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Pest categorisation of *Liriomyza bryoniae*

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Abstract

The EFSA Panel on Plant Health performed a pest categorisation of *Liriomyza bryoniae* (Diptera: Agromyzidae) for the EU. *L. bryoniae* (the tomato leaf miner; EPPO code: LIRIBO) is a polyphagous Palaearctic species which probably originates from southern Europe, where it occurs commonly outdoors and has now spread to many parts of central and northern Europe, where it is only found in greenhouses. The species is also reported in North Africa and in several countries in Asia. *L. bryoniae* can have multiple overlapping generations per year. Eggs are inserted in the leaves of host plants. Three larval instars feed internally within leaves and stems of field vegetables. Pupation generally takes place in the soil and very occasionally on the upper or lower surfaces of the leaves. *L. bryoniae* is regulated in the EU by Commission Implementing Regulation (EU) 2019/2072 (Annex III) in specific protected zones only (the Republic of Ireland and Northern Ireland in the United Kingdom). However, *L. bryoniae* is not specifically mentioned in any of the annexes of Commission Implementing Regulation 2019/2072 concerning controls regarding certain protected zones. The wide current geographic range of *L. bryoniae,* both in open fields and greenhouses, suggests that it is able to establish in most areas in the EU, including the protected zones, where its hosts are present and where impact would be possible both in open fields as well as greenhouses. All criteria for consideration as a potential protected zone quarantine pest are met. Besides, being *L. bryoniae* widely distributed in the EU and being plants for planting the primary pathway it could also qualify as regulated non-quarantine pest (RNQP).

Keywords: Tomato leaf miner, protected zone, European Union, pest risk, plant health, plant pest, quarantine

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1. Introduction

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

1.1.1. Background

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

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

1.1.2. Terms of reference

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

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

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

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

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

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

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

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

1.1.2.1. Terms of Reference: Appendix 1

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

Annex IIAI

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

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

(b) Bacteria

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

(c) Fungi

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

(d) Virus and virus-like organisms

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

Annex IIB

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

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

(b) Bacteria

Curtobacterium flaccumfaciens pv. flaccumfaciens (Hedges) Collins and Jones

(c) Fungi

Glomerella gossypii Edgerton
Gremmeniella abietina (Lag.) Morelet
Hypoxylon mammatum (Wahl.) J. Miller

1.1.2.2. Terms of Reference: Appendix 2

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

Annex IAI

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

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

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

Group of Tephritidae (non-EU) such as:

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

(c) Viruses and virus-like organisms

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

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

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

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

Annex IIAI

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

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

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

1.1.2.3. Terms of Reference: Appendix 3

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

Annex IAI

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

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

(b) Fungi

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

(c) Viruses and virus-like organisms

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

(d) Parasitic plants

Arceuthobium spp. (non-EU)

Annex IAII

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

Meloidogyne fallax Karssen
Popillia japonica Newman
Rhizoecus hibisci Kawai and Takagi

(b) Bacteria

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

(c) Fungi

Melampsora medusae Thümen
Synchytrium endobioticum (Schilbersky) Percival

Annex I B

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

Leptinotarsa decemlineata Say
Liriomyza bryoniae (Kaltenbach)

(b) Viruses and virus-like organisms

Beet necrotic yellow vein virus

1.2. Interpretation of the Terms of Reference

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

Since *L. bryoniae* is regulated in specific protected zones only, the scope of the categorisation is the territory of the protected zone (the Republic of Ireland and Northern Ireland in the United Kingdom), thus, the criteria refer to the protected zone instead of the whole EU territory.

Following the adoption of Regulation (EU) 2016/2031 on 14 December 2019 and the Commission Implementing Regulation (EU) 2019/2072 for the listing of EU regulated pests, the Plant Health Panel interpreted the original request (ToR in Section 1.1.2) as a request to provide pest categorisations for the pests in the Annexes of Commission Implementing Regulation (EU) 2019/2072.

2. Data and methodologies

2.1. Data

2.1.1. Literature search

A literature search on *Liriomyza bryoniae* was conducted at the beginning of the categorisation in the ISI Web of Science bibliographic database, using the scientific name *L. bryoniae* and the synonyms *Agromyza bryoniae, Liriomyza solani* and *Liriomyza citrulla* and the common name 'Tomato leaf miner' of the pest as search term. Relevant papers were reviewed, and further references and information were obtained from experts, as well as from citations within the references and grey literature.

2.1.2. Database search

Pest information, on host(s) and distribution, was retrieved from the European and Mediterranean Plant Protection Organization (EPPO) Global Database (EPPO, 2019) and relevant publications.

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

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

2.2. Methodologies

The Panel performed the pest categorisation for *L. bryoniae*, following guiding principles and steps presented in the EFSA guidance on quantitative pest risk assessment (EFSA PLH Panel, 2018) and in the International Standard for Phytosanitary Measures No 11 (FAO, 2013) and No 21 (FAO, 2004).

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

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

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

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

Criterion of pest categorisation	Criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Criterion in Regulation (EU) 2016/2031 regarding protected zone quarantine pest (articles 32–35)	Criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest
Identity of the pest (Section 3.1)	Is the identity of the pest established, or has it been shown to produce consistent symptoms and to be transmissible?	Is the identity of the pest established, or has it been shown to produce consistent symptoms and to be transmissible?	Is the identity of the pest established, or has it been shown to produce consistent symptoms and to be transmissible?
Absence/ presence of the pest in the EU territory (Section 3.2)	Is the pest present in the EU territory? If present, is the pest widely distributed within the EU? Describe the pest distribution briefly!	Is the pest present in the EU territory? If not, it cannot be a protected zone quarantine organism	Is the pest present in the EU territory? If not, it cannot be an RNQP. (A regulated non-quarantine pest must be present in the risk assessment area)

Criterion of pest categorisation	Criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Criterion in Regulation (EU) 2016/2031 regarding protected zone quarantine pest (articles 32–35)	Criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest
Regulatory status (Section 3.3)	If the pest is present in the EU but not widely distributed in the risk assessment area, it should be under official control or expected to be under official control in the near future	The protected zone system aligns with the pest-free area system under the International Plant Protection Convention (IPPC) The pest satisfies the IPPC definition of a quarantine pest that is not present in the risk assessment area (i.e. protected zone)	Is the pest regulated as a quarantine pest? If currently regulated as a quarantine pest, are there grounds to consider its status could be revoked?
Pest potential for entry, establishment and spread in the EU territory (Section 3.4)	Is the pest able to enter into, become established in, and spread within, the EU territory? If yes, briefly list the pathways!	Is the pest able to enter into, become established in, and spread within, the protected zone areas? Is entry by natural spread from EU areas where the pest is present possible?	Is spread mainly via specific plants for planting, rather than via natural spread or via movement of plant products or other objects? Clearly state if plants for planting is the main pathway!
Potential for consequences in the EU territory (Section 3.5)	Would the pests' introduction have an economic or environmental impact on the EU territory?	Would the pests' introduction have an economic or environmental impact on the protected zone areas?	Does the presence of the pest on plants for planting have an economic impact as regards the intended use of those plants for planting?
Available measures (Section 3.6)	Are there measures available to prevent the entry into, establishment within or spread of the pest within the EU such that the risk becomes mitigated?	Are there measures available to prevent the entry into, establishment within or spread of the pest within the protected zone areas such that the risk becomes mitigated? Is it possible to eradicate the pest in a restricted area within 24 months (or a period longer than 24 months where the biology of the organism so justifies) after the presence of the pest was confirmed in the protected zone?	Are there measures available to prevent pest presence on plants for planting such that the risk becomes mitigated?
Conclusion of pest categorisation (Section 4)	A statement as to whether (1) all criteria assessed by EFSA above for consideration as a potential quarantine pest were met and (2) if not, which one(s) were not met	A statement as to whether (1) all criteria assessed by EFSA above for consideration as potential protected zone quarantine pest were met, and (2) if not, which one(s) were not met	A statement as to whether (1) all criteria assessed by EFSA above for consideration as a potential RNQP were met, and (2) if not, which one (s) were not met

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

3. Pest categorisation

3.1. Identity and biology of the pest

3.1.1. Identity and taxonomy

Is the identity of the pest established, or has it been shown to produce consistent symptoms and to be transmissible?

Yes, the identity of *L. bryoniae* is established.

Liriomyza bryoniae (Kaltenbach) (Diptera: Agromyzidae), commonly known as tomato leaf miner, was originally described as *Agromyza bryoniae* Kaltenbach in 1858 (Spencer, 1973). Other former scientific names include *Liriomyza citrulla* Rohdendorf, *Liriomyza hydrocotylae* Hering, *Liriomyza solani* Hering, *Liriomyza mercurialis* Hering, *Liriomyza nipponallia* Sasakawa and *Liriomyza triton* Frey (Spencer, 1973; Smith et al., 1997; FAO, 2016; Pitkin et al., 2019).

The EPPO code[4] (Griessinger & Roy, 2015; EPPO, 2019a,b) for this species is LIRIBO.

3.1.2. Biology of the pest

Liriomyza bryoniae is highly polyphagous and has been reared from host plant genera in almost 35 families including many economically important hosts, such as cabbages (*Brassica oleracea var. capitata*), cucumbers (*Cucumis sativus*), lettuces (*Lactuca sativa*), courgettes (*Cucurbita pepo*), melons (*Cucumis melo*), tomatoes (*Solanum lycopersicum*) and watermelons (*Citrullus lanatus*) (Spencer, 1973). Approximately 30% of males emerge 1 day before females and copulation takes place immediately after adult female emergence. Adult females puncture the cotyledons or the young leaves of the host plants with their ovipositor causing wounds which serve as sites for feeding or oviposition. Females can live for a week or more but males only up to 3 days. Unmated females do not lay eggs. Eggs are mostly inserted in the upper surface of leaves but also occasionally in the lower surfaces, individually per each egg puncture. The duration of this stage varies from 3 to 6.1 days at 15°C and 25°C constant temperature, respectively (Minkenberg and Helderman, 1990). Females lay an average of seven eggs per day but up to a total of 163 eggs per female lifetime has been observed on tomato (Minkenberg and Helderman, 1990). In the greenhouses in Europe, the leaf miner breeds continuously throughout the spring, summer and autumn months. There are three larval instars which, in total, last 7–13 days, depending on the temperature. The larva feeds rapidly and forms an irregular linear mine. If a leaf is not sufficient for full development, then the larva can move up in the stem into a second leaf; larvae are unable to penetrate leaves from the outside. Just before pupation, the mature larvae cut semi-circular exit slits in the upper surface of the leaves and drop to the ground to pupate just below the surface of the soil. Very occasionally, larvae pupate on the upper or lower surfaces of the leaves. The duration of the pupal stages depends on the temperature and under glass in the spring and summer months in England, it averages 3 weeks (Smith et al., 1997). The total developmental time (oviposition to adult emergence) decreases with increasing temperature between 15°C and 25°C with a 15L–9D photoperiod. A significantly longer developmental period was found with 10L–14D at 18°C. The lower development threshold of *L. bryoniae* is 8.1°C and the thermal constant is 316.5 day-degrees. The highest adult emergence rate was recorded at 25°C. The intrinsic rate of increase was 0.12 on kidney beans and 0.18 on tomato. During winter, the pupae go into diapause or retarded development until the following spring (Minkenberg and van Lenteren, 1986; Minkenberg and Helderman, 1990; Smith et al., 1997; Tokumaro and Abe, 2003).

3.1.3. Intraspecific diversity

No intraspecific diversity is reported in the literature.

[4] An EPPO code, formerly known as a Bayer code, is a unique identifier linked to the name of a plant or plant pest important in agriculture and plant protection. Codes are based on genus and species names. However, if a scientific name is changed, the EPPO code remains the same. This provides a harmonised system to facilitate the management of plant and pest names in computerised databases, as well as data exchange between IT systems (Griessinger & Roy, 2015; EPPO, 2019a,b). EPPO codes are used in EU Regulation 2016/2031.

3.1.4. Detection and identification of the pest

Are detection and identification methods available for the pest?

Yes, there are standard protocols for detection and identification of *Liriomyza bryoniae* (EPPO, 2005; FAO, 2016).

There are almost 400 species in the genus *Liriomyza* (Kang et al., 2009; EPPO GD, 2019; Lucid keys, 2008), of which around 140 are found naturally in Europe (Seymour, 1994; de Jong et al., 2014). According to EPPO (Smith et al., 1997), the adult flies of all these minute species (1–3 mm long) look very similar. From above, they are seen to be mostly black, with in most species a bright yellow scutellum. As a result, separating these species can be difficult. In addition to *L. bryoniae*, three polyphagous species, namely *L. sativae* Blanchard 1938, *L. huidobrensis* (Blanchard, 1926) and *L. trifolii* (Burgess 1938), were listed in Directive 2000/29 *L. bryoniae* is indigenous to Europe, while the other three all originated in the Americas New World. To identify these species, the diagnostician has not only to distinguish between them but also from the background fauna of indigenous and naturalised *Liriomyza* spp. (which are mostly not pests). The composition of this background fauna varies across Europe and no morphological dichotomous key has been produced that separates each of the four species from the European fauna.

EPPO produced a standard for diagnostics of the above-mentioned four *Liriomyza* species (EPPO, 2005). More recently, FAO (2016) developed a diagnostic protocol for these species including morphological and molecular tools for both adults and immature stages of this fly (ISPM 27). This diagnostic protocol also includes a fifth species, the Eurasian highly polyphagous *L. strigata* (Meigen, 1830) (Spencer, 1990), which is closely related to both *L. bryoniae* and *L. huidobrensis.* Therefore, the diagnostician must be able to discriminate them when seeking to positively identify the four quarantine species. A summary of the most remarkable features in these diagnostic protocols follows:

- Detection
  - Symptoms:
    Feeding punctures and leaf mines are usually the first and most obvious signs of the presence of *Liriomyza*. Mines remain intact and relatively unchanged over a period of weeks. Mine configuration is affected by the host, by the physical and physiological condition of each leaf and by the number of larvae mining the same leaf. Therefore, species identification from mine configuration alone is not advisable, especially for polyphagous *Liriomyza* spp. like *L. bryoniae*.
  - Adults:
    Small greyish fly (females 2.0–2.3 mm in length, males 1.5 mm; wing length 1.75–2.1 mm) with a shining black mesonotum; predominantly yellow femora but tibiae and tarsi more brownish; abdomen with tergites yellow laterally; third antennal segment small, round, normally bright-yellow and arista gradually tapering (Spencer, 1973). Accurate identification, though, requires dissection of male terminalia (see below).
  - Immature stages:
    Egg: they are laid into the leaf tissue. They are white and oval, about 0.25 mm in length. Neither genus nor species identification is possible.
    Larva: headless maggot, up to 2.5 mm long when mature. Instars can be distinguished by the size of the sclerotised mouth hooks. They are cream-coloured, but in the final instar, they develop a yellow–orange patch dorsally at the anterior end, which can extend around to the ventral surface. *L. bryoniae* larvae are in practice indistinguishable from those of *L. huidobrensis*.
    Puparium: oval, gold-yellow to dark brown.
- Identification
  - Morphological identification:
    Because the morphological characters used to diagnose species are based on male genitalia (particularly the distiphallus, the terminal part of the aedeagus), adult males are needed in order to confirm species identification. There are no adequate keys for the species-level identification of adult females (which are often identifiable with certainty to genus level only) or for eggs, larvae or pupae.

— Molecular identification:
Various polymerase chain reaction (PCR)-based molecular tests have been used to identify *Liriomyza* species, including PCR-restriction fragment length polymorphism (RFLP), end-point PCR using species-specific primers, real-time PCR and DNA sequence comparison. Considering the specific limitations of molecular tests, a negative molecular test result does not exclude the possibility of positive identification by morphological tests. In fact, it is advisable to combine morphological and molecular-based identification methods for accurate species identification.

3.2. Pest distribution

3.2.1. Pest distribution outside the EU

L. bryoniae is a Palaearctic species which probably originates from southern Europe, where it occurs commonly outdoors but has now spread to many parts of central and northern Europe, where it is only found in greenhouses (Minkenberg and van Lenteren, 1986). The species is also reported in North Africa (Morocco and Egypt), as well as in several countries in Asia (CABI, 2019). It was reported to be present in the US; however, this is considered a misinterpretation of information in the paper by van Driesche and van Vittum (1987), which actually refers to Europe (EPPO, 2019) (Figure 1).

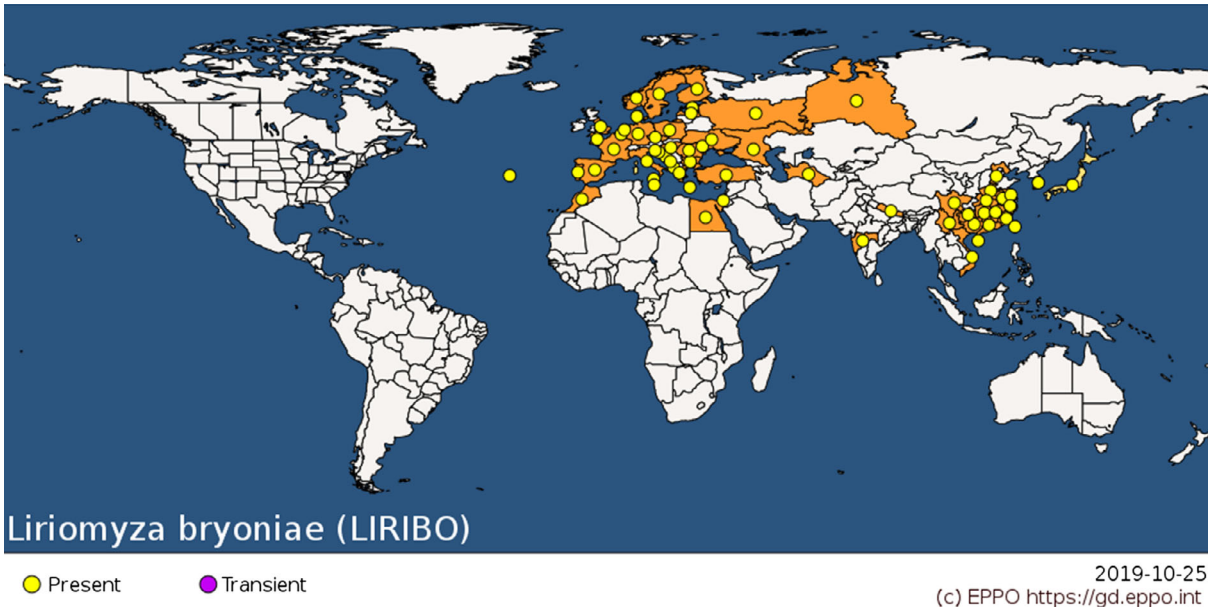


Figure 1: Global distribution map for *Liriomyza bryoniae* (extracted from the EPPO Global Database accessed on 11/11/2019)

3.2.2. Pest distribution in the EU

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

Yes, *L. bryoniae* is present and widely distributed within the EU.

According to the EPPO Global Database the pest is present in 22 out of 28 Member States. Lithuania declared by surveys that the pest is no longer present in their territory.

Table 2: Current distribution of *Liriomyza bryoniae* in the 28 EU MS based on information from the EPPO Global Database and other sources if relevant

Country	EPPO Global Database Last update: Date accessed: 11/11/2019	Other sources
Austria	Present, no details	Fauna Europaea, 2019

Country	EPPO Global Database Last update: Date accessed: 11/11/2019	Other sources
Belgium	Present, restricted distribution	
Bulgaria	Present, no details	
Croatia	Present, no details	
Cyprus		
Czech Republic	Present, restricted distribution	
Denmark	Present, restricted distribution	
Estonia	Present, restricted distribution	
Finland	Present, no details	
France	Present, no details	
Germany	Present, restricted distribution	
Greece	Present, widespread (State Kriti: Present, no details)	
Hungary	Present, restricted distribution	
Ireland		
Italy	Present, restricted distribution (State Sicily: Present, no details)	
Latvia	Present, restricted distribution	
Lithuania	Absent, pest no longer present	
Luxembourg		
Malta	Present, no details	
Netherlands	Present, restricted distribution	
Poland	Present, restricted distribution	
Portugal	Present, restricted distribution (State Azores: Present: No details)	
Romania	Present, no details	
Slovak Republic		
Slovenia	Present, widespread	
Spain	Present, no details (State: Canary Islands: Absent, invalid record)	
Sweden	Present, restricted distribution	
United Kingdom	Present, restricted distribution (UK: states: Channel Islands: Present, no details)	

3.3. Regulatory status

3.3.1. Commission Implementing Regulation 2019/2072

Liriomyza bryoniae is listed in Annex III of Commission Implementing Regulation (EU) 2019/2072[5]. Details are presented in Tables 3 and 4.

Table 3: *Liriomyza bryoniae* in Commission Implementing Regulation (EU) 2019/2072 (below)

Annex III	**List of protected zones and the respective protected zone quarantine pests and their respective codes** **C. Insects and mites**			
	Protected zone quarantine pests		EPPO code	Protected zones
	13.	*Liriomyza bryoniae* (Kaltenbach)	LIRIBO	(a) Ireland; (b) United Kingdom (Northern Ireland).

[5] 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.

3.3.2. Legislation addressing the hosts of *Liriomyza bryoniae*

Annexes IX (List of plants, plant products and other objects, whose introduction into certain protected zones is prohibited), X (List of plants, plant products and other objects, to be introduced into, or moved within protected zones and corresponding special requirements for protected zones), XII (List of plants, plant products and other objects for which a phytosanitary certificate is required for their introduction into a protected zone from certain third countries of origin or dispatch) and XIV (List of plants, plant products and other objects for which a plant passport with the designation 'PZ' is required for introduction into, and movement within certain protected zones) of Commission Implementing Regulation 2019/2072 concern controls regarding certain protected zones. While such annexes contain special requirements for specific named PZ pests, *L. bryoniae* is not specifically named in these annexes.

3.4. Entry, establishment and spread in the EU

3.4.1. Host range

L. bryoniae was first described on *Bryonia* (Cucurbitaceae), but it has been rarely reported on that host (Spencer, 1990). It is a highly polyphagous species and infests several hosts of economic importance including cabbages (*Brassica oleracea* var. *capitata*), cucumbers (*Cucumis sativus*), lettuces (*Lactuca sativa*), courgettes (*Cucurbita pepo*), melons (*Cucumis melo*), tomatoes (*Solanum lycopersicum*) and watermelons (*Citrullus lanatus*) (CABI Knowledge bank).

The species is common in the wild in southern Europe and is now common in greenhouses many other parts of the region. This pest has the potential to spread to any areas where Asteraceae, Brassicaceae, Cucurbitaceae or Solanaceae are grown under glass (Smith et al., 1997; EPPO, 2019).

3.4.2. Entry

Is the pest able to enter into the protected zones? If yes, identify and list the pathways.

Yes, the pest can enter the protected zones mainly human assisted from EU and non-EU areas where the pest is present.

Liriomyza bryoniae is a polyphagous species and its different life stages could use different pathways to enter the protected zone from third countries and from EU countries outside the protected zone (Table 4). In the previous EU legislation (Directive 2000/29 EC), *L. bryoniae* was listed in Annex IB as a pest whose introduction and spread within its protected zone was banned. Regarding pathways, there were no special requirements identified on any of its hosts. As noted in Section 3.3 above, there are no special requirements regarding *L. bryoniae* moving within the EU in the current legislation (2016/2031 EU).

Table 4: Potential pathways for *Liriomyza bryoniae* and existing mitigations

Pathways	Life stage	Relevant mitigations
Plants for planting (excluding seeds)	Eggs and larvae	Annex VI of Commission Implementing Regulation 2019/2072 bans the introduction of plants for planting of *Solanaceae* other than seeds, tubers and stolon- or tuber-forming species of *Solanum* L., from third countries other than: Albania, Algeria, Andorra, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Canary Islands, Egypt, Faeroe Islands, Georgia, Iceland, Israel, Jordan, Lebanon, Libya, Liechtenstein, Moldova, Monaco, Montenegro, Morocco, North Macedonia, Norway, Russia (only the following parts: Central Federal District (Tsentralny federalny okrug), Northwestern Federal District (Severo-Zapadny federalny okrug), Southern Federal District (Yuzhny federalny okrug), North Caucasian Federal District (Severo-Kavkazsky federalny okrug) and Volga Federal District (Privolzhsky federalny okrug)), San Marino, Serbia, Switzerland, Syria, Tunisia, Turkey and Ukraine

Pathways	Life stage	Relevant mitigations
Soil & growing media	Pupae	Annex VI of Commission Implementing Regulation 2019/2072 bans the introduction of soil and growing medium as such into the Union from third countries other than Switzerland Specific regulations apply to soil/growing medium attached to plants for planting for vitality (Annex VII)
Cut flowers and branches with foliage	Eggs and larvae	
Fresh fruit and vegetables	Eggs and larvae	
Hitchhiking on plants	Adults	

The soil/growing medium pathway can be considered as closed from third countries, as soil from third countries other than Switzerland is banned from entering the EU (Annex VI). When attached to plants for planting or machinery (Annex VII), special requirements apply. The plants for planting (excluding seeds), cut flowers and branches with foliage, and fruit and vegetable pathways are not specifically regulated for this pest; however, as an Annex III pest of the Commission Implementing Regulation 2019/2072, the entry of *L. bryoniae* into the protected zones is prohibited regardless of the commodity where they might have been found.

With the implementation of the Plant Health Regulation (EC 2016/2031), consignments of almost all fruits and vegetables require a phytosanitary certificate indicating that they have been inspected and are free from harmful organisms before entry into the EU.

Between 1999 and 2019, there was only one record of interception of *Liriomyza bryoniae* in the Europhyt database for Northern Ireland (accessed 11/11/2019). The pest was intercepted in 1999 on *Gypsophila* sp. in a consignment coming from Israel. All the other interceptions of *L. bryoniae* (n. 10) reported for the same time interval in the Europhyt database regard other EU countries outside the protected zone.

3.4.3. Establishment

Is the pest able to become established in the protected zones?

Yes, the pest is already established in 22 MS. The climate of the EU protected zones is similar to that of some of the MS where *L. bryoniae* is established. Moreover, susceptible host plants are present and cultivated both in open field and under protected conditions in the protected zones.

3.4.3.1. EU distribution of main host plants

Crop production of *L. bryoniae* hosts in Ireland is shown in Table 5 below and in Appendix A.

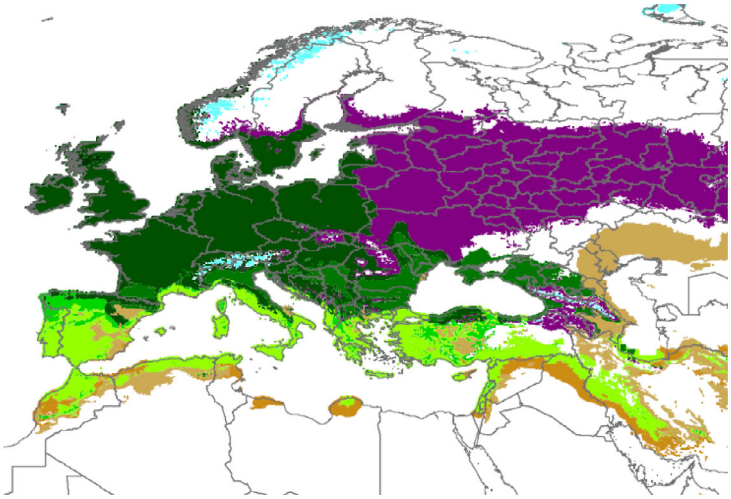
Table 5: Ireland crop production (1,000 ha) (2014–2018) of the main host plants affected by *Liriomyza bryoniae*

Crop	2014	2015	2016	2017	2018
Brassicas	1.90	1.90	1.82	1.68	1.78
Lettuces	0.30	0.30	0.31	0.26	0.26
Tomatoes	0.01	0.01	0.01	0.01	0.01
Cucumbers	0.01	0.01	0.01	0.01	0.01
Gourds and pumpkins	0.00	0.00	0.00	0.00	0.00
Muskmelons	0.00	0.00	0.00	0.00	0.00
Watermelons	0.00	0.00	0.00	0.00	0.00

The only official available crop production data for Northern Ireland report a total production area for 'vegetables for sale' of 1.4; 1.2 and 1.3 (1,000 ha) for 2015, 2016 and 2017, respectively (DAERA-NI, 2019, https://www.daera-ni.gov.uk/).

3.4.3.2. Climatic conditions affecting establishment

The climate of the EU protected zones is similar to that of some of the MS where *L. bryoniae* is established and susceptible host plants are present and cultivated both in open field and under protected conditions (Figure 2).



Köppen-Geiger climate	% of EU	Description
BSh	0.1	Dry, hot, semi-arid steppe
BSk	1.5	Dry, cold, semi-arid steppe
Cfa	6.3	Temperate, uniform precipitation, humid sub- tropical
Cfb	48.6	Temperate, uniform precipitation, oceanic
Cfc	0.5	Temperate, uniform precipitation, sub-polar oceanic
Csa	10.1	Temperate, dry, hot summer / Mediterranean hot summer
Csb	3.9	Temperate, dry, warm summer / Mediterranean warm or cool summer
Dfb	8.7	Continental, uniform precipitation, warm summer

Figure 2: EU Köppen–Geiger climate type zones occurring in the Western Palaearctic region (CSc, Dsb and DSc, each occupying < 0.05% of EU are not shown, nor is Dfc which in the EU occurs in Scandinavia. Map based on data in MacLeod and Korycinska (2019)

3.4.4. Spread

Is the pest able to spread within the protected zones following establishment?

Yes, adults can fly. However, *L. bryoniae* is not known to be a good flyer. It can be passively dispersed by wind currents.

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

Yes, main spread of *L. bryoniae* seems to be mostly dependent on human-mediated movement of plants.

To avoid the introduction and spread of other *Liriomyza* spp., EPPO recommends that propagating material (except seeds) of host plants from countries where the pests occur must have been inspected at least every month during the previous 3 months and found free from the pests. A phytosanitary certificate should be required for vegetables with leaves. In practice, these measures will also control the spread of *L. bryoniae* (EPPO, 2019).

3.5. Impacts

Would the pests' introduction have an economic or environmental impact on the protected zones?

Yes, the introduction of *L. bryoniae* into protected zones could have an economic impact especially on those hosts cultivated under protected conditions.

RNQPs: Does the presence of the pest on plants for planting have an economic impact, as regards the intended use of those plants for planting?[6]

Yes, should *L. bryoniae* be present in plants for planting, an economic impact on their intended use would be expected.

The principal impact of the fly is through the larvae mining into leaves and petioles; the photosynthetic ability of the plant is reduced, and growth is retarded.

Researchers have not been able to clearly correlate leaf mining injury with yield loss (Wolfenbarger and Wolfenbarger, 1966; Levins et al., 1975; Schuster et al., 1976). In tomato, it was seen that yield losses can occur as a result of leaf miner infestation but are not dependent on severity of damage alone; proximity to fruit at an early stage of development is very important. If damage on leaves adjacent to a truss reached 30 mines/leaf at the time fruit was half-swollen, a 10% loss of yield resulted.

Johnson et al. (1983) and Trumble et al. (1985) proved that photosynthesis rates in leaves mined by *Liriomyza* spp. are greatly reduced. Young host plants are particularly susceptible to attack and frequently die (Spencer, 1973). Larvae feeding on tomato cotyledons prevent normal development of the plants and can cause them to collapse (Speyer and Parr (1949) in Spencer, 1973). In Egypt, cucurbit plants were frequently attacked in the seedling stage and during heavy attacks, leaves were stunted and wilted, and fruit production was reduced (Abul-Nasr and Assem, 1961). *L. bryoniae* is a major problem on crucifers, cucurbits, lettuces and tomatoes grown in the greenhouse in all areas where the pest is present or in open fields in southern Europe and in Taiwan (EPPO, 2019).

In Taiwan, *L. bryoniae* has become more abundant and has been displacing *L. brassicae*. In Japan (Abe and Kawahara, 2001; Tokumaru et al., 2007) and Vietnam (Andersen et al., 2002), *L. bryoniae* is now less abundant than *L. sativae*.

L. bryoniae is able to transmit the tobacco mosaic virus (Kalutskii, 1992). This virus is not regulated in the EU, as it is widespread.

L. bryoniae has not been listed as a quarantine pest by EPPO or any other regional plant protection organisation. In most of the western part of the EPPO region, *L. bryoniae* is a major pest of crops within the Asteraceae, Brassicaceae, Cucurbitaceae and Solanaceae grown under glass or in the warmer parts of the region in the field. Until the introduction of *L. trifolii* and *L. huidobrensis* from North America, it was never considered a quarantine pest and no regulatory measures were taken to control it. In view of its great similarity to *L. huidobrensis*, *L. bryoniae* has been conveniently included in the regulatory package which includes the recently introduced alien species (EPPO/CABI, 1996). However, this is not a good reason for EPPO to consider it as an A2 quarantine pest (EPPO 2019).

3.6. Availability and limits of mitigation measures

Yes. As a pest listed in Annex III of Regulation (EU) 2016/2031 of the European Parliament, its introduction and spread in the specified protected zone is banned. However, compared to other protected zones pests, which are specifically named in Annexes IX, X, XII, XIV, measures to prevent entry specifically of *L. bryoniae* are not provided.

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

Yes, sourcing plants for planting from pest free areas or pest free places of production would mitigate the risk.

[6] See Section 2.1 on what falls outside EFSA's remit.

3.6.1. Identification of additional measures

Studies on a similar agromyzid, *Liriomyza trifolii*, have shown that newly laid eggs in chrysanthemum can survive cold storage at 0°C for up to 3 weeks, but larvae are killed in 1–2 weeks under the same conditions (Webb and Smith, 1970). Thus, plant material infested with *L. trifolii* could be maintained normal greenhouse conditions for at least 4 days and then stored at 0°C for a minimum of 2 weeks. Specific studies have not been conducted to confirm whether this procedure is also effective against *L. bryoniae* (EPPO, 2019).

3.6.1.1. Additional control measures

Potential additional control measures are listed in Table 6.

Table 6: Selected control measures (a full list is available in EFSA PLH Panel, 2018) for pest entry/establishment/spread/impact in relation to currently unregulated hosts and pathways. Control measures are measures that have a direct effect on pest abundance

Information sheet title (with hyperlink to information sheet if available)	Control measure summary	Risk component (entry/ establishment/ spread/impact)
Growing plants in isolation	Description of possible exclusion conditions that could be implemented to isolate the crop from pests and if applicable relevant vectors, e.g. a dedicated structure such as glass or plastic greenhouses	Entry, spread
Crop rotation, associations and density, weed/ volunteer control	Crop rotation, associations and density, weed/volunteer control are used to prevent problems related to pests and are usually applied in various combinations to make the habitat less favourable for pests The measures deal with (1) allocation of crops to field (over time and space) (multicrop, diversity cropping) and (2) to control weeds and volunteers as hosts of pests/vectors Nitrogen level and reflective mulches are sometimes said to influence leaf miner populations, but responses have not been consistent (Chalfant et al., 1977; Hanna et al., 1987) It was noted that, although the adults would feed and oviposit on the young lateral foliage (side shoots) of mature plants, they would not do so on young terminal foliage at the apex of plants. This suggests that it may be possible to exert some control of leaf miners by delaying removal of side shoots until after adults have laid eggs in them (Ledieu and Helyer, 1985)	Impact
Heat and cold treatments	Controlled temperature treatments aimed to kill or inactivate pests without causing any unacceptable prejudice to the treated material itself. The measures addressed in this information sheet are: autoclaving; steam; hot water; hot air; cold treatment All stages are killed within a few weeks by cold storage at 0°C. Newly laid eggs are, however, the most resistant stage and it is recommended that cuttings of infested ornamental plants be maintained under normal greenhouse conditions for 3–4 days after lifting to allow eggs to hatch. Subsequent storage of the plants at 0°C for 1–2 weeks should then kill off the larvae of leaf miner species (Webb and Smith, 1970)	Entry, spread, impact
Chemical treatments on crops including reproductive material	Some insecticides, particularly pyrethroids, are effective against leaf miners but resistance makes control difficult (Parrella, 1984) Foliar application of insecticides is often frequent in susceptible crops. Insecticide susceptibility varies greatly both spatially and temporally. Insecticides are disruptive to naturally occurring biological control agents, and leaf miner outbreaks are sometimes reported to follow chemical insecticide treatment for other insects (Parrella, 1987; Capinera, 2017)	Impact

Information sheet title (with hyperlink to information sheet if available)	Control measure summary	Risk component (entry/ establishment/ spread/impact)
Use of resistant and tolerant plant species/ varieties	Resistant plants are used to restrict the growth and development of a specified pest and/or the damage they cause when compared to susceptible plant varieties under similar environmental conditions and pest pressure It is important to distinguish resistant from tolerant species/varieties Some crops vary in susceptibility to leaf mining. This has been noted, e.g. in cultivars of tomato, cucumber, cantaloupe and beans (Hanna et al., 1987). However, the differences tend to be moderate, and not adequate for reliable protection (Capinera, 2017)	Impact
Biological control and behavioural manipulation	Since 1980, parasitoids have been used with increasing success in European greenhouses. Very good results have been achieved in the Netherlands (Hendriske et al., 1980; Schelt and Altena, 1997), UK (Wardlow, 1984), Sweden (Nedstam, 1987), Russia (Efremova and Shrol, 1996) and Belgium (Van de Veire, 1991) on tomatoes and other crops with the native species *Diglyphus isaea*, *Dacnusa sibirica* and *Opius pallipes*. Parasitoids have also been recorded from field crops in Taiwan (Lee et al., 1990) Trials have also been carried out which show effective control using entomopathogenic nematodes (Williams and Macdonald, 2008), and laboratory trials have shown that larvae of *L. bryoniae* can be killed with *Bacillus thuringiensis* (Ushchekov, 1994 in CABI knowledge bank)	Impact

3.6.1.2. Additional supporting measures

Potential additional supporting measures are listed in Table 7.

Table 7: Selected supporting measures (a full list is available in EFSA PLH Panel, 2018) in relation to currently unregulated hosts and pathways. Supporting measures are organisational measures or procedures supporting the choice of appropriate risk reduction options that do not directly affect pest abundance

Information sheet title (with hyperlink to information sheet if available)	Supporting measure summary	Risk component (entry/ establishment/ spread/impact)
Inspection and trapping	Inspection is defined as the official visual examination of plants, plant products or other regulated articles to determine if pests are present or to determine compliance with phytosanitary regulations (ISPM 5) The effectiveness of sampling and subsequent inspection to detect pests may be enhanced by including trapping and luring techniques	Entry
Laboratory testing	Examination, other than visual, to determine if pests are present using official diagnostic protocols. Diagnostic protocols describe the minimum requirements for reliable diagnosis of regulated pests	Entry
Certified and approved premises	Mandatory/voluntary certification/approval of premises is a process including a set of procedures and of actions implemented by producers, conditioners and traders contributing to ensure the phytosanitary compliance of consignments. It can be a part of a larger system maintained by a National Plant Protection Organization in order to guarantee the fulfilment of plant health requirements of plants and plant products intended for trade. Key property of certified or approved premises is the traceability of activities and tasks (and their components) inherent the pursued phytosanitary objective. Traceability aims to provide access to all trustful pieces of information that may help to prove the compliance of consignments with phytosanitary requirements of importing countries	Entry

Information sheet title (with hyperlink to information sheet if available)	Supporting measure summary	Risk component (entry/ establishment/ spread/impact)
Sampling	According to ISPM 31, it is usually not feasible to inspect entire consignments, so phytosanitary inspection is performed mainly on samples obtained from a consignment. It is noted that the sampling concepts presented in this standard may also apply to other phytosanitary procedures, notably selection of units for testing For inspection, testing and/or surveillance purposes, the sample may be taken according to a statistically based or a non-statistical sampling methodology	Entry
Phytosanitary certificate and plant passport	An official paper document or its official electronic equivalent, consistent with the model certificates of the IPPC, attesting that a consignment meets phytosanitary import requirements (ISPM 5) a) export certificate (import) b) plant passport (EU internal trade) To avoid the introduction and spread of other *Liriomyza* spp., EPPO (OEPP/EPPO, 1990) recommends that propagating material (except seeds) of host plants from countries where the pests occur must have been inspected at least every month during the previous 3 months and found free from the pests. A phytosanitary certificate should be required for vegetables with leaves. In practice, these measures will also control the spread of *L. bryoniae* (Smith et al., 1997)	Entry
Certification of reproductive material (voluntary/ official)	–	Entry
Surveillance	–	Entry

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

- Minute size of all developmental stages of *L. bryoniae*
- High mobility of adults
- Egg and larval stages within and protected by plant tissue
- Long pupal stage occurring in the soil
- Control with insecticides is usually complicated by the insect's biology, including the ability of *Liriomyza* spp. to develop resistance to insecticides (Parrella, 1987).

3.6.1.4. Biological or technical factors limiting the ability to prevent the presence of the pest on plants for planting

- Fast development time
- High reproductive capability
- Pupation in the soil

3.7. Uncertainty

There are no uncertainties affecting the conclusions of this pest categorisation.

4. Conclusions

L. bryoniae meets the criteria assessed by EFSA for consideration as a potential protected zone quarantine pest for the territory of the protected zones: Ireland and Northern Ireland in the United Kingdom. Besides, since the pest is widely distributed in the EU and plants for planting are the primary pathway it could also qualify as RNQP.

Table 8: The Panel's conclusions on the pest categorisation criteria defined in Regulation (EU) 2016/2031 on protective measures against pests of plants (the number of the relevant sections of the pest categorisation is shown in brackets in the first column)

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding protected zone quarantine pest (articles 32–35)	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest	Key uncertainties
Identity of the pests (Section 3.1)	The identity of *Liriomyza bryoniae* is well established and there are taxonomic keys available for its identification to species level	The identity of *Liriomyza bryoniae* is well established and there are taxonomic keys available for its identification to species level	
Absence/presence of the pest in the EU territory (Section 3.2)	The pest is already established in 22 MS	The pest is already established in 22 MS and plants for planting is the main pathway	
Regulatory status (Section 3.3)	The pest is listed in Annex III of Commission Implementing Regulation (EU) 2019/2072. and is therefore regarded as regarding protected zone quarantine pest	The pest is listed in Annex III of Commission Implementing Regulation (EU) 2019/2072 and is currently regarded as a protected zone quarantine pest	
Pest potential for entry, establishment and spread in the EU territory (Section 3.4)	The climate of the EU protected zones is similar to that of some of the MS where *L. bryoniae* is established and susceptible host plants are present and cultivated both in open field and under protected conditions Adults can fly. However, *L. bryoniae* is not known to be a good flyer. It can be passively dispersed by wind currents	Plants for planting is the main pathway	
Potential for consequences in the EU territory (Section 3.5)	The introduction of *L. bryoniae* into protected zones could have an economic impact on some of its main hosts (*Solanum* spp.) that are mainly cultivated under protected conditions	Should *L. bryoniae* be present in plants for planting, an economic impact on their intended use would be expected	
Available measures (Section 3.6)	There are measures available to prevent the entry into, establishment within or spread of the pest within the protected zones (i.e. sourcing plants from PFA)		
Conclusion on pest categorisation (Section 4)	All criteria assessed by EFSA above for consideration as potential protected zone quarantine pest are met with no uncertainties	Being the pest widely distributed in the EU territory and plants for planting the main means of spread as the pest could also qualify as RNQP	
Aspects of assessment to focus on/ scenarios to address in future if appropriate			

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Abbreviations

EPPO	European and Mediterranean Plant Protection Organization
FAO	Food and Agriculture Organization
IPPC	International Plant Protection Convention
ISPM	International Standards for Phytosanitary Measures
MS	Member State
PCR	Polymerase chain reaction
PLH	EFSA Panel on Plant Health
PZ	Protected Zone
RFLP	Restriction fragment length polymorphism
RNQP	regulated non-quarantine pest
TFE	Treaty on the Functioning of the European Union
ToR	Terms of Reference

Glossary

Containment (of a pest)	Application of phytosanitary measures in and around an infested area to prevent spread of a pest (FAO, 1995, 2017)
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)
Eradication (of a pest)	Application of phytosanitary measures to eliminate a pest from an area (FAO, 2017)
Establishment (of a pest)	Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO, 2017)
Greenhouse	The term 'greenhouse' is used in the current opinion as defined by EPPO (https://gd.eppo.int/taxon/3GREEL) as a walk-in, static, closed place of crop production with a usually translucent outer shell, which allows controlled exchange of material and energy with the surroundings and prevents release of plant protection products (PPPs) into the environment. A similar definition is also given in EFSA Guidance Document on protected crops (2014) https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efsa.2014.3615.
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 Reduction Options 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 zones (PZ)	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 reduction option (RRO)	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 RRO 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)

Appendix A – EU28 crop production in standard humidity Eurostat (Area (cultivation/harvested/production) (1,000 ha) (accessed 11.11.2019)

Brassicas

GEO/TIME	2014	2015	2016	2017	2018
European Union – 28 countries	**:**	**273.77**	**273.01**	**279.9**	**:**
Ireland	**1.9**	**1.9**	**1.82**	**1.68**	**1.78**
United Kingdom*	**27**	**26.88**	**26**	**27.3**	**25.6**
Austria	1.76	1.64	1.57	1.53	1.44
Belgium	8.58	8.73	8.98	9.82	9.58
Bulgaria	:	2.11	3.03	1.85	2.13
Croatia	0.94	1.66	1.67	2.13	1.98
Cyprus	0.13	0.12	0.14	0.15	0.16
Czech Republic	1.68	1.71	1.77	1.64	1.47
Denmark	:	1.65	1.87	2.07	2.18
Estonia	0.3	0.3	0.28	0.29	0.38
Finland	1.27	1.22	1.21	1.49	1.46
France	26.89	26.09	26.23	26.39	26
Germany	19.53	18.7	18.8	20.09	18.84
Greece	9.73	7.15	6.32	5.89	6.22
Hungary	4.46	4.37	4.43	4.24	3.55
Italy	:	30.26	29.74	29.81	:
Latvia	0.9	1	0.8	0.6	0.7
Lithuania	2.41	2.04	2.22	1.99	2.16
Luxembourg	0	0.01	0.01	0.01	0.03
Malta	0	0	0	0	0
Netherlands	10.08	9.65	10.27	11.14	10.85
Poland	43.3	44	39.98	40.69	41.58
Portugal	10.57	8.71	10.17	9.35	9.47
Romania	31.45	32.41	30.76	30.9	32.08
Slovakia	0	0.55	0.6	0.51	0.44
Slovenia	:	0.91	0.97	0.97	0.94
Spain	:	38.84	42.16	45.98	46.99
Sweden	1.18	1.18	1.2	1.4	1.38

: Data not available.
* Statistics are not available for Northern Ireland, but it will be a proportion of UK total.

Lettuces

GEO/TIME	2014	2015	2016	2017	2018
European Union –28 countries	**96.03**	**93.95**	**91.19**	**91**	**:**
Ireland	**0.3**	**0.3**	**0.31**	**0.26**	**0.26**
United Kingdom*	**6**	**6.43**	**4.7**	**4.8**	**4.8**
Austria	1.41	1.32	1.45	1.39	1.31
Belgium	1.25	1.33	1.29	1.28	1.18
Bulgaria	0.29	0.18	0.12	0.29	0.24
Croatia	0.1	0.2	0.28	0.2	0.25
Cyprus	0.08	0.15	0.28	0.19	0.18
Czech Republic	0.18	0.14	0.15	0.59	0.62
Denmark	0.67	0.61	0.42	0.56	0.53
Estonia	0	0	0	0	0
Finland	0.65	0.65	0.7	0.59	0.67

GEO/TIME	2014	2015	2016	2017	2018
France	8.96	8.84	8.86	8.6	8.43
Germany	6.7	6.56	6.5	7.09	6.93
Greece	4.76	3.67	3.56	3.29	3.31
Hungary	0.31	0.37	0.4	0.34	0.28
Italy	19.78	18.58	15.67	15.66	:
Latvia	0	0	0	0	0
Lithuania	0.22	0.24	0.27	0.24	0.25
Luxembourg	0.01	0.01	0.02	0.02	0.02
Malta	0	0	0	0	0
Netherlands	3.51	3.48	3.52	3.45	3.35
Poland	1.7	1.8	2.31	2.78	2.53
Portugal	2.42	2.15	2.18	2.28	1.93
Romania	0.15	0.16	0.15	0.14	0.15
Slovakia	0.2	0.04	0.02	0.02	0.01
Slovenia	0.67	0.73	0.75	0.74	0.71
Spain	33.87	34.31	35.65	34.51	33.67
Sweden	1.85	1.71	1.63	1.7	1.81

: Data not available.
* Statistics are not available for Northern Ireland, but it will be a proportion of UK total.

Tomatoes

GEO/TIME	2014	2015	2016	2017	2018
European Union - 28 countries	**248.09**	**254.43**	**247**	**241.07**	**243.44**
Ireland	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**
United Kingdom*	**0.2**	**0.23**	**0.2**	**0.2**	**0.18**
Austria	0.19	0.19	0.18	0.18	0.2
Belgium	0.51	0.51	0.51	0.52	0.55
Bulgaria	3.59	3.28	4.2	5.01	4.52
Croatia	0.32	0.42	0.37	0.45	0.49
Cyprus	0.21	0.27	0.22	0.26	0.26
Czech Republic	0.28	0.2	0.34	0.24	0.3
Denmark	0.04	0.03	0.03	0.03	0.03
Estonia	0	0	0.01	0	0
Finland	0.11	0.11	0.11	0.11	0.1
France	5.83	5.69	5.65	5.75	5.74
Germany	0.33	0.33	0.34	0.37	0.4
Greece	17.26	15.25	14.01	13.32	16.02
Hungary	1.88	2.26	2.08	2.19	2.5
Italy	103.11	107.18	96.78	92.67	100.9
Latvia	0	0	0	0	0
Lithuania	0.54	0.49	0.57	0.55	0.57
Luxembourg	0	0	0	0	0
Malta	0	0	0	0	0
Netherlands	1.78	1.76	1.78	1.79	1.79
Poland	13.5	13.8	12.42	12.64	13.11
Portugal	18.46	18.66	20.85	20.87	15.83
Romania	24.43	24.84	22.71	22.21	22.97
Slovakia	0.51	0.57	0.68	0.6	0.59

GEO/TIME	2014	2015	2016	2017	2018
Slovenia	0.23	0.19	0.21	0.2	0.19
Spain	54.75	58.13	62.72	60.85	56.13

: Data not available.
* Statistics are not available for Northern Ireland, but it will be a proportion of UK total.

Cucumbers

GEO/TIME	2014	2015	2016	2017	2018
European Union – 28 countries	**37.31**	**33.51**	**32.43**	**31.91**	**:**
Ireland	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**
United Kingdom*	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**
Austria	0.21	0.21	0.19	0.19	0.2
Belgium	0.04	0.04	0.06	0.06	0.06
Bulgaria	0.73	0.71	0.73	0.67	0.93
Croatia	0.14	0.13	0.16	0.11	0.09
Cyprus	0.22	0.2	0.2	0.19	0.19
Czech Republic	0.05	0.03	0.05	0.04	0.05
Denmark	0.05	0.05	0.05	0.04	0.04
Estonia	0.1	0.1	0.09	0.1	0.1
Finland	0.96	0.09	0.08	0.08	0.1
France	1.56	1.56	1.64	1.71	1.68
Germany	0.33	0.34	0.37	0.37	0.39
Greece	2.34	1.85	1.85	1.88	1.89
Hungary	0.23	0.25	0.4	0.38	0.31
Italy	2.02	1.89	1.84	1.79	:
Latvia	0.1	0.1	0	0.1	0.1
Lithuania	1.17	0.96	1.13	1.08	1.11
Luxembourg	0	0	0	0	0
Malta	0	0	0	0	0
Netherlands	0.6	0.55	0.54	0.6	0.59
Poland	10.6	10.1	9.49	9.19	9.17
Portugal	0.19	0.22	0.13	0.11	0.13
Romania	6.44	5.73	5.7	5.44	6.04
Slovakia	0.05	0.05	0.05	0.05	0.05
Slovenia	0.08	0.06	0.06	0.06	0.06
Spain	8.9	8.1	7.44	7.48	7.5
Sweden	0.08	0.09	0.09	0.08	0.09

: Data not available.
* Statistics are not available for Northern Ireland, but it will be a proportion of UK total.

Gourds and pumpkins

GEO/TIME	2014	2015	2016	2017	2018
European Union – 28 countries	**:**	**:**	**:**	**:**	**:**
Ireland	**0**	**0**	**0**	**0**	**0**
United Kingdom*	**0**	**0**	**0**	**0**	**0**
Austria	0.5	0.5	0.55	0.6	0.7
Belgium	0.21	0.3	0.51	0.51	0.46
Bulgaria	0	2.44	11.76	1.87	1.57
Croatia	0.09	0.27	0.16	0.21	0.14
Cyprus	0	0	0	0	0

GEO/TIME	2014	2015	2016	2017	2018
Czech Republic	0	0	0	0	0
Denmark	0	0	0	0	0
Estonia	0	0	0	0	0
Finland	0.01	0.01	0.02	0.03	0.04
France	3.85	3.83	4.08	4.31	4.21
Germany	3.23	3.49	3.99	4.48	4.15
Greece	0	0	0	0	0
Hungary	0.96	0.73	1.17	1.39	1.54
Italy	:	:	0	0	:
Latvia	0.1	0.2	0.2	0.1	0.1
Lithuania	0.1	0.1	0.13	0.22	0.21
Luxembourg	0	0	0.01	0.02	0.01
Malta	0	0	0	0	0
Netherlands	0.29	0.82	0.82	0.93	0.76
Poland	1.1	1.3	1.34	1.66	1.69
Portugal	3.25	3.06	2.94	2.95	2.86
Romania	3.36	2.46	1.29	1.18	1.23
Slovakia	0	2.25	2.87	0.67	0.21
Slovenia	:	:	:	:	:
Spain	2	2.89	3.17	3.74	4.05

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Muskmelons

GEO/TIME	2014	2015	2016	2017	2018
European Union – 28 countries	**76.46**	**73.73**	**73.27**	**72.6**	**:**
Ireland	**0**	**0**	**0**	**0**	**0**
United Kingdom*	**0**	**0**	**0**	**0**	**0**
Austria	0.02	0.02	0.02	0.02	0.03
Belgium	0	0	0	0	0
Bulgaria	0.48	0.66	1.75	2.67	2.77
Croatia	0.1	0.11	0.17	0.15	0.22
Cyprus	0.14	0.17	0.15	0.15	0.15
Czech Republic	0	0	0	0	0
Denmark	0	0	0	0	0
Estonia	0	0	0	0	0
Finland	0	0	0	0	0
France	14.1	14.02	14.17	14.16	13.41
Germany	0	0	0	0	0
Greece	4.72	4.22	3.91	4.03	3.74
Hungary	0.59	0.8	0.83	0.64	0.57
Ireland	0	0	0	0	0
Latvia	0	0	0	0	0
Lithuania	0	0	0	0	0
Luxembourg	0	0	0	0	0
Malta	0	0	0	0	0
Netherlands	0	0	0	0	0
Poland	0	0	0	0	0
Portugal	3.26	2.56	2.08	1.84	1.94
Romania	4.19	4.18	4.73	4.26	4.26

GEO/TIME	2014	2015	2016	2017	2018
Slovakia	0.04	0.04	0.04	0.03	0.01
Slovenia	0	0.01	0.02	0.01	0.01
Spain	23.79	22.14	20.69	20.47	19.03

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Watermelons

GEO/TIME	2014	2015	2016	2017	2018
European Union – 28 countries	**75.56**	**76.39**	**75.29**	**76.47**	**:**
Ireland	**0**	**0**	**0**	**0**	**0**
United Kingdom*	**0**	**0**	**0**	**0**	**0**
Austria	0	0	0	0	0
Belgium	0	0	0	0	0
Bulgaria	2.86	3.21	4.74	4.82	4.32
Croatia	0.69	0.61	0.68	0.68	0.97
Cyprus	0.6	0.53	0.47	0.44	0.43
Czech Republic	0	0	0	0	0
Denmark	0	0	0	0	0
Estonia	0	0	0	0	0
France	0.8	0.89	0.91	0.93	0.94
Germany	0	0	0	0	0
Greece	12.54	11.41	10.76	11.13	9.62
Hungary	6.12	6.02	5.41	5.27	5.09
Italy	11.42	11.58	12.01	12.84	:
Latvia	0	0	0	0	0
Lithuania	0	0	0	0	0
Luxembourg	0	0	0	0	0
Malta	0	0	0	0	0
Netherlands	0	0	0	0	0
Poland	0	0	0	0	0
Portugal	0.87	1.05	1.11	1.11	0.93
Romania	21.55	21.81	19.9	19.09	17.8
Slovakia	0.15	0.12	0.14	0.12	0.06
Slovenia	0	0.03	0.02	0.01	0.01
Spain	17.95	19.15	19.16	20.03	20.4

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