be experimentally sap-transmissible in potato (Jones 1982). It can also be seed transmitted in *Chenopodium quinoa*, *Datura stramonium* and *Nicandra physalodes*, as well as can be transmitted from pollen to true seeds, but infected pollen does not appear to infect the plant pollinated (Salazar and Harrison, 1978; Jones 1982). There are no insect vectors, animal or fungal known to transmit PVT.

#### Uncertainties:

- Lack of information on the biology of PVT in ulluco.
- It is uncertain to what extent the detection and sampling strategies are effective to detect asymptomatic plants.
- Lack of information on the potential alternative hosts for PVT in the surrounding areas.
- The potential PVT transmission by true seeds and pollen in ulluco is uncertain

Taking into consideration the above evidence and uncertainties, the Panel considers that it may be possible for the pest to enter the producing place.

#### **A.2.2.2. Possibility of entry with new plants/seeds**

PVT spreads to tubers and via pollen to true seed produced by infected plants. Ulluco plants are grown from non-certified seed tubers. This crop is traditionally managed by subsistence farmers, and producers select the seed tubers from the best plants of the previous crop/harvest to use them as propagation materials. PVT has a relatively limited host range with most susceptible species in the Amaranthaceae, Chenopodiaceae, Fabaceae and Solanaceae families. It has been reported to be transmitted mechanically in experimental conditions, including plant to plant contact and by tubers with 0–59% seed infection in potato (Jones, 1982). The producing areas of ulluco are in close proximity to other cultivated host plants of PVT (e.g. mashua, potato or oca) both in space and time.

#### Uncertainties:

- It is uncertain to what extent other cultivated host plants (mashua, potato or oca) could be potential source of PVT inoculum.
- It is uncertain to what extent the true seeds that are used to produce ulluco are virus-free.

Taking into consideration the above evidence and uncertainties, the Panel considers it may be possible that the pathogen could enter the producing area with undetected infected tubers and plants.

#### **A.2.2.3. Possibility of spread within the production places**

PVT is asymptomatic in ulluco and other potential cultivated (mashua, potato or oca) plant hosts. It has been reported to be transmitted mechanically in experimental conditions, including plant to plant contact and by tubers with 0–59% seed infection in potato (Jones, 1982). Agricultural practices for ulluco production is labour intensive and involves the use of tools during production, which could contribute to the PVT dispersal in ulluco.

#### Uncertainties:

- It is uncertain to what extent the detection and sampling strategies are effective to detect the occurrence of infected asymptomatic plants.

Taking into consideration the above evidence and uncertainties, the Panel considers that the transfer of the pathogen within the producing area may be possible.

#### **A.2.3. Information from interceptions**

Considering imports of *U. tuberosus* tubers from Peru to the EU, between 1995 and 2020 (until May), there are no records of interceptions of PVT.

#### A.2.4. Evaluation of the risk mitigation options

The description of all the risk mitigation measures currently applied in Peru is provided in Table 11. In the table below, those relevant for PVT are listed along with an indication of their effectiveness.

No	Risk mitigation measure	Effect on the pest	Evaluation and uncertainties
1	Surveillance and monitoring	Yes	<p><u>Evaluation:</u> Inspection activities in ulluco-producing areas by SENASA follow ISPMs. Tubers are visually inspected, and when suspected of pests are sent to a diagnostic laboratory. If the pest is detected, SENASA headquarters and producers are informed and corrective measures are applied.</p> <p><u>Uncertainties:</u> It is unclear to what extent the monitoring by visual inspection is effective to detect asymptomatic plants. This virus may remain asymptomatic in ulluco plants, and also in some other plant host species. It is uncertain the measures applied after diagnosis.</p>
2	Sampling and laboratory testing	Yes	<p><u>Evaluation:</u> The samples are registered in the database 'Integrated System of Plant Health Management' (SIGSVE) and sent the Unit of Diagnostic Center of Plant Health of SENASA, under adequate conditions of protection. The analyses are performed by the SENASA Plant Health Diagnostic Centers Unit (UCDSV), which has diagnostic methods based on pest morphology, ELISA and molecular biology (conventional PCR, real time and sequencing). This diagnostic approach is methodologically appropriate.</p> <p><u>Uncertainties:</u> It is unclear to what extent the detection and sampling strategies are effective to detect asymptomatic plants. This virus may remain asymptomatic in ulluco plants, and also in some other plant host species. Additionally, they stated that during the harvest, no analysis is done.</p>
3	Crop rotation	Yes	<p><u>Evaluation:</u> Ulluco production can be part of a rotation scheme with different crops e.g. oca, beans, barley. However, the overlapping with alternative crops could favour the PVT dispersal in crops, as other alternative host plants may act as a source of viral inoculum.</p> <p><u>Uncertainties:</u> It is unclear to what extent other cultivated host plants (potato) could be potential source of PVT inoculum.</p>
4	Selection of production sites	Yes	<p><u>Evaluation:</u> The environmental conditions in the areas where ulluco is cultivated allow limited pest pressure.</p> <p><u>Uncertainties:</u> Lack of information on the biology of PVT in ulluco. This control measure is considered of low relevance for the spread of the virus.</p>
5	Use of healthy propagation material	Yes	<p><u>Evaluation:</u> The use of healthy propagation material is correct, and a visual selection during the cultivation may be useful, but virus may be unnoticed and ulluco plants are grown from non-certified seeds. The use of certified virus-free seed tubers would have been preferable.</p> <p><u>Uncertainties:</u> It is unclear to which extent the implemented method is effective to prevent potential infections. Moreover, it is also uncertain the transmission of the virus to tubers, true seeds and pollen in ulluco.</p>
14	Sorting/grading/tuber selection	Yes	<p><u>Evaluation:</u> There is a field selection for tubers that are used for export, but PVT infection can be asymptomatic.</p> <p><u>Uncertainties:</u> Lack of information on the biology of PVT in ulluco (tubers). It is uncertain to what extent the inspection is effective to detect asymptomatic tubers.</p>



No	Risk mitigation measure	Effect on the pest	Evaluation and uncertainties
16	Pre-consignment inspection	Yes	<p><u>Evaluation:</u> SENASA is monitoring 2% of tubers and those with symptoms are sent for laboratory testing, but PVT infection can be asymptomatic.</p> <p><u>Uncertainties:</u> It is uncertain to what extent visual inspection is effective in detecting infected tubers (as it is regarded as an asymptomatic virus). Additionally, it is stated that no analysis is done during harvest.</p>

### A.2.5. Overall likelihood of pest freedom

#### A.2.5.1. Reasoning for a scenario which would lead to a reasonably low number of infested consignments

- Inspections and surveillance are effective to detect PVT.
- Cultivation areas have a low virus prevalence.
- Crop rotation can prevent the occurrence and/or spread of the virus by using non-host plants.
- Diseased plants are not able to produce infected tubers.

#### A.2.5.2. Reasoning for a scenario which would lead to a reasonably high number of infested consignments

- Inspections and surveillance are ineffective to detect PVT because of the low number of sampling and asymptomatic plants.
- Other cultivation areas have similar virus prevalence than Ayacucho Cusco, Ancash and Puno
- Crop rotation cannot prevent the occurrence/spread of the virus.
- Latent infections in tubers are asymptomatic and produce infected tubers.

#### A.2.5.3. Reasoning for a central scenario equally likely to over- or underestimate the number of infested consignments (median)

- The main uncertainty is the effectiveness of the sampling method during (visual) inspections.

#### A.2.5.4. Reasoning for the precision of the judgement describing the remaining uncertainties (1st and 3rd quartile/interquartile range)

- The host range is restricted.

#### A.2.5.5. Elicitation outcomes of the assessment of the pest freedom for potato virus T (PVT)

The following tables show the elicited and fitted values for pest infestation/infection (Table A.3) and pest freedom (Table A.4).

**Table A.3:** Elicited and fitted values of the uncertainty distribution of pest infestation by PVT per 10,000 tubers

Percentile	1%	2.5%	5%	10%	17%	25%	33%	50%	67%	75%	83%	90%	95%	97.5%	99%
Elicited values	20.00					200.00		400.00		630.00					900.00
EKE	19.22	29.72	47.61	84.26	134.63	198.68	264.49	402.55	550.00	628.14	711.11	783.53	843.28	876.89	899.88

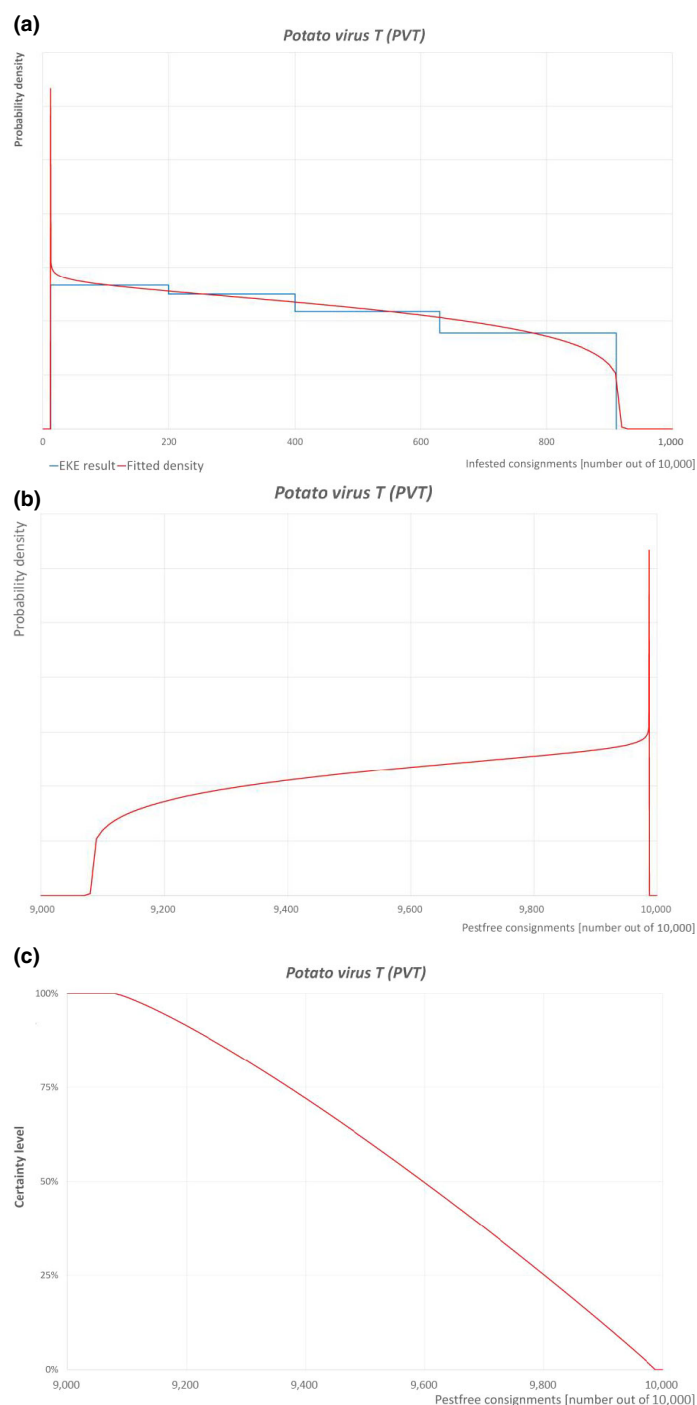
The EKE results are BetaGeneral(0.97552, 1.2018, 12.5, 920) fitted with @Risk version 7.6.

Based on the numbers of estimated infested tubers, the pest freedom was calculated (i.e. = 10,000 – the number of infested tubers per 10,000). The fitted values of the uncertainty distribution of the pest freedom are shown in Table A.4.

**Table A.4:** The uncertainty distribution of plants free of PVT per 10,000 tubers calculated by Table A.3

Percentile	1%	2.5%	5%	10%	17%	25%	33%	50%	67%	75%	83%	90%	95%	97.5%	99%
Values	9,100.00					9,370.00		9,600.00		9,800.00					9,980.00
EKE results	9,100.12	9,123.11	9,156.72	9,216.47	9,288.89	9,371.86	9,450.00	9,597.45	9,735.51	9,801.32	9,865.37	9,915.74	9,952.39	9,970.28	9,980.78

The EKE results are the fitted values.



**Figure A.2:** (a) Comparison of judged values for the uncertainty distribution of pest infestation per 10,000 tubers (histogram in blue) and fitted distribution (red line); (b) density function to describe the uncertainties of the likelihood of pest freedom; (c) descending distribution function of the likelihood of pest freedom

#### A.2.5.6. References

CABI (Centre for Agriculture and Bioscience International), online. CABI Crop Protection Compendium. Potato virus T, datasheet. Available online: <https://www.cabi.org/cpc/datasheet/43686> [Accessed: 28 May 2020].

EPPO (European and Mediterranean Plant Protection Organization), online. EPPO Global Database. Potato virus T, datasheet. Available online: <https://gd.eppo.int/taxon/PVT000> [Accessed: 28 May 2020].

- EFSA Panel on Plant Health (PLH), Bragard C, Dehnen-Schmutz K, Gonthier P, Jaques Miret JA, Justesen AF and Jacques MA, 2020. Pest categorisation of the non-EU phytoplasmas of tuber-forming *Solanum* spp. EFSA Journal 2020;18(12), e06356. <https://doi.org/10.2903/j.efsa.2020.e06356>
- EUROPHYT, online. European Union Notification System for Plant Health Interceptions – EUROPHYT. Available online: [http://ec.europa.eu/food/plant/plant\\_health\\_biosecurity/europhyt/index\\_en.htm](http://ec.europa.eu/food/plant/plant_health_biosecurity/europhyt/index_en.htm) [Accessed: 28 May 2020].
- Jones RAC, 1982. Tests for transmission of four potato viruses through potato true seed. Annals of Applied Biology, 100, 315–320.
- Martelli GP, Candresse T and Namba S, 1994. Trichovirus, a new genus of plant viruses. Archives of virology, 134, 451–455.
- NVWA, der Gaag DJ, Colon L, de Hoop B, Roenhorst A, Tjou-Tam-Sin L, 2015. Pest Risk Assessment (PRA) on EU internal movement of true potato seed (TPS) of registered TPS varieties: probability of association of regulated pests and analysis of risk reduction options. Netherlands Food and Consumer Product Safety Authority (NVWA), Utrecht, the Netherlands.
- Salazar LT and Harrison BD, 1978. Host range, purification and properties of potato virus T. Annals of Applied Biology, 89, 223–235.
- VKM, Rafoss T, Magnusson C, Sletten A, Wendell M, Sundheim L, Brodal G, Ergon Å, Solheim H and Tronsmo AM, 2018. Assessment of quarantine pest dispersal in waste from potato and root vegetable packing plants in Norway. Opinion of the Panel on Plant Health of the Norwegian Scientific Committee for Food and Environment. VKM report 2018:15, ISBN: 978-82-8259-312-0, ISSN: 2535-4019. Norwegian Scientific Committee for Food and Environment (VKM), Oslo, Norway.

### A.3. Andean potato latent virus (APLV)

#### A.3.1. Organism information

<b>Taxonomic information</b>	<p>Current valid scientific name: Andean potato latent virus</p> <p>Synonyms: Andean potato latent tymovirus, Eggplant mosaic tymovirus Andean potato latent str, Eggplant mosaic virus (Andean potato latent str.), potato (Andean) latent virus, Potato Andean latent tymovirus, Potato Andean latent virus</p> <p>Name used in the EU legislation: Andean potato latent virus [APLV00];</p> <p>Order: Tymovirales</p> <p>Family: <i>Tymoviridae</i></p> <p>Common name: Andean potato latent virus</p> <p>Name used in the Dossier: Andean potato latent virus (APLV)</p>
<b>Group</b>	Virus
<b>EPPO code</b>	APLV
<b>Regulated status</b>	<p>Annex II: List of Union quarantine pests, Part A: Pests not known to occur in the Union territory</p> <p>Quarantine pest: Morocco (2018), Canada (2019), Mexico (2018), USA (1989), Israel (2009), Norway (2012), New Zealand (2000)</p> <p>A1 list: Argentina (2019), Brazil (2018), Jordan (2013), Kazakhstan (2017), Uzbekistan (2008), Russia (2014), Turkey (2016), EAEU (2016), EPPO (1978)</p>
<b>Pest status in Peru</b>	Present: widespread (EPPO, CABI CPC)
<b>Pest status in the EU</b>	Absent (EPPO, CABI CPC)
<b>Host status on <i>Ullucus tuberosus</i></b>	According to CABI CPC, <i>Ullucus tuberosus</i> (ulluco) is one of the main hosts of APLV.
<b>PRA information</b>	Pest categorisation of non-EU viruses and viroids of potato (EFSA, 2020). Biosecurity Guidance on Ulluco, Preventing the introduction and spread of ulluco viruses (DeFRA, 2017)

## Other relevant information for the assessment

<b>Biology</b>	Andean potato latent virus (APLV) consists of a single-stranded RNA genome of 6.0–6.7 kb in size and isometric particles of 30 nm in diameter, belonging to the tymovirus group, which is typically beetle-transmitted (CABI CPC, Online). APLV can be transmitted by a flea beetle ( <i>Epitrix</i> sp.) with low efficiency in experimental conditions. The virus is readily transmitted by contact, and its transmission to tubers is erratic. APLV was considered a strain of eggplant mosaic tymovirus, but nucleotide sequence comparison has showed to be distinct species. There are three major serological strain groups recognised; CCC, Col-Cay and Hu (Fribourg et al., 1977; Koenig et al., 1979). Although, it has been recently suggested that APLV should be subdivided into two species, APLV and APMNV, based on comparison of the complete genomic RNA sequences of Hu and Col isolates (Kreuze et al. 2013; EPPO Standard, Diagnostics, 2018).	
<b>Symptoms</b>	<b>Main type of symptoms</b>	APLV is usually latent in <i>Solanum</i> spp., but occasionally it causes chlorotic netting of minor veins or mild or even severe mosaic symptoms (Fribourg et al., 1977). Symptoms depend on the virus species, strain, plant species and environmental conditions (EPPO Standard, Diagnostics, 2018). Severe symptoms are also induced in mixed infections with other potato viruses (Jones and Fribourg, 1978). Some experimental plant species are used for APLV diagnosis. APLV causes chlorotic and necrotic local lesions in <i>Nicotiana benthamiana</i> , <i>N. hesperis</i> 67A and <i>N. occidentalis</i> P1 (EPPO Standard, Diagnostics, 2018).
	<b>Presence of asymptomatic plants</b>	According to CABI CPC, APLV appear to be latent on <i>Solanum</i> sp. and no symptoms are observed on ulluco (Lizarraga et al., 1996) (CABI CPC, Online).
	<b>Confusion with other pests</b>	N/A
<b>Host plant range</b>	<p>The natural host range of APLV is restricted, its principal host is potato (<i>Solanum tuberosum</i>), and also includes <i>Solanum acaule</i> and ulluco (<i>Ullucus tuberosus</i>) (Lizarraga et al., 1996; Roenhorst and Verhoeven, 1998; EPPO Standard, Diagnostics, 2018). APLV can also be transmitted mechanically to species of Amaranthaceae, Chenopodiaceae, Cucurbitaceae and Solanaceae (Fribourg et al., 1977).</p> <p>According to EFSA pest categorisation on non-EU viruses, APLV in <i>U. tuberosus</i> was reported to be distinct from APLV in potato (Fox et al., 2019), and additional natural hosts may exist.</p>	
<b>Pathways</b>	<ul style="list-style-type: none"> <li>– Vegetative propagation material (true seeds and possibly through tubers)</li> <li>– Mechanically by sap and plant-to-plant contact</li> <li>– Insect vector transmission (<i>Epitrix</i> sp.)</li> <li>– Pollen</li> </ul>	
<b>Surveillance information</b>	<p>Following the Peruvian NPPO Dossier, there are no phytosanitary regulations on viruses that affect ulluco crops. SENASA carries out permanent phytosanitary surveillance of crop fields, which includes sampling for laboratory analysis and supporting the producer for pest prevention and management. These activities are carried out in accordance with the 'Pest Prospecting Instructions' and 'Sampling and Handling Manual' developed by SENASA to carry out the prospecting actions on crops, including ulluco, as well as the procedures for sampling and remission of samples to the laboratory of plant parts and/or pests.</p> <p>Personnel trained in SENASA regional offices travel daily to the crop-producing areas for the identification of symptoms or damage due to pests and the transfer of samples to the laboratory. In the case of ulluco, this crop is managed in the highland's areas, the fields are travelled in order to identify anomalies in their growth, which may be related to the presence of virus or other disease.</p> <p>The samples collected in the field are registered in the database 'Integrated System of Plant Health Management' (SIGSVE) and sent the Unit of Diagnostic Center of Plant Health of SENASA, under adequate conditions of protection. Laboratory analyses are performed by the SENASA Plant Health Diagnostic Centers Unit, which has diagnostic methods based on pest morphology, ELISA and molecular biology (conventional PCR, real time and sequencing).</p>	

<p>According to the Dossier APLV in Peru has been reported in La Libertad and Acash. A survey for viruses' detection on ulluco crops from certified plants and tubers (three field exposures) showed that a 28% and 57% of plants in the field were infected with APLV, among other viruses (Lizárraga et al., 1999).</p>
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### A.3.2. Possibility of pest presence in the production places

#### A.3.2.1. Possibility of entry from the surrounding environment

Ulluco production sites are located in areas with low average temperatures, and therefore, the potential occurrence of pests is comparatively lower than other regions in Peru. There are no phytosanitary regulations on viruses.

APLV is widespread in Peru. Although its natural host is potato, it is also able to infect some other alternative host plants that may be act as a source of APLV inoculum. The traditional cropping systems could favour the APLV dispersal in crops, as ulluco fields may be beside potato fields, or planted in fields where potato has previously been grown. The latent infection of APLV in primary *Solanum* spp. infections and symptomless infections in ulluco could contribute to unnoticed diseased material. According to EFSA Pest Categorisation on non-EU viruses and viroids on potato, the main pathway of APLV are plants for planting, including tubers, true seeds and microplants. Transmission to tubers is erratic, but the use of diseased propagative material (tuber or true seeds) may favour the entry and dispersal of APLV to the ulluco production areas from the surrounding environment. Additional pathways include transmission by beetles in a semi-persistent manner (Sastry et al., 2019). In this sense, *Epitrix* spp. (flea beetles) have been associated with the APLV transmission in experimental conditions, and could act as natural vectors, but only when high populations are present (Jones and Fribourg, 1977; Jones 1982). No other vectors, animal or fungal are known to transmit APLV.

##### Uncertainties:

- Lack of information available on the biology of APLV in ulluco, including the potential presence of alternative hosts for APLV.
- It is uncertain to what extent the detection and sampling strategies are effective to detect asymptomatic plants.
- Whether *Epitrix* spp. can transmit the virus, and if so, to what extent, is unknown.

Taking into consideration the above evidence and uncertainties, the Panel considers that it may be possible for the pest to enter the producing place.

#### A.3.2.2. Possibility of entry with new plants/seeds

Ulluco plants are grown from non-certified seeds. This crop is traditionally managed by subsistence farmers, and producers select the seed tubers from the best plants of the previous crop/harvest to use them as propagation materials. APLV has a very limited host range and can be transmitted erratically to potato tubers in experimental conditions (Jones and Fribourg, 1977). As mentioned above, plants can be asymptomatic and traditional cropping systems (close to or in combination with potato crops) can favour the infection of ulluco crops.

##### Uncertainties:

- It is uncertain to what extent other cultivated host plants (potato) could be a potential source of APLV inoculum.
- It is uncertain to what extent true seeds are used to produce ulluco are virus-free
- The APLV transmission rate to tubers is uncertain.

Taking into consideration the above evidence and uncertainties, the Panel considers it may be possible that the pathogen could enter the producing area.

#### A.3.2.3. Possibility of spread within the production places

APLV is asymptomatic in ulluco, and can be transmitted mechanically by plant to plant contact, as well as it is potentially transmitted by flea beetles (*Epitrix* spp.).



Uncertainties:

- It is uncertain to what extent the inspection and sampling strategies are effective to detect asymptomatic plants.
- Whether *Epitrix* spp. can transmit the virus, and if so, to what extent, is unknown.

Taking into consideration the above evidence and uncertainties, the Panel considers that the transfer of the pathogen within the producing area may be possible.

**A.3.3. Information from interceptions**

Considering imports of *U. tuberosus* tubers from Peru to the EU, between 1995 and 2020 (until May), there are no records of interceptions of APLV. However, one interception of APLV has been reported on *Solanum tuberosum* (ware potatoes) imported from Peru to the Netherlands in 2017 (EUROPHYT, online).

**A.3.4. Evaluation of the risk mitigation options**

The description of all the risk mitigation measures currently applied in Peru is provided in Table 11. In the table below, those relevant for APLV are listed along with an indication of their effectiveness.

No.	Risk mitigation measure	Effect on the pest	Evaluation and uncertainties
1	Surveillance and monitoring	Yes	<p><u>Evaluation:</u> Inspection activities in ulluco-producing areas by SENASA follow ISPMs. Tubers are visually inspected, and when suspected of pests are sent to a diagnostic laboratory. If the pest is detected, SENASA headquarters are informed and further actions are considered.</p> <p><u>Uncertainties:</u> It is unclear to what extent the monitoring by visual inspection is effective to detect asymptomatic plants. This virus may remain asymptomatic in ulluco plants, and also in some other plant host species.</p>
2	Sampling and laboratory testing	Yes	<p><u>Evaluation:</u> The samples are registered in the database 'Integrated System of Plant Health Management' (SIGSVE) and sent the Unit of Diagnostic Center of Plant Health of SENASA, under adequate conditions of protection. The analyses are performed by the SENASA Plant Health Diagnostic Centers Unit (UCDSV), which has diagnostic methods based on pest morphology, ELISA and molecular biology (conventional PCR, real time and sequencing). This diagnostic approach is methodologically appropriate.</p> <p><u>Uncertainties:</u> It is unclear to what extent the detection and sampling strategies are effective to detect asymptomatic plants. This virus may remain asymptomatic in ulluco plants, and also in some other plant host species. Additionally, they stated that during the harvest, no analysis is done.</p>
3	Crop rotation	Yes	<p><u>Evaluation:</u> Ulluco production can be part of a rotation scheme with different crops e.g. oca, beans, barley. However, the overlapping with alternative crops could favour the APLV dispersal in crops, as other alternative host plants may act as a source of viral inoculum.</p> <p><u>Uncertainties:</u> It is unclear to what extent other cultivated host plants (potato) could be potential source of APLV inoculum.</p>
4	Selection of production sites	Yes	<p><u>Evaluation:</u> The environmental conditions in the areas where ulluco is cultivated allow limited pest pressure.</p> <p><u>Uncertainties:</u> Lack of information on the biology of AVL in ulluco. This control measure is considered of low relevance for the spread of the virus.</p>

No.	Risk mitigation measure	Effect on the pest	Evaluation and uncertainties
5	Use of healthy propagation material	Yes	<p><u>Evaluation:</u> The use of healthy propagation material is correct, and a visual selection during the cultivation may be useful, but virus may be unnoticed and ulluco plants are grown from non-certified seeds. The use of certified virus-free seed tubers would have been preferable.</p> <p><u>Uncertainties:</u> It is unclear to which extent the implemented method is effective to prevent potential infections. Moreover, it is also uncertain the transmission of the virus to tubers, true seeds and pollen in ulluco.</p>
10	Application of plant extracts/repellent	Yes	<p><u>Evaluation:</u> Plant extracts are applied to control aphids and other insect pests, and control <i>Epitrix</i> spp., a potential vector of APLV.</p> <p><u>Uncertainties:</u> It is unclear the efficacy of these repellents against aphids and flea beetles. In addition to the capacity and transmission efficiency of APLV by flea beetles in ullucus is uncertain</p>
14	Sorting/grading/tuber selection	Yes	<p><u>Evaluation:</u> There is a field selection for tubers that are used for export, but APLV infection can be asymptomatic.</p> <p><u>Uncertainties:</u> Lack of information on the biology of APLV in ulluco (tubers). It is uncertain to what extent the inspection is effective to detect asymptomatic tubers.</p>
16	Pre-consignment inspection	Yes	<p><u>Evaluation:</u> SENASA is monitoring 2% of tubers and those with symptoms are sent for laboratory testing, but APLV infection can be asymptomatic.</p> <p><u>Uncertainties:</u> It is uncertain to what extent visual inspection is effective in detecting infected tubers (as it is regarded as an asymptomatic virus). Additionally, it is stated that no analysis is done during harvest.</p>

### A.3.5. Overall likelihood of pest freedom

#### A.3.5.1. Reasoning for a scenario which would lead to a reasonably low number of infested consignments

- Inspections and surveillance are effective to detect APLV.
- Cultivation areas have a low virus prevalence.
- Crop rotation can prevent the occurrence/spread of the virus by using non-host plants.
- Diseased plants are not able to produce infected tubers.
- Diseased plants are easily detected.

#### A.3.5.2. Reasoning for a scenario which would lead to a reasonably high number of infested consignments

- Inspections and surveillance are ineffective to detect APLV because of the low number of sampling and asymptomatic plants.
- Cultivation areas have similar virus prevalence than Ancash and La Libertad.
- Crop rotation cannot prevent the occurrence/spread of the virus.
- Diseased plants are able to produce infected tubers.
- Latent infections in tubers are asymptomatic and therefore remain undetected.

#### A.3.5.3. Reasoning for a central scenario equally likely to over- or underestimate the number of infested consignments (median)

- The effectiveness of (visual) inspections and field sampling methods to detect APLV is uncertain.

#### A.3.5.4. Reasoning for the precision of the judgement describing the remaining uncertainties (1st and 3rd quartile/interquartile range)

- The host range of APLV is restricted.

### A.3.5.5. Elicitation outcomes of the assessment of the pest freedom for Andean potato latent virus (APLV)

The following tables show the elicited and fitted values for pest infestation/infection (Table A.5) and pest freedom (Table A.6).

**Table A.5:** Elicited and fitted values of the uncertainty distribution of pest infestation by APLV per 10,000 tubers

Percentile	1%	2.5%	5%	10%	17%	25%	33%	50%	67%	75%	83%	90%	95%	97.5%	99%
Elicited values	20.00					180.00		350.00		550.00					800.00
EKE	17.23	27.59	44.53	78.01	122.74	178.56	235.24	353.33	479.77	547.51	620.51	685.69	741.26	773.82	797.18

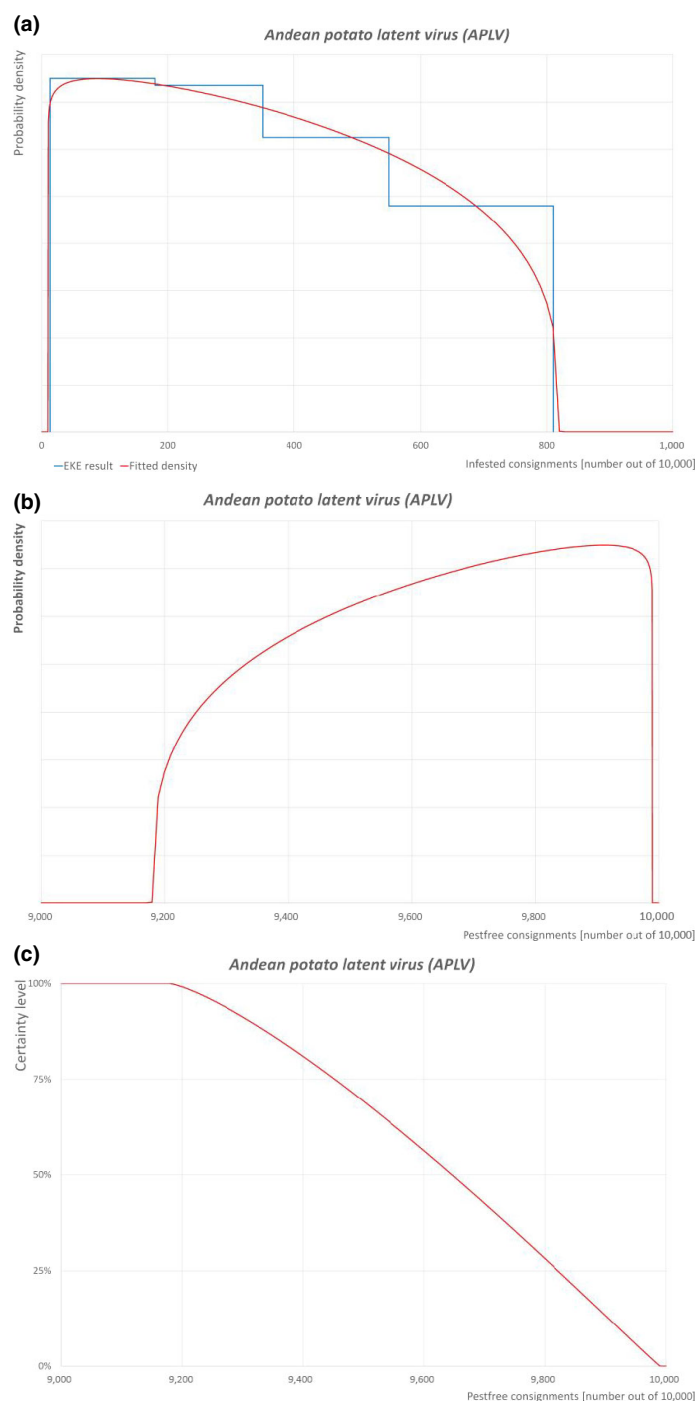
The EKE results are BetaGeneral (1.0325, 1.3006, 10, 820) fitted with @Risk version 7.6.

Based on the numbers of estimated infested tubers, the pest freedom was calculated (i.e. = 10,000 – the number of infested tubers per 10,000). The fitted values of the uncertainty distribution of the pest freedom are shown in Table A.6.

**Table A.6:** The uncertainty distribution of plants free of APLV per 10,000 tubers calculated by Table A.5

Percentile	1%	2.5%	5%	10%	17%	25%	33%	50%	67%	75%	83%	90%	95%	97.5%	99%
Values	9,200.00					9,450.00		9,650.00		9,820.00					9,980.00
EKE results	9,202.82	9,226.18	9,258.74	9,314.31	9,379.49	9,452.49	9,520.23	9,646.67	9,764.76	9,821.44	9,877.26	9,921.99	9,955.47	9,972.41	9,982.77

The EKE results are the fitted values.



**Figure A.3:** (a) Comparison of judged values for the uncertainty distribution of pest infestation per 10,000 tubers (histogram in blue) and fitted distribution (red line); (b) density function to describe the uncertainties of the likelihood of pest freedom; (c) descending distribution function of the likelihood of pest freedom

### A.3.6. Reference list

CABI (Centre for Agriculture and Bioscience International), online. CABI Crop Protection Compendium. Andean potato latent virus, datasheet. Available online: <https://www.cabi.org/cpc/datasheet/42518> [Accessed: 28 May 2020].

Defra EM, 2017. Preventing the introduction and spread of ulluco viruses. Department for Environment Food and Rural Affairs, UK.

- EFSA Panel on Plant Health (PLH), Bragard C, Dehnen-Schmutz K, Gonthier P, Jaques Miret JA, Justesen AF and Jacques MA, 2020. Pest categorisation of the non-EU phytoplasmas of tuber-forming *Solanum* spp. EFSA Journal 2020;18(12), e06356. <https://doi.org/10.2903/j.efsa.2020.e06356>
- EPPO (European and Mediterranean Plant Protection Organization), online. EPPO Global Database. Andean potato latent virus, datasheet. Available online: <https://gd.eppo.int/taxon/APLV00> [Accessed: 28 May 2020].
- EPPO (European and Mediterranean Plant Protection Organization), 2018. Bulletin OEPP/EPPO Bulletin, 48, 405–413.
- Fox A, Fowkes AR, Skelton A, Harju V, Buxton-Kirk A, Kelly M and Adams IP, 2019. Using high-throughput sequencing in support of a plant health outbreak reveals novel viruses in *Ullucus tuberosus* (Basellaceae). Plant Pathology, 68, 576–587.
- Fribourg CE, Jones RAC and Koenig R, 1977. Andean potato mottle, a new member of the cowpea mosaic virus group. Phytopathology, 67, 969–974.
- Jones RAC, 1982. Tests for transmission of four potato viruses through potato true seed. Annals of Applied Biology, 100, 315–320.
- Jones RAC and Fribourg CE, 1978. Symptoms induced by Andean potato latent virus in wild and cultivated potatoes. Potato Research, 21, 121–127.
- Koenig R, Fribourg CE and Jones RAC, 1979. Symptomatology, serological, and electrophoretic diversity of isolates of Andean potato latent virus from different regions of the Andes. Phytopathology, 69, 748–752.
- Kreuze J, Koenig R, De Souza J, Vetten HJ, Muller G, Flores B and Cuellar W, 2013. The complete genome sequences of a Peruvian and a Colombian isolate of Andean potato latent virus and partial sequences of further isolates suggest the existence of two distinct potato-infecting tymovirus species. Virus Research, 173, 431–435.
- Lizarraga C, Santa Cruz M and Jayasinghe U, 1996. Detection of an isolate of Andean potato latent tymovirus in ulluco (*Ullucus tuberosus* Caldas). Plant Disease, 80.
- Sastry KS, Mandal B, Hammond J, Scott SW, Briddon RW, Sastry SK and Hammond J, 2019. *Ullucus tuberosus* (Ulluco). Encyclopedia of Plant Viruses and Viroids, 2629–2631.
- Verhoeven TJ and Roenhorst JW, 1998. Occurrence of tospoviruses in the Netherlands. In Recent Progress in Tospovirus and Thrips Research, Abstracts of Papers and Poster Presentations Presented at the Fourth International Symposium on Tospoviruses and Thrips in Floral and Vegetable Crops held (pp. 2–6).

## A.4. *Nacobbus aberrans* (The false root-knot nematode)

### A.4.1. Organism information

<b>Taxonomic information</b>	<p><b>Current valid scientific name:</b> <i>Nacobbus aberrans</i> (Thorne, 1935) Thorne and Allen, 1944</p> <p><b>Synonyms:</b> <i>Anguillulina aberrans</i> Thorne, 1935, <i>Nacobbus batatiformis</i> Thorne and Schuster, <i>Nacobbus serendipiticus</i> Franklin, <i>Nacobbus serendipiticus bolivianus</i> Lordello, Zamith and Boock</p> <p>name used in the EU legislation: <i>Nacobbus aberrans</i> (Thorne) Thorne and Allen</p> <p>Name used in the Dossier: –</p> <p>Order: Rhabditida</p> <p>Family: Pratylenchidae</p>
<b>Group</b>	Nematoda
<b>EPPO code</b>	NACOPA
<b>Regulated status</b>	<p><b>EU status:</b> Annex IAI</p> <p><b>Non- EU:</b> A1 list: Brazil (2018), Paraguay (1995), Uruguay (1995), Bahrain (2003), Jordan (2013), Uzbekistan (2008), Georgia (2018), Russia (2014), Turkey (2016), Ukraine (2010), EPPO (1981)</p> <p>A2 list: Argentina (2019)</p> <p>Quarantine pest: Morocco (2018), Israel (2009), Norway (2012)</p>

<b>Pest status in Peru</b>	Present, restricted distribution (EPPO, online)
<b>Pest status in the EU</b>	Absent
<b>Host status on <i>Ullucus tuberosus</i></b>	In CABI (2020) and EFSA Journal (2018), ulluco, <i>Ullucus tuberosus</i> is recorded as a host of <i>Nacobbus aberrans</i> .
<b>PRA information</b>	<p><i>Nacobbus aberrans</i>, the false root-knot nematode is a species complex (= <i>N. aberrans sensu lato</i>) comprising more than one species (Reid et al., 2003; Vovlas et al., 2007). It is a root endoparasite with mobile (juveniles and immature adults) and immobile developmental stages (sedentary mature females). According to the host preferences <i>N. aberrans</i> is classified into three groups (potato, sugar beet and bean group) (Franco and Main, 2008, EFSA, 2018). According to the EFSA Scientific Opinion on pest categorization of <i>N. aberrans</i> published in 2018, all populations of <i>N. aberrans sensu lato</i> are highly polyphagous and could attack and cause severe damage to many important host plants in the EU. Yield losses reported on crops infected by <i>N. aberrans</i> depend on initial density, climatic conditions, soil type and crop cultivar and average 65% for potato in the Andean region of South America, and 55% and 36% for tomato and bean, respectively in Mexico (Inserra et al., 2004; EFSA, 2018). The false root-knot nematode is adapted to different climatic conditions and has been reported from temperate and subtropical regions of North (USA, Mexico) and South America (Argentina, Bolivia, Chile, Ecuador and Peru) (EFSA Journal, 2018). South American populations are able to develop at temperatures of 10–25°C (Anthoine et al., 2006).</p> <p><i>N. aberrans</i> is widely distributed in the areas of oca and ulluco production (Bridge et al., 2005) and is considered the most common pest of potato and other Andean crops including ulluco in the temperate highlands of the Andean regions (Manzanilla-Lopez et al., 2002; Franco and Main, 2008). In the Andes, it is associated with potatoes at temperatures of 15–18°C (Mai et al., 1981). Although ulluco roots can be heavily attacked, information on the economic impact of <i>N. aberrans</i> as a limiting factor of ulluco production is poor (Bridge et al., 2005). According to Bridge et al. (2005), the response of ulluco to the attack of <i>N. aberrans</i> as well as <i>Atalodera andina</i> indicates the possibility of an available resistant gene base.</p> <p>In the answers provided by Peru to the questions raised by the working group, it is stated that distribution of false root-knot nematode in Peru is restricted. The nematode causes damage to potatoes; however, its attacks are rare. According to SENASA, no false root-knot nematode attacks were detected on ulluco.</p> <p><i>N. aberrans</i> is quarantine plant parasitic nematode pest posing a high risk for the EU agriculture if introduced either with infested plants (plants for planting) or soil attached to plants.</p> <p>Unwashed/unbrushed ulluco tubers are contaminated with soil and could pose a significant risk of introduction of plant parasitic nematodes, including <i>N. aberrans</i> into the EU.</p> <p>Cleaned ulluco tubers intended for consumption, that are essentially free from soil present a lower risk for quarantine plant parasitic nematodes, but washing (or brushing) does not reduce the risk of nematodes associated with tubers infected with certain endoparasitic nematodes, including <i>N. aberrans</i>. Although <i>N. aberrans</i> may be present inside ulluco tubers, the risk which is generally associated with the end use of ulluco is considered low as the ulluco will be processed for consumption – tubers will be heat treated. Plant residues like peels or culled tubers may, however, still pose certain risk, if they are not properly removed or treated.</p>



## Other relevant information for the assessment

Symptoms	<b>Main type of symptoms</b>	<p>The above-ground symptoms of <i>N. aberrans</i> attack are not very specific. They appear as irregular patchy areas of infested plants manifested in poor growth, wilting and leaf chlorosis.</p> <p>The symptoms caused by the false root-knot nematode attack are more obvious on the roots, on which root galls are developed mainly along the root axis and at the root tips. These galls are similar to those caused by <i>Meloidogyne</i> spp. Gall shape may vary with nematode density, biological race and root size (Brodie et al., 2005). Galls are not so pronounced on tubers.</p>
	<b>Presence of asymptomatic plants</b>	Tubers and roots inhabited by the vermiform and motile stages of <i>N. aberrans</i> escape any visual inspection. The absence of symptoms (galls) in certain plants is possible and the presence of <i>N. aberrans</i> within tubers of ulluco may be overlooked (EFSA, 2018).
	<b>Confusion with other pathogens/pests</b>	Galls formed by <i>N. aberrans</i> may be confused with symptoms caused by root-knot nematodes ( <i>Meloidogyne</i> spp.). For proper nematode identification, it is therefore necessary to use morphologic characters or molecular tools.
Host plant range	<p><i>N. aberrans</i> is a highly polyphagous nematode parasitising more than 90 plant species from 21 botanical families including potatoes (<i>Solanum tuberosum</i> L.), sugar beet (<i>Beta vulgaris</i> L.), tomato (<i>Solanum lycopersicum</i> L.) and beans (<i>Phaseolus vulgaris</i> L.) (EFSA Journal, 2018).</p> <p>Other hosts (EFSA Journal, 2018):</p> <p>Amaranthaceae (<i>Amaranthus</i> sp., <i>A. hybridus</i> L., <i>A. hypochondriacus</i> L., <i>A. quitensis</i> H.B. &amp; K., <i>A. retroflexus</i> L., <i>A. spinosus</i> L., <i>Bassia</i> (=Kochia) <i>scoparia</i> (L.) Voss); Apiaceae (<i>Daucus carota</i> L.); Asteraceae (<i>Eupatorium azangaroense</i> Sch. Bip., <i>Baccharis salicifolia</i> (Ruiz and Pav) Pers., <i>Gaillardia pulchella</i> Fouger, <i>Lactuca sativa</i> L., <i>Simsia amplexicaulis</i> Pers., <i>Tagetes mandonii</i> Sch. Bip., <i>Taraxacum officinale</i> L., <i>Tragopogon porrifolius</i> L.); Basellaceae (<i>Ullucus tuberosus</i> Caldas); Brassicaceae (<i>Brassica campestris</i> L., <i>B. juncea</i> (L.) Czern. &amp; Cass. (=B. <i>japonica</i>), <i>B. napus</i> (L.) Rchb. Napobrassica Group, <i>B. nigra</i> (L.) Koch, <i>B. oleracea</i> L., <i>B. rapa</i> L., <i>Calandria albis</i> Kunth., <i>Capsella bursa-pastoris</i> (L.) Medic., <i>Matthiola</i> sp., <i>Raphanus sativus</i> L., <i>Sisymbrium irio</i> L.); Cactaceae (<i>Coryphantha vivipara</i> Britt. and Rose, <i>Escobaria</i> (=Mammillaria) <i>vivipara</i> (Nutt.) F. Buxb, <i>Mammillaria vivipara</i> (Nutt.) Haw., <i>Opuntia fragilis</i> Haw., <i>O. macrorhiza</i> Engelm. (= <i>tortispina</i> Nutt.); Caryophyllaceae (<i>Spergula arvensis</i> L., <i>Stellaria media</i> (L.) Vill.; Chenopodiaceae (<i>Atriplex confertifolia</i> (Torr. and Fr_em.) S. Wats, <i>Chenopodium album</i> L., <i>Chenopodium ambrosioides</i> L., <i>Ch. murale</i> L., <i>Ch. nuttalliae</i> Saff., <i>Ch. quinoa</i> Willd., <i>Salsola kali</i> L. var <i>tenuifolia</i> Tausch, <i>Spinacia oleracea</i> L.); Convolvulaceae (<i>Ipomoea batatas</i> Lam.); Cucurbitaceae (<i>Cucumis sativus</i> L., <i>Cucurbita maxima</i> Duchesne, <i>C. pepo</i> L.); Fabaceae (<i>Physalis</i> spp., <i>Pisum sativum</i> L., <i>Trifolium</i> sp.); Lamiaceae (<i>Origanum vulgare</i> L.); Malvaceae (<i>Abelmoschus</i> (=Hibiscus) <i>esculentus</i> Moench, <i>Alcea rosea</i> L., <i>Anoda cristata</i> (L.) Schlecht., <i>Malva parviflora</i> L.); Nyctaginaceae (<i>Mirabilis jalapa</i> L.); Oxalidaceae (<i>Oxalis tuberosa</i> Molina); Plantaginaceae (<i>Plantago lanceolata</i> L.); Polygonaceae (<i>Fagopyrum esculentum</i> Moench.); Portulacaceae (<i>Portulaca oleracea</i> L.); Solanaceae (<i>Solanum</i> sp., <i>Capsicum annuum</i> L., <i>C. annuum</i> L. var. <i>Glabriusculum</i> (Dunal) Heiser &amp; Pickersgill (=C. <i>baccatum</i> L.), <i>C. frutescens</i> L., <i>C. pendulum</i> Willd., <i>C. pubescens</i> Ruiz &amp; Pav., <i>Cestrum roseum</i> H.B. &amp; K., <i>Cyphomandra betacea</i> Sendt., <i>Datura ferox</i> L., <i>D. stramonium</i> L., <i>Nicotiana tabacum</i> L., <i>Solanum acaule</i>, <i>S. andigena</i> Juz. and Buk., <i>S. chacoense</i> Bitter, <i>Solanum chmielewskii</i> (C.M.Rick, Kesicki, Fobes &amp; M.Holle) D.M.Spooner, G.J.Anderson &amp; R.K.Jansen, <i>Solanum hirsutum</i>, <i>Solanum hybrids</i>, <i>Solanum infundibuliforme</i>, <i>Solanum megistacrolobum</i>, <i>S. melongena</i> L., <i>S. nigrum</i> L., <i>Solanum peruvianum</i> Mill., <i>Solanum pimpinellifolium</i> Mill., <i>S. rostratum</i> Dun., <i>S. triquetrum</i> Cav., <i>Solanum sparsipilum</i>); Tropaeolaceae (<i>Tropaeolum tuberosum</i> Ruiz. et Pav.); Zygophyllaceae (<i>Tribulus terrestris</i> L.).</p>	

<b>Pathways</b>	<ul style="list-style-type: none"> <li>– Plants, plants for planting (tubers, roots)</li> <li>– Subterranean plant parts intended for consumption (e.g. edible ulluco tubers)</li> <li>– Soil and growing media as such or attached to plants</li> <li>– Soil and growing media attached to machinery, tools, packaging materials etc.</li> </ul>
<b>Surveillance information</b>	In the dossier (Sections 1 and 2), it is stated that pest surveys are permanently carried out on various crops, including Andean tubers, such as ulluco. Staff of SENASA periodically inspect the fields for the presence of symptoms caused by specific pests and take samples that are sent to appropriate laboratory at SENASA. The results of the laboratory are sent to the nearby SENASA headquarters so that it communicates with the producer and appropriate management measures are taken. According to Peru, there are no information on nematode 'outbreaks' on ulluco. The nematodes are therefore considered minor pests of ulluco.

## A.4.2. Possibility of pest presence in the production site

### A.4.2.1. Possibility of entry from the surrounding environment

In the dossier (Section 1), it is stated that the producing areas of ulluco are located at high altitudes and consequently at low temperatures, which in their view means that the nematodes do not pose significant phytosanitary problems. The producers do not perceive problems caused by pests and consequently do not implement specific phytosanitary measures against nematodes.

The false root-knot nematode is a polyphagous nematode parasitising a wide range of economically important host plants such as potatoes, sugar beet, tomato and beans as well as many weeds i.e. *Calandria albis*, *Physalis* spp. and *Chenopodium album* that are very common in potato fields in Peru and are considered as good hosts (Manzanilla-Lopez et al., 2002). In the answers provided by Peru to the questions raised by the working group, it is stated that several hosts of *N. aberrans*, i.e. potato, sweet potato, oca and quinoa are grown in ulluco production area. The production of different host plants in the same fields makes this nematode difficult to control by crop rotation (Apaza, 2011).

*N. aberrans* is reported to cause damage to potatoes in Peru, but reports of such attacks are rare. It is uncertain how many fields in potato/ulluco/oca production areas in Peru are infested by *N. aberrans*.

In case *N. aberrans* is present in the surrounding environment, it can enter ulluco production fields with plants for planting, including tubers, water, soil and growing media attached to agricultural machinery, tools and footwear. Agricultural implements are very important means of nematode spread within and between different fields/plantations.

Active spread of *N. aberrans* is limited to short distances (in the range of ca. 1 m). From the surrounding environment to the production field, it can mainly be transmitted passively, through distribution of infected plants, contaminated soil and run-off rain water.

#### Uncertainties:

- No details on the distribution and abundance of *N. aberrans* in the area of ulluco production (in ulluco and other crops).
- Lack of data from official monitoring surveys and reports on problems caused by this nematode in ulluco production in Peru. This could be related to either actual absence or non-detection of the nematode within the ulluco fields.
- There are uncertainties regarding the possible infestation of common weeds in the surrounding area that are good hosts for this nematode.

In view of above evidence and uncertainties, the Panel considers that it is possible that the nematode is present in the surrounding environment and could enter the ulluco production fields with new plants/tubers or different human activities.

### A.4.2.2. Possibility of entry with new plants/seeds

Ulluco tubers may be an important pathway. *N. aberrans* has been found on or in tubers of its host plants (potato, ulluco etc.) (Jatala and de Scurrah, 1975; Rojas et al., 1997; Lax et al., 2008).

In the dossier (Section 2), it is stated that in the area of ulluco production several other host plants of *N. aberrans* such as sweet potato, potato, oca and quinoa are produced. It is also stated that

selected tubers of ulluco are used as propagation material under simple selection. The producers select the seed tubers from the best plants of the previous harvest season to use them as propagation materials (it seems that there is no certification scheme of ulluco seed tubers in place).

Seed tubers deriving from places of production where nematode is present may be infested. Infestations of such plants (tubers), however, can be easily overlooked.

#### Uncertainties:

- Lack of data regarding the monitoring of the false root-knot nematode in the fields from which the seed tubers of ulluco intended for planting in the following year originate.
- The absence of nematode-induced symptoms (galls) is possible in certain plants; therefore, the presence of *N. aberrans* within tubers of ulluco may be undetectable by visual inspections.

Taking into consideration the above evidence and uncertainties, the Panel considers it is possible that the nematode could enter the production fields with new plants/tubers.

#### **A.4.2.3. Possibility of spread within the production site**

*N. aberrans* only moves short distances (around 1 m) and has no natural means of long-range movement. The main means of dispersal of this nematode within the nursery/production field is therefore in general human assisted. The nematode may be spread with tubers or other underground organs of host plants and soil moving activities – with soil as such or soil associated with tools and machinery as well as with contaminated run-off rain and irrigation water.

#### Uncertainties:

- If present, it is quite likely that the nematode is spreading within the production field.

Taking into consideration the above evidence and uncertainties, the Panel considers that in case the nematode is present within the field it is possible to be transferred from one host plant to another.

#### **A.4.3. Information from interceptions**

No interceptions of *N. aberrans* from Peru to EU have been reported so far.

#### **A.4.4. Evaluation of the risk reduction options**

The description of all the risk mitigation measures currently applied in Peru is provided in Table 11. In the table below, those relevant for *N. aberrans* are listed along with an indication of their effectiveness.

No.	Risk mitigation measures	Effect on pest	Evaluation and uncertainties
1	Surveillance and monitoring	Yes	<p><u>Evaluation:</u> Pest surveys are permanently carried out on various crops, including Andean tubers, such as ulluco. Pest survey is based on a series of periodic visits by SENASA staff to observe symptoms and take samples, which are then sent to the appropriate SENASA diagnostic laboratory. The results of laboratory testing are then sent to the nearby SENASA headquarters so that it communicates with the producer and appropriate management measures are taken.</p> <p><u>Uncertainties:</u> The uncertainty relates to the lack of available data from official monitoring surveys for certain nematode species. <i>N. aberrans</i> occurs in Peru, but its distribution in the country is limited. It causes damage to potatoes, but its infestation is rare; there have been no reports of attacks of this species on potatoes (according to SENASA); the effects on the ulluco have no significant incidence. However, ulluco is a confirmed host of <i>N. aberrans</i> and is cultivated in association with the potato and some other Andean host plants.</p>

No.	Risk mitigation measures	Effect on pest	Evaluation and uncertainties
2	Sampling and laboratory testing	Yes	<p><u>Evaluation:</u> Regarding the process of inspection and phytosanitary certification developed by SENASA, a sample of 2% of the total consignment to be exported is taken. This sample is visually inspected and if pests are suspected to be present, the sample is sent for further laboratory analysis.</p> <p><u>Uncertainties:</u> Symptoms caused by <i>N. aberrans</i> may be overlooked. Symptomless tubers are not laboratory tested – infection may be overlooked. The consequences of pest presence in the sample are not described.</p>
5	Use of healthy propagation and production material	Yes	<p><u>Evaluation:</u> The use of ulluco as a vegetative seed is mainly based on a visual selection of the harvested tubers. This selection allows farmers to select pest-free tubers.</p> <p><u>Uncertainties:</u> Symptoms caused by <i>N. aberrans</i> can be overlooked and infected tubers can be used for the further cultivation of ulluco.</p>
14	Sorting/grading/ tuber selection	Yes	<p><u>Evaluation:</u> Only first category tubers (those for export) are selected in the field. Tubers are individually and visually inspected.</p> <p><u>Uncertainties:</u> Symptoms caused by <i>N. aberrans</i> (motile stages of <i>N. aberrans</i> within tubers) may be overlooked.</p>
15	Brushing/ washing (removal of soil from tubers)	Yes	<p><u>Evaluation:</u> Brushing/cleaning of the tubers is carried out. Damaged ulluco tubers and tubers with symptoms of the pests are removed.</p> <p><u>Uncertainties:</u> Brushing/washing of the tubers does not reduce the nematode pest risk associated with edible ulluco tubers or seed tubers that are infested with endoparasitic or migratory endoparasitic nematodes (e.g. motile stages of <i>N. aberrans</i>). Symptomless tubers are not laboratory tested – infection may be overlooked.</p>
16	Pre-consignment inspection	Yes	<p><u>Evaluation:</u> According to SENASA, 2% of tubers are visually inspected; tubers with symptoms are sent for laboratory testing.</p> <p><u>Uncertainties:</u> Symptomless tubers may be overlooked and are not sent for laboratory testing.</p>

#### A.4.4.1. Reasoning for a scenario which would lead to a reasonably low number of infested consignments (lower limit)

- Ulluco is assumed to be a minor host and its growing areas are mainly in the northern part of the country, where *N. aberrans* pressure is lower and only few fields are infested with this pest and infestations are mainly patchy.
- Ulluco plants are resistant to this nematode, thus preventing its multiplication.
- Effective weed control, crop rotation and field hygiene limit Ulluco infestation.
- Regular inspections by crop protection authorities (SENASA) are also effective and further help to reduce the infection pressure of this nematode.
- Visual selection of tubers for planting results in low rate of spread as infested material is effectively detected.
- Farmers are able to detect and discard infested plants/tubers.
- Brushing is effective against mobile worm stages and in addition,
- Nematodes cannot survive the transport conditions as they cannot complete their life cycle.

#### A.4.4.2. Reasoning for a scenario which would lead to a reasonably high number of infested consignments (upper limit)

- Similar pest pressure exists throughout the country, as 40% of Ulluco acreage is assumed to be in the south.
- Ulluco is an important and preferred host of *N. aberrans*.
- The nematode is widespread in ulluco-growing areas and its infestation is homogeneous.

- Weed control, crop rotation and field sanitation are ineffective and do not help to reduce infestation of ulluco by this nematode.
- Most ulluco plants are expected to be infested with nematodes.
- Regular inspections by crop protection authorities (SENASA) are not effective due to non-specific symptoms or an inadequate sampling scheme.
- Fields with *N. aberrans* problems in potatoes or other tubers from the Andes are used for ulluco, resulting in a higher risk of infestation.
- Visual selection of tubers for planting and visual inspections before export without laboratory testing are not effective and result in high infestation.
- Farmers are not able to detect and dispose of infested plants/tubers.
- Brushing of tubers after harvest is not effective against life stages inside the tubers.
- The nematode is also expected to survive the transport conditions by going into diapause.

#### **A.4.4.3. Reasoning for a central scenario equally likely to over- or underestimate the number of infested consignments (median)**

- Uncertainties about pest pressure in Peru.
- The likelihood of introduction into ulluco production fields by natural means and human activities.
- The information on infections of *N. aberrans* on ulluco plants.
- The lack reported problems within the ulluco production area in Peru and at the EU borders.

#### **A.4.4.4. Reasoning for the precision of the judgement describing the remaining uncertainties (1st and 3rd quartile/interquartile range)**

- The main uncertainty is the absence of nematode-induced symptoms in certain plants, so that the presence of the nematode in the ulluco tubers can be overlooked; cannot be detected by visual inspection.

#### A.4.5. Elicitation outcomes of the assessment of the pest freedom for *Nacobbus aberrans*

The following tables show the elicited and fitted values for pest infestation/infection (Table A.7) and pest freedom (Table A.8).

**Table A.7:** Elicited and fitted values of the uncertainty distribution of pest infestation by *N. aberrans* per 10,000 tubers

Percentile	1%	2.5%	5%	10%	17%	25%	33%	50%	67%	75%	83%	90%	95%	97.5%	99%
Elicited values	1.00					60.00		120.00		300.00					500.00
EKE	1.04	1.99	4.43	11.69	25.33	47.38	74.50	143.54	232.62	285.58	345.98	402.27	451.44	480.39	500.94

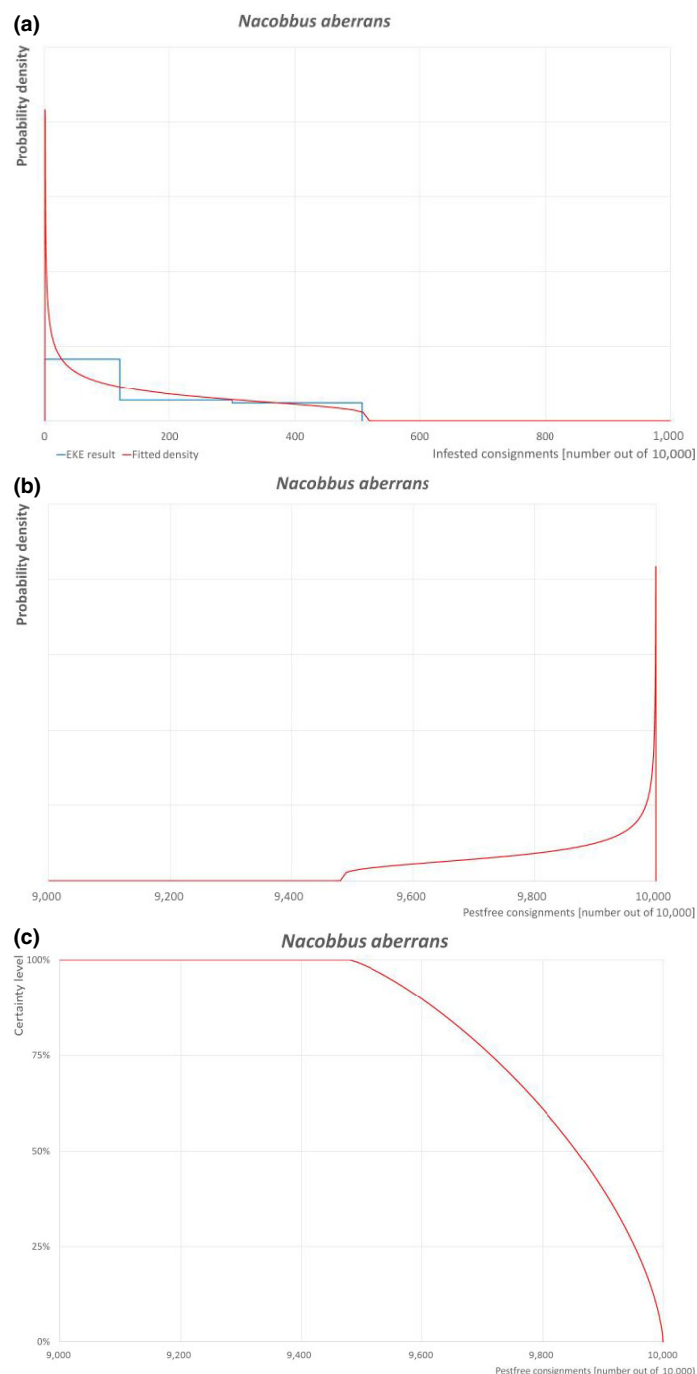
The EKE results are BetaGeneral (0.63669, 1.2412, 0.75, 520) fitted with @Risk version 7.6.

Based on the numbers of estimated infested tubers, the pest freedom was calculated (i.e. = 10,000 – the number of infested tubers per 10,000). The fitted values of the uncertainty distribution of the pest freedom are shown in Table A.8.

**Table A.8:** The uncertainty distribution of plants free of *N. aberrans* per 10,000 tubers calculated by Table A.7

Percentile	1%	2.5%	5%	10%	17%	25%	33%	50%	67%	75%	83%	90%	95%	97.5%	99%
Values	9,500.00					9,700.00		9,880.00		9,940.00					9,999.00
EKE results	9,499.06	9,519.61	9,548.56	9,597.73	9,654.02	9,714.42	9,767.38	9,856.46	9,925.50	9,952.62	9,974.67	9,988.31	9,995.57	9,998.01	9,998.96

The EKE results are the fitted values.



**Figure A.4:** (a) Elicited uncertainty of pest infestation per 10,000 tubers (histogram in blue – vertical blue line indicates the elicited percentile in the following order: 1%, 25%, 50%, 75%, 99%) and distributional fit (red line); (b) uncertainty of the proportion of pest free tubers per 10,000 (i.e.  $=1 - \text{pest infestation proportion expressed as percentage}$ ); (c) descending uncertainty distribution function of pest infestation per 10,000 tubers

#### A.4.6. Reference list

- Anthoine G, Buisson A, Gauthier JP and Mugni\_ery D, 2006. Aspects of the biology of *Nacobbus aberrans* (Thorne, 1935) Thorne and Allen, 1944 (Nematoda : Pratylenchidae): 2 - Capacities of development on hosts under in vivo and in vitro conditions. Bulletin OEPP, 36, 365–372.
- Bridge J, Coyne DL and Kwoseh CK, 2005. Nematode Parasites of Tropical Root and Tuber Crops (Excluding Potatoes). In: Luc M, Sikora RA and Bridge J (eds.). Plant Parasitic Nematodes in Subtropical and Tropical Agriculture, 2nd Edition, CABI Bioscience, 221–258.



- CABI (Centre for Agriculture and Bioscience International), online. CABI Crop Protection Compendium. *Nacobbus aberrans*, datasheet. Available online: <https://www.cabi.org/cpc/datasheet/35671> [Accessed: 18 December 2020].
- EFSA PLH Panel (EFSA Panel on Plant Health), Jeger M, Bragard C, Caffier D, Candresse T, Chatzivassiliou E, Dehnen-Schmutz K, Gilioli G, Gregoire J-C, Jaques Miret JA, MacLeod A, Navajas Navarro M, Parnell S, Potting R, Rafoss T, Rossi V, Urek G, Van Bruggen A, Van der Werf W, West J, Winter S, Kaluski T and Niere B, 2018. Scientific Opinion on pest categorisation of *Nacobbus aberrans*. EFSA Journal 2018;16(4):5249, 27 pp. <https://doi.org/10.2903/j.efsa.2018.5249>
- EPPO (European and Mediterranean Plant Protection Organization), online. EPPO Global Database. *Nacobbus aberrans*, datasheet. Available online: <https://gd.eppo.int/taxon/NACOBABA> [Accessed: 18 December 2020]
- Franco J and Main G, 2008. Management of nematodes of Andean tuber and grain crops. In: Ciancio A and Mukerji KG (eds.). Integrated Management and Biocontrol of Vegetable and Grain Crops Nematodes, Springer, 99–117.
- 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. Available online: <https://www.researchgate.net/publication/237285653>
- Jones JT, Haegeman A, Danchin EGJ, Gaur HS, Helder J, Jones MGK, Kikuchi T, Manzanilla-López R, Palomares-Rius JE, Wesemael WML and Perry RN, 2013. Top 10 plant-parasitic nematodes in molecular plant pathology. *Molecular Plant Pathology*, BSPP and John Wiley & Sons LTD, 1–16. <https://doi.org/10.1111/mpp.12057>
- Jatala P and de Scurrah MM, 1975. Mode of dissemination of *Nacobbus* spp. in certain potato-growing areas of Peru and Bolivia. *Journal of Nematology*, 7, 324–325.
- Lax P, Doucet ME, Gallardo C, De l'Argentier SM and Bautista R, 2008. Presence of soil nematodes in andean tubers. *Nematopica*, 38, 87–94.
- 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.
- 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 and Allen, 1944 (Nematoda : Pratylenchidae): Systematics, distribution, biology and management. *Nematopica*, 32, 149–227.
- Franco J and Main G, 2008. Management of nematodes of Andean tuber and grain crops. In: Ciancio A and Mukerji KG (eds.), Integrated Management and Biocontrol of Vegetable and Grain Crops Nematodes, 99–117.
- Reid, A, Manzanilla-López RH, and Hunt DJ, 2003. *Nacobbus aberrans* (Thorne, 1935) Thorne and 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.
- Vovlas N, Nico AI, De Luca F, De 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.

## A.5. *Atalodera andina* (Round cystoid nematode)

### A.5.1. Organism information

<b>Taxonomic information</b>	<p><b>Current valid scientific name:</b> <i>Atalodera andina</i> (Golden, Franco, Jatala and Astogaza, 1983) de Souza and Huang, 1994</p> <p><b>Synonyms:</b> <i>Thecavermiculatus andinus</i> Golden, Franco, Jatala and Astogaza, 1983</p> <p>Name used in the EU legislation: –</p> <p>Name used in the Dossier: –</p> <p>Order: Rhabditida</p> <p>Family: Heteroderidae</p>
<b>Group</b>	Nematoda
<b>EPPO code</b>	ATADAN
<b>Regulated status</b>	<p><b>EU status:</b></p> <p>No status</p> <p><b>Non- EU:</b></p> <p>No status</p>

<b>Pest status in Peru</b>	Present, widespread
<b>Pest status in the EU</b>	Absent
<b>Host status on <i>Ullucus tuberosus</i></b>	Several nematode species are known to be associated with ulluco (Jatala, 1988). Ulluco is recorded as a good host of <i>Atalodera</i> (= <i>Thecavermiculatus</i> ) <i>andina</i> .
<b>PRA information</b>	<p><i>A. andina</i> (round cystoid nematode) is a non-cyst forming heteroderid nematode belonging to the subfamily Ataloderinae. It is an indigenous species in South America where it attacks some important Andean crops. <i>A. andina</i> was first described from oca plants <i>Oxalis tuberosa</i> collected in Peru near Lake Titicaca (Golden et al. 1983). Due to the fact that it multiplies intensively on oca plants and because it is very widespread on farms where this crop is grown, it is commonly known as the 'nematode of the oca' (Franco and Mosquera, 1993; Franco and Main, 2008). In addition to oca, ulluco, potato, quinoa, wild quinoa, lupine, Shepherds purse, wild turnip (<i>B. campestris</i>), common groundsel (<i>Senecio vulgaris</i>) and wild tobacco (<i>N. paniculata</i>) are also considered to be effective hosts of <i>A. andina</i> (Franco and Mosquera, 1993). Although the roots of ulluco plants can be heavily attacked with this species information of its economic importance is lacking (Bridge et al., 2005).</p> <p>On the roots of ulluco plants <i>A. andina</i> is often found in association with root-knot nematodes <i>Meloidogyne</i> spp. and false root-knot nematode <i>N. aberrans</i>.</p> <p>The life cycle of <i>A. andina</i> consists of egg, four juvenile stages and an adult stage. The eggs spontaneously hatch inside female body at the end of the reproductive cycle and remain there, within the swollen females (Franco and Main, 2008). The first stage juveniles develop within the egg. Second-stage juveniles (J2) hatch from eggs and after emerging from the female body move through the soil looking for roots of suitable host plant. After finding appropriate host plant, juveniles (J2) penetrate into the host roots inducing multinucleate giant cells – special feeding sites, called syncytium. After undergoing a series of three moults (J3 and J4 juvenile stages), they develop to swollen round-oval females; adult males remain vermiform. Females rupture root cortex and protrude from root surface (Baldwin and Mundo Ocampo, 1991).</p> <p>According to Jatala, <i>A. andina</i> (= <i>T. andinus</i>) is considered an important nematode species of potatoes in some Andean regions of Peru, but crop loss caused by it on potato and other tuber crops has not been adequately quantified (Scurrah et al., 2005). Based on greenhouse experiments, it was found that increasing the population density of <i>A. andina</i> in the soil negatively affects plant development and production of lupine, quinoa, oca and ulluco. This nematode has been reported to reduce quinoa yields significantly (Franco and Main, 2008).</p> <p>Although ulluco and oca can be severely attacked with some economically important plant parasitic nematodes such as <i>N. aberrans</i>, <i>Meloidogyne</i> spp. and <i>A. andina</i>, the control (chemical) of these nematodes is rarely practiced due to the fact that ulluco and oca are grown mainly on economically less important small farms (Bridge et al., 2005). <i>A. andina</i>, therefore, does not pose a major problem in production of these crops. According to Bridge et al. (2005), the response of ulluco to the attack of <i>N. aberrans</i> as well as <i>A. andina</i> indicates the possibility of an available resistant gene base.</p> <p><i>A. andina</i> has been reported to reduce quinoa yield significantly (Franco and Main, 2008). According to Jatala, <i>A. andina</i> (= <i>T. andinus</i>) is considered an important nematode species of potatoes in some Andean regions of Peru, but information on crop loss caused by it on potato and other tuber crops is lacking (Scurrah et al., 2005).</p> <p>In the answers provided by Peru to the questions raised by the working group, it is stated that SENASA reported attacks of this nematode on potatoes but not on ulluco. It is also stated that <i>A. andina</i> is present in the highlands of the sierra attacking various species of tuberous plants, but its damage is minor. The impact on the ulluco is therefore negligible.</p>

**Other relevant information for the assessment**

<b>Symptoms</b>	<b>Main type of symptoms</b>	The symptoms caused by <i>A. andina</i> are detected mainly on the roots, on which white spherical female bodies may appear.
	<b>Presence of asymptomatic plants</b>	The absence of symptoms (absence of females bodies in certain plants) is possible; therefore, the presence of <i>A. andina</i> can be overlooked.
	<b>Confusion with other pathogens/pests</b>	<i>A. andina</i> can be misidentified as <i>Globodera</i> spp. by the presence of white spherical females bodies attached to the roots of its host plant (Franco and Main, 2008). However, these females do not change colour nor become cysts (= non cyst forming heteroderid species).
<b>Host plant range</b>	<p><i>A. andina</i> has a broad host range. It has been reported from more than 30 plant species from 12 botanical families.</p> <p>As suitable hosts are considered: oca (<i>Oxalis tuberosa</i> Mol), quinoa (<i>Chenopodium quinoa</i> Willd), wild quinoa (<i>C. amaranticolor</i> (H.J.Coste &amp; A.Reyn.) H.J.Coste &amp; A.Reyn.), ulluco (<i>Ullucus tuberosus</i> Loz) – fam. Basellaceae, potato (<i>Solanum tuberosum</i> subsp. <i>Andigena</i> Hawkes), wild tobacco (<i>Nicotiana paniculata</i> L.), Shepherd's purse (<i>Capsella bursa-pastoris</i> L.) and lupin (<i>Lupinus mutabilis</i> Sweet) (Franco and Mosquera, 1993).</p> <p>Other possible hosts (Golden et al., 1983; Franco and Mosquera, 1993):</p> <p>Amaranthaceae: <i>Amaranthus peruvianus</i> Stadley, <i>A. caudatus</i> L.; Cruciferae: <i>Brassica oleracea</i> L. vr. Capitata, <i>B. oleracea</i> L. vr. Botrytis, <i>B. napus</i>, <i>B. campestris</i> L., <i>Raphanus sativus</i> L.; Cactaceae: <i>Cereus geometricus</i>, <i>C. candelabrus</i>, <i>Opuntia</i> sp.; Compositae: <i>Senecio vulgaris</i> L.; Chenopodiaceae: <i>Chenopodium ambrosioides</i> L., <i>Beta vulgaris</i> L.; Leguminosae: <i>Phaseolus vulgaris</i> L., <i>Vicia faba</i> L., <i>Pisum sativum</i> L., <i>Lens esculenta</i> L., <i>Medicago hispida</i> Garth, <i>Trifolium repens</i> L., <i>T. pretense</i> L., <i>T. hybridum</i> L., <i>Medicago sativa</i> L.</p> <p>Labiatae: <i>Salvia</i> sp.; Oxalidaceae: <i>Oxalis solarensis</i> Knuth; Solanaceae: <i>Physalis peruviana</i> L., <i>Lycopersicon pimpinellifolium</i> Mill, <i>L. esculentum</i> Mill, <i>Solanum melongena</i> L.; Tropaeolaceae: <i>Tropaeolum tuberosum</i> R. et P.; Malvaceae: <i>Malvastrum coromandelianum</i> L.</p>	
<b>Pathways</b>	<ul style="list-style-type: none"> <li>– Plants, plants for planting (tubers, roots)</li> <li>– Subterranean plant parts intended for consumption (e.g. edible ulluco tubers)</li> <li>– Soil and growing media as such or attached to plants</li> <li>– Soil and growing media attached to machinery, tools, packaging materials etc.</li> </ul>	
<b>Surveillance information</b>	– Same as for <i>N. aberrans</i>	

**A.5.2. Possibility of pest presence in the production sites****A.5.2.1. Possibility of entry from the surrounding environment**

In the dossier (Section 1), it is stated that the producing areas of ulluco are located at high altitudes and consequently at low temperatures, which in their view means that the nematodes do not pose significant phytosanitary problems. The producers do not perceive problems caused by pests and consequently do not implement specific phytosanitary measures against nematodes.

In the answers provided by Peru to the questions raised by the working group, it is stated that several hosts of *A. andina*, i.e. potato, quinoa are grown in ulluco production area. The production of different host plants in the same fields makes this nematode difficult to control by crop rotation (Apaza, 2011).

*A. andina* is reported to cause damage to potatoes in Peru but reports of such attacks are rare. It is uncertain how many fields in potato/ulluco/oca production areas in Peru are infested by *A. andina*.

In case *A. andina* is present in the surrounding environment, it can enter ulluco production fields with plants for planting, including tubers, water, soil and growing media attached to agricultural machinery, tools and footwear. Agricultural implements are very important means of nematode spread within and between different fields/plantations.

Active spread of *A. andina* is limited to short distances (in the range of ca. 1 m). From the surrounding environment to the production field, it can mainly be transmitted passively, through distribution of infected plants, contaminated soil and run-off rain water.

Uncertainties:

- No details on the distribution and abundance of *A. andina* in the area of ulluco production (in ulluco and other crops).
- Lack of data from official monitoring surveys and reports on problems caused by this nematode in ulluco production in Peru. This could be related to either actual absence or non-detection of the nematode within the ulluco fields.
- There are uncertainties regarding the possible infestation of common weeds in the surrounding area that are good hosts for this nematode.

In view of above evidence and uncertainties, the Panel considers that it is possible that the nematode is present in the surrounding environment and could enter the ulluco production fields with new plants/tubers or different human activities.

**A.5.2.2. Possibility of entry with new plants/seeds**

Ulluco tubers may be an important pathway. *A. andina* has been found on or in tubers of its host plants (potato, ulluco, etc.) (Jatala and de Scurrah, 1975; Rojas et al., 1997; Lax et al., 2008).

In the dossier (Section 2), it is stated that in the area of ulluco production several other host plants of *A. andina* such as sweet potato, potato, oca and quinoa are produced. It is also stated that selected tubers of ulluco are used as propagation material under simple selection. The producers select the seed tubers from the best plants of the previous harvest season to use them as propagation materials (it seems that there is no certification scheme of ulluco seed tubers in place).

Seed tubers deriving from places of production where nematode is present may be infested. Infestations of such plants (tubers), however, can be easily overlooked.

Uncertainties:

- Lack of data regarding the monitoring of the false root-knot nematode in the fields from which the seed tubers of ulluco intended for planting in the following year originate.
- The absence of nematode-induced symptoms is possible in certain plants; therefore, the presence of *A. andina* within tubers of ulluco may be undetectable by visual inspections.

Taking into consideration the above evidence and uncertainties, the Panel considers it is possible that the nematode could enter the production fields with new plants/tubers.

**A.5.2.3. Possibility of spread within the production site**

*A. andina* only moves short distances (around 1 m) and has no natural means of long-range movement. The main means of dispersal of this nematode within the nursery/production field is therefore in general human assisted. The nematode may be spread with tubers or other underground organs of host plants and soil moving activities – with soil as such or soil associated with tools and machinery as well as with contaminated run-off rain and irrigation water.

Uncertainties:

- If present, it is quite likely that the nematode is spreading within the production field.

Taking into consideration the above evidence and uncertainties, the Panel considers that in case the nematode is present within the field, it is possible to be transferred from one host plant to another.

**A.5.3. Information from interceptions**

No interceptions of *N. aberrans* from Peru to EU have been reported so far.

**A.5.4. Evaluation of the risk reduction options**

The description of all the risk mitigation measures currently applied in Peru is provided in Table 11. In the table below, those relevant for *A. andina* are listed along with an indication of their effectiveness.

No.	Risk mitigation measures	Effect on pest	Evaluation and uncertainties
1	Surveillance and monitoring	Yes	<p><b>Evaluation:</b> Pest surveys are permanently carried out on various crops, including Andean tubers, such as ulluco. Pest survey is based on a series of periodic visits by SENASA staff to observe symptoms and take samples, which are then sent to the appropriate SENASA diagnostic laboratory. The results of laboratory testing are then sent to the nearby SENASA headquarters so that it communicates with the producer and appropriate management measures are taken.</p> <p><b>Uncertainties:</b> The uncertainty relates to the lack of available data from official monitoring surveys for certain nematode species. <i>A. andina</i> occurs in Peru, but its distribution in the country is limited. It causes damage to potatoes, but its infestation is rare; there have been no reports of attacks of this species on potatoes (according to SENASA); the effects on the ulluco have no significant incidence. However, ulluco is a confirmed host of <i>A. andina</i>, and is cultivated in association with the potato and some other Andean host plants.</p>
2	Sampling and laboratory testing	Yes	<p><b>Evaluation:</b> Regarding the process of inspection and phytosanitary certification developed by SENASA, a sample of 2% of the total consignment to be exported is taken. This sample is visually inspected and if pests are suspected to be present, the sample is sent for further laboratory analysis.</p> <p><b>Uncertainties:</b> Symptoms caused by <i>A. andina</i> may be overlooked. Symptomless tubers are not laboratory tested – infection may be overlooked. The consequences of pest presence in the sample are not described.</p>
5	Use of healthy propagation and production material	Yes	<p><b>Evaluation:</b> The use of ulluco as a vegetative seed is mainly based on an visual selection of the harvested tubers. This selection allows farmers to select pest-free tubers.</p> <p><b>Uncertainties:</b> Symptoms caused by <i>A. andina</i> can be overlooked and infected tubers can be used for the further cultivation of ulluco.</p>
14	Sorting/grading/tuber selection	Yes	<p><b>Evaluation:</b> Only first category tubers (those for export) are selected in the field. Tubers are individually and visually inspected.</p> <p><b>Uncertainties:</b> Symptoms if any caused by <i>A. andina</i> may be overlooked.</p>
15	Brushing/cleaning (removal of soil from tubers)	Yes	<p><b>Evaluation:</b> Brushing/cleaning of the tubers is carried out. Damaged ulluco tubers and tubers with symptoms of the pests are removed.</p> <p><b>Uncertainties:</b> Brushing/cleaning of the tubers does not reduce the nematode pest risk associated with edible ulluco tubers or seed tubers that are infested with endoparasitic or migratory endoparasitic nematodes. Symptomless tubers are not laboratory tested – infection may be overlooked.</p>
16	Pre-consignment inspection	Yes	<p><b>Evaluation:</b> According to SENASA, 2% of tubers are visually inspected; tubers with symptoms are sent for laboratory testing.</p> <p><b>Uncertainties:</b> Symptomless tubers may be overlooked and are not sent for laboratory testing.</p>

### A.5.5. Overall likelihood of pest freedom

#### A.5.5.1. Reasoning for a scenario which would lead to a reasonably low number of infested consignments (lower limit)

- Only a few fields are infested with *A. andina* and infestations within infested fields are predominantly patchy.
- Effective weed control, crop rotation, and field sanitation limit infestations.

- Fields with *A. andina* infestations on potatoes or other tubers from the Andes are not used for ulluco production and regular inspections of these fields by crop protection authorities are effective.
- Ulluco tubers are not infested because the nematode is mainly found in the roots.
- If nematodes are present in the soil attached to the tubers, brushing the tubers is an effective phytosanitary measure.
- Visual selection of tubers for planting results in low rate of spread as infested material is effectively detected;
- Farmers are able to detect and dispose of infested plants/tubers.

#### **A.5.5.2. Reasoning for a scenario which would lead to a reasonably high number of infested consignments (upper limit)**

- Ulluco is a suitable host for *A. andina*, which is quite polyphagous and widespread nematode species in Peru.
- Weed control, crop rotation and field sanitation are considered ineffective and do not limit infestations.
- Fields with *A. andina* infestations on potatoes or other Andean tubers are used also for ulluco production, resulting in a higher risk of field infestation.
- Some tubers are expected to be infested externally, and brushing in this scenario does not remove all soil attached to the tuber.
- Visual selection of tubers for planting and visual inspection prior to export without laboratory testing are not effective and result in high infestation.
- Farmers are not able to detect and dispose of infested plants/tubers.

#### **A.5.5.3. Reasoning for a central scenario equally likely to over- or underestimate the number of infested consignments (median)**

- The likelihood of introduction into ulluco production fields by natural means and human activities.
- The information on infections of *A. andina* on ulluco plants.
- Absence of reported problems within the ulluco production area in Peru and at the EU borders.

#### **A.5.5.4. Reasoning for the precision of the judgement describing the remaining uncertainties (1st and 3rd quartile/interquartile range)**

The main uncertainty is the absence of nematode-induced symptoms in certain plants, so that the presence of the nematode in the ulluco tubers can be overlooked and cannot be detected by visual inspection.

#### A.5.6. Elicitation outcomes of the assessment of the pest freedom for *Atalodera andina*

The following tables show the elicited and fitted values for pest infestation/infection (Table A.9) and pest freedom (Table A.10).

**Table A.9:** Elicited and fitted values of the uncertainty distribution of pest infestation by *A. andina* per 10,000 tubers

Percentile	1%	2.5%	5%	10%	17%	25%	33%	50%	67%	75%	83%	90%	95%	97.5%	99%
Elicited values	0.00					10.00		20.00		35.00					70.00
EKE	0.77	1.56	2.69	4.69	7.17	10.17	13.24	20.04	28.62	34.21	41.67	50.60	61.99	72.79	86.38

The EKE results are Weibull (1.2964, 26.594) fitted with @Risk version 7.6

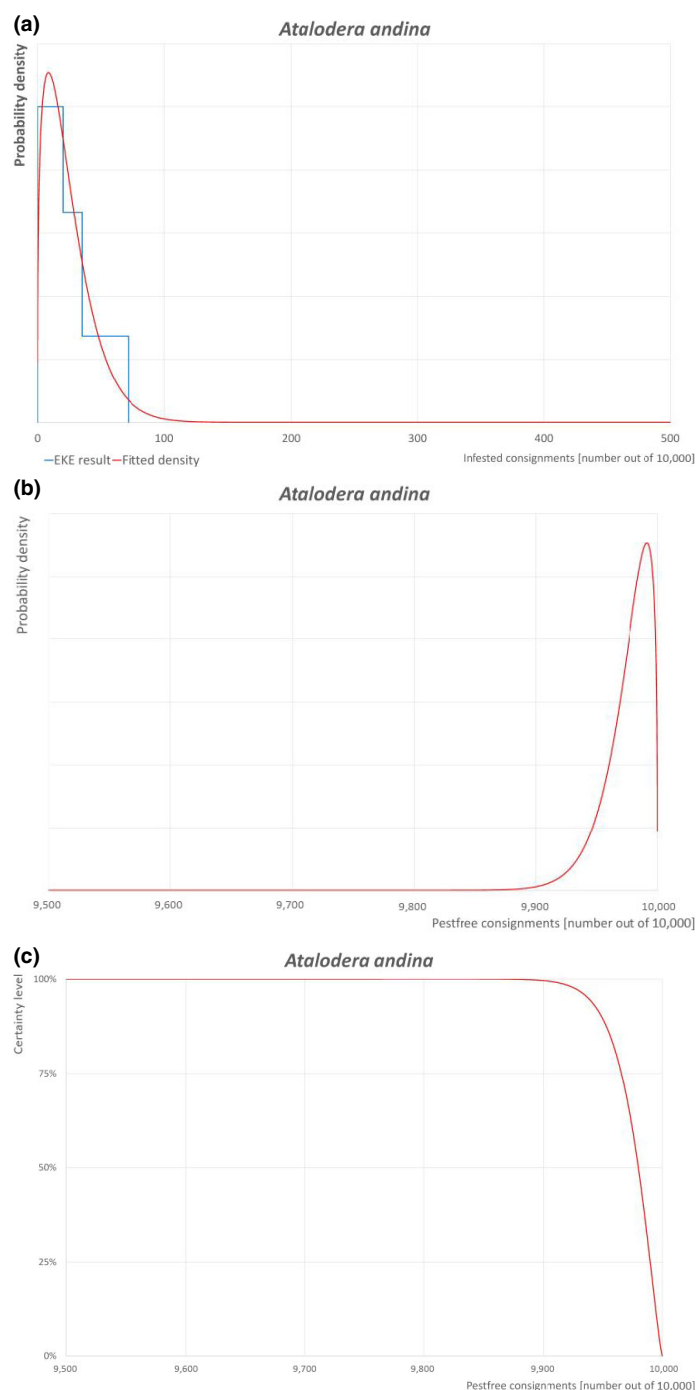
Based on the numbers of estimated infested tubers, the pest freedom was calculated (i.e. = 10,000 – the number of infested tubers per 10,000). The fitted values of the uncertainty distribution of the pest freedom are shown in Table A.10.

**Table A.10:** The uncertainty distribution of plants free of *N. aberrans* per 10,000 tubers calculated by Table A.9

Percentile	1%	2.5%	5%	10%	17%	25%	33%	50%	67%	75%	83%	90%	95%	97.5%	99%
Values	9,930.00					9,965.00		9,980.00		9,990.00					10,000.0
EKE results	9,913.62	9,927.21	9,938.01	9,949.40	9,958.33	9,965.79	9,971.38	9,979.96	9,986.76	9,989.83	9,992.83	9,995.31	9,997.31	9,998.44	9,999.23

The EKE results are the fitted values.





**Figure A.6:** (a) Elicited uncertainty of pest infestation per 10,000 tubers (histogram in blue– vertical blue line indicates the elicited percentile in the following order: 1%, 25%, 50%, 75%, 99%) and distributional fit (red line); (b) uncertainty of the proportion of pest free tubers per 10,000 (i.e.  $=1 -$  pest infestation proportion expressed as percentage); (c) descending uncertainty distribution function of pest infestation per 10,000 tubers

### A.5.7. Reference list

- Baldwin JG and Mundo Ocampo M, 1991. Heteroderinae, Cyst and Non-Cyst-Forming Nematodes. In Nickle WR, Manual of Agricultural Nematology, Marcel Dekker Inc., 275–362.
- Bridge J, Coyne, DL and Kwoseh CK, 2005. Nematode Parasites of Tropical Root and Tuber Crops. In: Luc M, Sikora RA and Bridge J (eds.). Plant parasitic nematodes in subtropical and tropical agriculture, 2nd Edition, CAB International, 221–258.

- Franco J and Main G, 2008. In: Ciancio A and Mukerji KG, Integrated Management and Biocontrol of Vegetable and Grain Crops Nematodes, Springer, Dordrecht, The Netherlands, 99–117.
- Franco J and Mosquera P, 1993. Patogenicidad del "nematodo de la oca" *Thecavermiculatus andinus* n. sp. Golden e tal., 1983 en los Andes Peruanos. Revista Latinoamericana de la Papa, 5/6, 39–40.
- Franco J and Mosquera P, 1993. Ampliacion de la gama hospedantes del »nematodo de la oca" (*Thecavermiculatus andinus* sp. n) en cuatro cultivos andinos. Revista Latinoamericana de la Papa, 5/6, 30–38.
- Golden AM, Franco j, Jatala P and Astooza E, 1983. Description of *Thecavermiculatus andinus* n.sp. (Meloidoderidae), a Round Cystoid Nematode from the Andes Mountains of Peru. Journal of Nematology, 15, 357–363.
- Scurrah ML, Niere B and Bridge J, 2005. Nematode Parasites of Solanum and Sweet Potato. In: Luc M, Sikora RA and Bridge J (eds.). Plant parasitic nematodes in subtropical and tropical agriculture, 2nd Edition, CAB International, 193–220.
- Jatala P, 1988. Nematodes in tuber and root crops and their management, 91–100; In: International potato Center. Improvement of sweet potato (*Ipomea batatas*) in East Africa, with some references of other tuber and root crops. Report of the Workshop on Sweet Potato Improvement in Africa, held at ILRAD, Nairobi, September 28-October 2, 1987. (UNDP Project CIAT-CIP-IITA) 208 pp.

## Appendix B – Web of Science All Databases Search String

In the table below, the search string used in Web of Science is reported. In total, 26 papers were retrieved. Titles and abstracts were screened, and 41 pests were added to the list of pests (see Appendix D).

Web of Science All databases	<p>TOPIC: "Ullucus" OR "Ullucus tuberosus" OR "U. tuberosus" OR "Ulluco tuberosus" OR "Ullucus tuberosus Loz" OR "Ullucus kunthii Moq" OR "Basella tuberosa HBK" OR "Melloca tuberosa Lindl" OR "Melloca peruviana Lindl" OR "Basella tuberosa Kunth" OR "Melloca peruviana Moq" OR "Ullucus tuberosus Moq" OR "Ullucus tuberosus Caldas" OR "Ullucus tuberosus subsp. aborigineus" OR "Ullucus tuberosus subsp. tuberosus" OR "ulluco" OR "papalisa" OR "rubas" OR "olluco"</p> <p>AND</p> <p>(pathogen* OR "pathogenic bacteria" OR fung* OR oomycet* OR myce* OR bacteri* OR virus* OR viroid* OR insect\$ OR mite\$ OR phytoplasm* OR arthropod* OR nematod* OR disease\$ OR infecti* OR damag* OR symptom* OR pest\$ OR vector OR hostplant\$ OR "host plant\$" OR host OR "root lesion\$" OR decline\$ OR infestation\$ OR damage\$ OR symptom\$ OR dieback* OR die back* OR malaise OR aphid\$ OR curculio OR thrip\$ OR cicad\$ OR miner\$ OR borer\$ OR weevil\$ OR "plant bug\$" OR spittlebug\$ OR moth\$ OR mealybug\$ OR cutworm\$ OR pillbug\$ OR "root feeder\$" OR caterpillar\$ OR "foliar feeder\$" OR virosis OR viroses OR blight\$ OR wilt\$ OR wilted OR canker OR scab\$ OR rot\$ OR "rotten" OR "damping off" OR "damping-off" OR blister\$ OR smut OR mould OR "mold" OR "damping syndrome\$" OR mildew OR scald\$ OR "root knot" OR "root-knot" OR rootknot OR cyst\$ OR dagger OR "plant parasitic" OR "parasitic plant" OR "plant\$parasitic" OR "root feeding" OR "root\$feeding" OR "ambrosia beetle\$" OR gall\$ OR "bark beetle\$")</p>
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## Appendix C – List of pests that can potentially cause an effect not further assessed

**Table C.1:** List of potential pests not further assessed

	Pest name	EPPO code	Group	Pest present in Peru	Present in the EU	<i>U. tuberosus</i> confirmed as a host (reference)	Pest can be associated with the commodity	Impact	Justification for inclusion in this list
1	Papaya mosaic virus- <i>U</i>	PAPMV0	Virus	Yes	No	Yes	Yes	Uncertainty	The impact is not demonstrated
2	<i>Dematophora bunodes</i>	–	Fungi	Yes	No	Uncertain	Uncertain	Yes	Only found in the warm tropical areas where ulluco is not cultivated

## Appendix D – Excel file with the pest list of *U. tuberosus* from Peru

Appendix D can be found in the online version of this output (in the 'Supporting information' section):