ORGANISATION EUROPEENNE ET MEDITERRANEENNE POUR LA PROTECTION DES PLANTES
EUROPEAN AND MEDITERRANEAN PLANT PROTECTION ORGANIZATION

16-22170 (11-17790, 11-16591)(minor editorial modifications in 2012, note in yellow added in 2016)

It should be noted that in 2015, the species present in Portugal and initially identified as Epitrix similaris was later described as a new species, named named *Epitrix papa*[1].
Because the PRA was based on information available from Portugal at that time, the evaluation made for *E. similaris* is valid for E. papa.
The EPPO Working Party in June 2016 agreed that *Epitrix similaris* should no longer be recommended for regulation as a quarantine pest, and that *Epitrix papa* should be listed as an A2 pest, based on the information available in this PRA.

Pest Risk Analysis for *Epitrix* species damaging potato tubers

The Expert Working Group was composed of:

First meeting (2010-01-11/14)
- Ms Boavida Conceiçao (Instituto Nacional de Recursos Biologicos, PT)
- Ms Chatot-Balandras Catherine (GERMICOPA, FR)
- Ms Erdogan Pervin (Plant Protection Central Research Institute, TR)
- Ms Fransen Joanne (Plant Protection Service, NL)
- Mr Germain Jean-François (Laboratoire National de la Protection des Végétaux, FR)
- Mr Giltrap Neil (Food and Environment Research Agency, GB)
- Ms Schrader Gritta (Julius Kühn Institut, DE)
- Mr Vernon Robert (Agriculture and Agri-Food Canada, CA)

Second meeting (2010-03-31/04-01)
- Ms Boavida Conceiçao (Instituto Nacional de Recursos Biologicos, PT)
- Ms Chatot-Balandras Catherine (GERMICOPA, FR)
- Mr Giltrap Neil (Food and Environment Research Agency, GB)
- Mr Pfeilstetter Ernst (Julius Kühn Institut, DE)
- Mr Potting Roel (Plant Protection Service, NL)
- Mr Vernon Robert (Agriculture and Agri-Food Canada, CA)

EPPO Secretariat:
- Ms Petter Françoise
- Ms Suffert Muriel

Core members reviewed this PRA in May 2010.
The pest risk management section for seed and ware potatoes was reviewed by the Panel on Phytosanitary Measures on 2010-06-03. The risk management section for Soil or growing medium attached to rooted host plants (Solanaceae) was drafted in early 2011 and reviewed by the Panel on Phytosanitary Measures on 2010-04-07. Measures were agreed by the Working Party on phytosanitary regulations in 2011-06-22.

[1] Orlova-Bienkowskaja MJ (2015) *Epitrix papa* sp. n. (Coleoptera: Chrysomelidae: Galerucinae: Alticini), previously misidentified as *Epitrix similaris*, is a threat to potato production in Europe. *European Journal of Entomology* **112**(4) DOI: 10.14411/eje.2015.096. http://www.eje.cz/pdfs/eje/2015/04/28.pdf

Content (you may click you title to reach the selected section):

Stage 1: Initiation

1 - Give the reason for performing the PRA

Identification of a single pest

Comments:

In Portugal, unusual damage to potato crops (superficial lesions on the tubers) was first observed in 2004 in the northern area of the country (near Porto) (Moreira & Belchior, 2007; Oliveira *et al.*, 2008). In the following years, damage symptoms were reported further south but the causal agent remained unknown. Two North American flea beetles, *Epitrix cucumeris* and *Epitrix similaris* were later identified in fields where tuber damage was observed (Boavida & Germain, 2009). The second species seems to be responsible for the characteristic type of tuber injury observed since it is consistently associated with crop damage. However, at this point, it still cannot be excluded that other species of *Epitrix* might also be involved because of limited survey and investigational work undertaken together with the difficulties associated with identification to species level (members of this genus are small insects with similar exterior morphology). *E. tuberis* is the species usually associated with such tuber damage in North America. The EPPO Working Party on Phytosanitary Regulations decided that a PRA for these 3 species should be performed.

Considering the difficulties of identification in the field and uncertainty about the distribution of the different species, the Expert Working Group decided that this PRA should address all *Epitrix* species potentially damaging potato tubers.

2a - Enter the name of the pest

Potato tuber damaging *Epitrix* species

Comments:

This PRA addresses *Epitrix* species which damage potato tubers (e.g. *Epitrix similaris, E. cucumeris, E. subcrinita, E. tuberis*).

Five flea beetles of the genus *Epitrix* are reported to feed on foliage and/or tubers of potatoes in North America (Gentner, 1944; Hoy *et al.*, 2008): *E. cucumeris* (Potato flea beetle), *E. hirtipennis* (Tobacco flea beetle), *E. similaris* (no common name), *E. subcrinita* (Western potato flea beetle), *E. tuberis* (Tuber flea beetle).

E. tuberis is reported to cause tuber damage in North America. *E. similaris* has been found coincident with tuber damage in Portugal. Damage to tubers by *E. subcrinita* and *E. cucumeris* is also reported in the literature although their impact differs according to authors. *E. hirtipennis* is not reported to cause tuber damage.

Epitrix species are difficult to distinguish in practice even by specialists as their external morphology is very similar (Seeno & Andrews, 1972, Boavida & Germain, 2009) and dissection of genitalia is needed to confirm the species. Some specimens from Portugal in 2007 were identified as *E. tuberis* by Dr Lesage (Canada) based on external morphology but not on genitalia (Vernon, pers. comm. 2010). *E. tuberis* and *E. similaris* were described by Gentner as new species only in 1944 and therefore all previous literature is unreliable, since prior to that at least 3 species of *Epitrix* had been identified as a single species - *E. cucumeris*. In practice, identification in North America is generally based on damage (i.e. when there is damage to tuber, it is assumed that the species responsible is *E. tuberis*) or all species are considered together as "flea beetles" and pest management usually addresses all species together. Many records only mention *Epitrix* spp., which makes it difficult to have a reliable geographical distribution worldwide for each species.

The EWG noted that *Epitrix* species may behave differently in the EPPO region than in North America: e.g. *E. similaris* has not been reported to cause damage to potato tubers in North America but has been associated with damage in Portugal. The EWG hypothesized that due to the morphological similarity between *E. tuberis* and *E. similaris*, and to the apparently wider geographic distribution of *E. tuberis*, damage attributed to *E. tuberis* in western North America could in fact be caused by *E. similaris,* as pointed out by Boavida & Germain (2009). This is an issue deserving further investigation.

This PRA focusses on *E. similaris, E. tuberis* , *E. cucumeris* and *E. subcrinita* because they are known to attack potato tubers or have been associated with damage to potato tubers. A significant amount of literature is available for at least *E. tuberis* and *E. cucumeris*. Nevertheless, because of the difficulties of identification of these species in the field, eventually resulting in species misidentification and confusion of symptoms, other *Epitrix* species might also be involved in tuber damage. The North-American information retrieved and used in this PRA may need to be reassessed after the distribution and the pest status of *Epitrix* spp is clarified in the future. This PRA will be relevant to all *Epitrix* causing damage to tubers.

2b - Indicate the type of the pest

arthropod

2d - Indicate the taxonomic position

Taxonomic Tree
Domain: Eukaryota
Kingdom: Animalia
Phylum: Arthropoda
Class: Insecta
Order: Coleoptera
Family: Chrysomelidae
Subfamily: Alticinae
Genus: *Epitrix*
Species: *Epitrix cucumeris* (Harris, 1851)
Epitrix similaris Gentner, 1944
Epitrix tuberis Gentner, 1944
Epitrix subcrinita LeConte 1857

Comments:

There is no unanimity among authors regarding the classification of the families and subfamilies of Coleoptera, since Lawrence and Newton´s (1995) work on Coleoptera classification. Some authors consider flea beetles as a tribe (Alticini) of the Subfamily Galerucinae. Others consider that flea beetles belong to the subfamily Alticinae which is kept separated from the subfamily Galerucinae. Here we adopt this later classification which is followed by eminent flea beetle specialists, such as S. Doguet (France), M. Doeberl (Germany) and D. Furth (USA)

3 - Clearly define the PRA area

The PRA area is the EPPO region (see map www.eppo.org).

4 - Does a relevant earlier PRA exist?

no

Comments:

No formal PRAs exist, but datasheets for *E. tuberis* (EPPO, 1997) and *E. cucumeris* (EPPO, 2004) were drafted when these pests were added to the EPPO A1 List.

6 - Specify all host plant species (for pests directly affecting plants) or suitable habitats (for non parasitic plants). Indicate the ones which are present in the PRA area.

Comments:

Adults of the *Epitrix* species listed below are reported to feed on a wide range of host plants but Solanaceous plants appear to be preferred. It should be noted that foliage feeding does not necessarily imply egg laying and larval survival. Completion of life cycle of various *Epitrix* species on potato (_Solanum tuberosum)_** is well documented but there is little data for other host plant species. Because Epitrix species are very similar in their external morphology and difficult to distinguish in the field even by specialists, species are often considered together as a pest complex. Data on host range is therefore not fully reliable.**

There is no literature available to confirm that *Epitrix* species can complete their life cycle on all the hosts listed below. The only known host on which *E. tuberis* can complete its life cycle is potato. There is field evidence demonstrating that *E. tuberis* can establish and reproduce on wild Solanaceous plants (e. g. weeds like *S. nigrum*) growing in the margin of fields (Vernon, pers. comm., 2010).

Epitrix tuberis
Potato (*Solanum tuberosum*) is the preferred host plant: Hill (1946) notes that egg production is higher when beetles feed on potato foliage than on other host plants (which were not specified in the publication), and survival of larvae is also higher on potato plants. *E. tuberis* is also reported to attack other Solanaceae, such as tomato (*Lycopersicon esculentum*), aubergine (*S. melongena)*, tobacco (*Nicotiana tabacum*), *Capsicum* sp., and weeds (*Datura stramonium, S. nigrum*). Adults can occasionally feed on leaves of other plant families (Chenopodiaceae, Cucurbitaceae, Fabaceae). Experimental work mentions that adults can feed on a wide range of species: *Armoracia rusticana* (horseradish), *Beta vulgaris* (beetroot), *Brassica oleracea* (cabbages, cauliflowers), *Capsicum frutescens* (chilli), *Cucumis sativus* (cucumber), *Descurainia pinnata* (pinnate tansymustard), *Lactuca sativa* (lettuce), *Lycopersicon esculentum* (tomato), *Medicago sativa* (lucerne), *Nicotiana tabacum* (tobacco), *Phaseolus vulgaris* (common bean), *Physalis* (Groundcherry), *Raphanus sativus* (radish), *Ribes rubrum* (red currant), *Solanaceae*, *Solanum melongena* (aubergine), *Spinacia oleracea* (spinach). Wild hosts: *Alcea rosea* (Hollyhock), *Chenopodium album* (fat hen), *Cirsium arvense* (creeping thistle), *Sinapis arvensis* (wild mustard), *Solanum rostratum* (prickly nightshade), *Solanum triflorum*, *Stellaria media*, *Taraxacum officinale* complex (dandelion). (Neilson & Finlayson, 1953; Wallis, 1957; CABI, 2007b)

Epitrix cucumeris
The most significant host of *E. cucumeris* is potato (*Solanum tuberosum*), but it has also been reported on other Solanaceae, such as aubergine (*Solanum melongena)*, *Capsicum* sp., tomato (*Lycopersicon esculentum*) and tobacco (*Nicotiana tabacum*). Adult beetles may feed on a great variety of hosts, even non Solanaceous species: *Brassica oleracea* var. *capitata* (cabbage), *Beta vulgaris* (sugar beet), *Cucumis sativus* (cucumber), *Helianthus annuus* (sunflower), *Lactuca sativa* (lettuce), *Phaseolus* (beans), *Zea mays* (maize), various weeds including *Chenopodium* spp., *Datura stramonium*. (EPPO, 2004; CABI, 2007b, Foster & Obermeyer, 2009; Hirnyck & Downey, 2005; Hollingsworth, 2009; Natwick & Trumble, 2009). In the Azores islands (PT), *E. cucumeris* was collected on citrus, banana, apple and pear but it is not known if it can feed on these plants (Santos *et al.,* 2009).
Allium is reported as major host in the Crop Protection Compendium (CABI, 2007) but this is not supported by literature or by field experience in North America and Portugal (Vernon, pers. comm., 2010, Boavida, pers. comm., 2010). The only report of *E. cucumeris* as a major pest of *Allium cepa* was in Costa Rica (Sibaja Chinchilla & Sanabria Ujueta, 2002).

Epitrix similaris
In North America, foliar damage is reported on potato (*Solanum tuberosum*) and other Solanaceae, such as tomato (*Lycopersicon esculentum*) (Gentner, 1944; Seeno & Andrews, 1972)
According to recent experience In Portugal, foliar and tuber damage was observed coincident with *E. similaris* populations in potato fields (*Solanum tuberosum*). Foliar damage was observed in aubergine (*S. melongena*), and weeds (*Datura stramonium*, *S. nigrum, S. trifolium*) (Boavida & Germain, 2009) and on *Solanum jasminoides* (Boavida pers. comm., 2010).
In experimental conditions, *E. similaris* completed its life cycle on aubergine (Boavida, pers. comm., 2010).

Epitrix subcrinita
Potato (*Solanum tuberosum*) (Hoy *et al.*, 2008; Anonymous, 1996)
Sweet potato (*Ipomoea batatae*) (Anonymous, 1996)
Quinoa (*Chenopodium quinoa*) (Anonymous, 1996; Rasmussen *et al.*, 2003), aubergine (*Solanum melongena*), pepper (*Capsicum* spp.), sugar beet (*Beta vulgaris*) (Hollingsworth, 2009; Natwick & Trumble, 2009)
Very little information is available on this species.

7 - Specify the pest distribution

Comments:

The great morphological similarity of several Epitrix species makes identification in the field very difficult, even by specialists. This has meant that identification to species level has not been regularly undertaken and *Epitrix* species have often been considered together as a pest complex. Data on distribution of individual species is therefore not fully reliable. In addition, systematic surveys on *Epitrix* species in North America have not been performed since Gentner (1944).

Epitrix tuberis

E. tuberis is believed to be native to Colorado (USA), from which it spread to California, Nebraska, New Mexico, Oregon, South Dakota, Washington and Wyoming (USA), and to British Columbia and Alberta (Canada), during the course of the 20th century (see references below).

EPPO region: absent

North America: Canada (British Columbia, Alberta, Manitoba, Saskatchewan), USA (California, Colorado, Nebraska, New Mexico, North Dakota, Oregon, South Dakota, Washington, Wyoming) (Arnett, 2000; Bousquet, 1991; Campbell et al., 1989; Fauske, 2003; Gentner, 1944; Seeno & Andrews, 1972; Wallis, 1957; CABI 2007 a)

South America Ecuador (EPPO, 1990) based on data provided by the NPPO.

Epitrix cucumeris

EPPO region: Azores Islands and Northern mainland Portugal (Borges, 2008; Boavida & Germain, 2009)

North America:

- Canada (Alberta, Manitoba, New Brunswick, Nova Scotia, Ontario, Prince Edward Island, Quebec, Saskatchewan),
- USA (at least California, Florida, Indiana, Kansas, Maine, Manitoba, New Hampshire, New Mexico, Nebraska, North Carolina, North Dakota, South Dakota, Vermont, Virginia, New York); (Gentner, 1944; Senanayake & Holliday, 1989, Stewart & Thompson, 1989; Bousquet, 1991; Arnett, 2000; Foster & Obermeyer, 2009).

There is some uncertainty on the distribution of *E. cucumeris*: for example Arnett, 2000 mentions less American states than Gentner in 1944; Alberta and Prince Edward Island are not mentioned in Bousquet (1991). Ferro & Boiteau (1993) provide a map of North America which gives a wider geographical distribution for E. cucumeris. This is confirmed by Schmidt (1987) who states that "the potato flee beetle is probably present although sometimes not reported in all provinces of Canada and is the only species of *Epitrix* on potatoes east of Alberta".

- Mexico (Durango, Guerrero, Morelos, Puebla, Veracruz) (Furth & Savini 1996, Furth 2006)

Central America and Caribbean: Costa Rica, Dominican Republic, Guadeloupe, Guatemala, Jamaica, Nicaragua, Puerto Rico (Furth & Savini 1996; CABI, 2007b; Sibaja Chinchilla & Sanabria Ujueta, 2002)

South America: Bolivia, Colombia, Ecuador, Venezuela (Anonymous, 1996; Briceno, 1975)

Africa?: *E. cucumeris* is reported as a pest of *Solanum macrocarpon* in Africa (Bukenya-Ziraba & Bonsu, 2004) but there are no details on its distribution.

Epitrix similaris

EPPO region:

- Portugal (mainly in the North and centre; *E. similaris* is reported to be widespread in the main potato-growing areas, Boavida & Germain, 2009).
- Spain: a single adult was identified from a field in Xinzo, near the Portugal border (Boavida & Germain, 2009). The Spanish NPPO was not aware of significant damage to potatoes in 2009 (Spanish NPPO, pers. comm., 2010). Surveys are being undertaken by the Spanish NPPO in 2010 to evaluate the presence of the pest[2].

North America: USA (at least California, Gentner, 1944). *E. similaris* is considered to have originated from North America, but very little data is available on its geographical distribution in its area of origin.

Epitrix subcrinita

EPPO region: absent.

Rasmussen *et al.* (2003) noted that *E. subcrinita* was present in experimental fields of quinoa in Mediterranean countries like Italy and Greece. When contacted the author explained that no specimen of *Epitrix* was actually identified to species during these studies and the pest was identified as *E. subcrinita* on the basis that it is the *Epitrix* species that damages quinoa in the area of origin of this crop. This record is therefore considered as doubtful because the presence of *E. subcrinita* is not confirmed by checklists available for Europe (Borowiec, 2004; Biondi, 1990; Biondi, pers. comm., 2010)

[2] In December 2010, the Spanish NPPO informed the EPPO Secretariat that *E. similaris* has been found in several potato plots in Galicia. Phytosanitary measures are implemented.

North America: Canada (British Columbia) (Bousquet, 1991), USA (Arizona (North), California, Colorado, Idaho, Nevada, New Mexico (North), Oregon, Utah, Washington, Wyoming) (Gentner, 1944; Arnett 2000; Hoy *et al*., 2008)
South America: Peru – coast and Sierra regions (Ramakrishna, 1988; Anonymous, 1996; Alcazar, 1997)

Stage 2: Pest Risk Assessment - Section A: Pest categorization

8 - Does the name you have given for the organism correspond to a single taxonomic entity which can be adequately distinguished from other entities of the same rank?

yes

Comments:

The various species of *Epitrix* can be distinguished based on morphological characteristics. The adults of *E. similaris*, *E. cucumeris* and *E. tuberis* are very similar in their external aspects and so dissection and examination of their habitus and genitalia is necessary. *E. tuberis* and *E. similaris* were described by Gentner as new species only in 1944; prior to that at least 3 species of *Epitrix* had been treated as a single species, *E. cucumeris*.

10 - Is the organism in its area of current distribution a known pest (or vector of a pest) of plants or plant products?

yes (the organism is considered to be a pest)

Comments:

Five flea beetles of the genus *Epitrix* are reported to feed on potatoes in North America (Gentner, 1944): *E. cucumeris* (Potato flea beetle), *E. similaris* (no common name), *E. subcrinita (*Western potato flea beetle*), E. tuberis* (Tuber flea beetle), and *E. hirtipennis* (Tobacco flea beetle). There are no reports of significant economic damage on potato tubers by *E. hirtipennis* (Tobacco flea beetle) in North America or in Europe.

Little information is available for *E. similaris* as causing tuber damage in North America, but it was identified in fields where tuber damage occurred in Portugal, which lead to crop rejections (Boavida, pers. comm. 2010; Silva, 2008).

12 - Does the pest occur in the PRA area?

E. cucumeris and *E. similaris* are present in the PRA area (see answer to question 7)

Comments:

E. cucumeris

The pest is reported in Azores and Northern Portugal (Boavida & Germain, 2009).

E. similaris

Portugal (mainly in the north and centre; *E. similaris* is reported to be widespread in potato-growing areas). One adult collected in Spain, near to the Portugal border, was identified as *E. similaris* (Boavida & Germain, 2009).

E. subcrinita

The pest is absent from the EPPO region.

E. tuberis

The pest is absent from the EPPO region.

13 - Is the pest widely distributed in the PRA area?

not widely distributed

Comments:

E. similaris and *E. cucumeris* are not widely distributed in the EPPO region. Nevertheless, in Portugal *E. similaris* is widespread in potato-growing areas (Boavida & Germain, 2009).

No official control measures have been taken against either species in Portugal.

14 - Does at least one host-plant species (for pests directly affecting plants) or one suitable habitat (for non parasitic plants) occur in the PRA area (outdoors, in protected cultivation or both)?

yes

Comments:

The major host of these *Epitrix* species, potato, is extensively grown in the EPPO region (more detail is provided in the section on establishment potential)

15 - Is transmission by a vector the only means by which the pest can spread naturally?
no
Comments:
The pest is a free living organism.

16 - Does the known area of current distribution of the pest include ecoclimatic conditions comparable with those of the PRA area or sufficiently similar for the pest to survive and thrive (consider also protected conditions)?
yes
Comments:
E. cucumeris and *E. similaris* have established in Portugal (northern and central parts)
Although differences exist between individual species, the wide distribution of *E. cucumeris* in North America, and the known presence of *E. similaris* in California, indicate that they could readily find suitable climatic conditions in at least some part of the EPPO region (see Köppen-Geiger climate maps, Peel *et al.* 2007)

17 - With specific reference to the plant(s) or habitats which occur(s) in the PRA area, and the damage or loss caused by the pest in its area of current distribution, could the pest by itself, or acting as a vector, cause significant damage or loss to plants or other negative economic impacts (on the environment, on society, on export markets) through the effect on plant health in the PRA area?
yes
Comments:
Damage caused by adult flea beetles on leaves is rarely of economic importance. By contrast, tuber injury caused by larvae of some species can be extremely serious and can have a high economic impact when beetle populations are dense (Gentner 1944, Morisson *et al.* 1967)
E. cucumeris and *E. similaris* have established in Portugal, and damage to potato tubers has been observed since 2004 (Oliveira *et al.*, 2008). Damage reported in Portugal was in the form of worm tracks has resulted in lots of consumption potatoes being rejected (Oliveira *et al.*, 2008). It should be noted that such symptoms are usually attributed to *E. tuberis* but this species has not been detected in any samples of beetles submitted to the laboratories fields where damage has been evident. *E. similaris*, but not necessarily *E. cucumeris,* has been confirmed as being associated with tuber damage in Portugal.

18 - Summarize the main elements leading to this conclusion.
Comments:
These pests present a risk to the EPPO region because:
- These flea beetles can have high economic impact on potato
- Economic impact has been noted in Portugal on potato
- The pests can find suitable ecoclimatic conditions in a large area of the EPPO region (depending on species)
- Potato is an important crop in the EPPO region.

Consequently the pest risk assessment should continue

Stage 2: Pest Risk Assessment - Section B: Probability of entry of a pest

1.1 - Consider all relevant pathways and list them
- Potato tubers for planting with soil attached originating from areas where the pests occur
- Potato for consumption with soil and/or plant debris attached originating from areas where the pests occur
- Natural spread within the EPPO region
- Soil or growing medium attached to rooted host plants from areas where the pests occur
- Soil or growing medium attached to rooted non-host plants from areas where the pests occur
- Soil or growing medium as such from countries where the pests occur
- Soil attached to machinery from countries where the pests occur

Comments:

Most likely pathways

The most probable means of international entry or spread is considered to be as pupae or dormant adults in soil associated to potato tubers and the attached soil (i.e. tubers have not been brushed and/or washed).

- *Potato tubers for planting with soil attached originating from areas where the pests occur*

(see detailed assessment)

- *Potato for consumption with soil and/or plant debris attached originating from areas where the pests occur*

(see detailed assessment).

- *Natural spread within the EPPO region*

There is no strong evidence of long distance natural spread of these pests. Dispersal distances are not mentioned in scientific literature. Field observations in North America with *E. tuberis* show that it can fly to search for host plants in the local vicinity when their food source is no longer available (e.g. when early potato varieties are lifted, Vernon, pers. comm., 2010). Some authors (e.g. Glendenning & Fulton, 1948, Fulton & Banham, 1962) note that *Epitrix* beetles can fly freely on fine days and cover long distances when searching for their hosts. Other authors (e.g. Elliot 2009) say that "the beetles jump actively, particularly when disturbed, but they seldom, if ever, fly". *E. tuberis* is often reported to be a strong flyer but this is not supported by data published in literature. Döberl (1994) cited by Bennen, 2005 speculate movement by trade winds as a possibility to explain the spread of *E. hirtipennis* in Italy, Greece and Turkey (in addition to spread with trade).

In Portugal, tuber damage was first seen in the Porto region in 2004. During the course of the next 4 years there were reports throughout the central part of the country and as far south as Setubal, a city approximately 300 km away from Porto. The reports of damage to the North were much more limited (ca 100 km) (Oliveira, *et al.*, 2008) and in 2009 reports of damage in outside the affected areas have been very limited (Boavida, pers. comm., 2010). It is difficult to know how important natural spread has been in Portugal but the absence of any official controls have meant that human mediated spread, through the movement of infested ware and possibly seed potatoes, is much more likely to be responsible for the long distance spread of *Epitrix*. Speed of pest dispersal can not be directly extrapolated from the reports of damage, as the pest may have been present and spread for several years before damage was first noticed. In addition increased reporting often occurs in response to publicity and raised public awareness

- *Soil or growing medium attached to host plants for planting with roots from areas where the pests occur*

Adult *Epitrix* overwinter in the soil where host plants are grown, pupae may also be present in soil. Consequently soil attached to rooted host plants may contain dormant adults or pupae. Tomato plants with soil attached are suspected to have been the pathway for the spread of *Epitrix tuberis* into California (Seeno & Andrews, 1972).
The EWG considered that there was a risk that *Epitrix* might be introduced with host plants for planting *but that a detailed study was not possible as there is no detailed data available for these host species. It is difficult to know the potential concentration of these pests, the possible association with host, the possibility of transfer, etc.* Relevant data on volume of entry is not available as there are no specific custom codes to identify species of plants for planting. Species of plants for planting are not always specified on the Phytosanitary certificates and would consequently not show up in export/import databases. It is therefore not possible to distinguish between host plants and non-host plants. Import from countries where the pests are present are limited compared to global import of plants for planting worldwide in the EU (see Appendix 1).

Some general statements could be made about the risk associated to this pathway:

- Plants for planting produced in soil are likely to pose a greater risk than plants produced in artificial growing media because the soil can be infested.
- Similarly, plants produced in open air conditions are more at risk from infestation than those grown

under protection.

- In the EU, most of the tomato seedlings are produced by specialists in greenhouses. Young plants are not grown in soil but in artificial media and so are only likely to carry *Epitrix* if they become infested during growth. Boavida (pers. comm., 2010) showed that *Epitrix similaris* could complete its life cycle on aubergine in growing media (humus and turf).
- In the case of potatoes, only microplants (for seed potato production) are marketed as rooted plants; they are normally produced in axenic conditions so should pose no risk.
- More data would be needed to determine which plants are really hosts, i.e. allow completion of the pest life cycle. Considering the current knowledge, Solanaceous plants, including ornamentals, are considered to be at highest risk because *Epitrix* is more likely to feed and possibly complete its life cycle.
- In the EU import of Solanaceous plants is prohibited from third countries (except European and Mediterranean countries). Nevertheless, this pathway may spread *E. similaris* and *E. cucumeris* from Portugal to other EPPO countries.

- *Soil or growing media attached to non-host plants for planting*

Adult *Epitrix* overwinter in the soil where host plants are grown or nearby (Cusson *et al.*, 1990), pupae may also be present in soil. Nursery plants (or other plants for planting) may be grown in fields where potatoes or other hosts had been grown previously and consequently soil attached to rooted non host plants may contain dormant adults or pupae The EWG was not aware of scientific data indicating how long *Epitrix* species may survive in soil without host plants. As *Epitrix* species are reported to be able to overwinter in hedge rows bordering potato fields, it may be extrapolated that *Epitrix* adults may survive in soil between from autumn to spring. There is no data on other life stages.
Those species of non-host plants for planting that are regularly grown in rotation with potatoes pose a greater risk, a list of such plants is given in the EU directive on the control of potato cyst nematodes 2007/33/EC (EU, 2007b): *Allium porrum, Beta vulgaris, Brassica spp., Fragaria, Asparagus officinalis;* and bulbs *(Allium ascalonicum, Allium cepa, Dahlia* spp*., Gladiolus, Hyacinthus* spp*., Iris* spp*., Lilium* spp*., Narcissus, Tulipa*). Clearly, some of these species are normally marketed largely free of soil, thereby markedly reducing the risk of spreading the pest.

Even non-host plants raised in containers can pose a risk albeit small. For example, the following sequence of events might occur: host weeds might grow in a container in which a nursery plant is cultivated and attract *Epitrix* adults (to feed on foliage and/or lay eggs); EWG considered that it was a very low risk compared to other pathways.

Plants for planting produced in soil pose a greater risk than plants produced in artificial growing media.
Relevant data on volume of entry is difficult to retrieve for the same reason as for the pathway "*Soil or growing medium attached to host plants for planting with roots from areas where the pests occur".* See Appendix 1 for data on bulbs and plants for planting (host and non host).

- *Soil attached to machinery*

Infested soil attached to machinery may play a role in local spread of the pest. Transboundary movement of agricultural machinery and equipment also occurs in many countries in Europe but it is not possible to control at least within EU. Cleaning of machinery entering infested fields will reduce the risk of spread by this pathway.

- *Soil from countries where the pests occur*

In theory, soil is a pathway for movement of *Epitrix* species. Nevertheless, the volume of soil imported into EPPO countries from outside the region is minimal as EU countries prohibit the import of soil from countries outside the EU. Similar restrictions on international movement exists in most other countries in the region (North Africa, CIS countries).
Movement of soil from Portugal to other EPPO countries is not known to occur. Nevertheless, soil is usually not transported over long distances as it is too heavy and too expensive and such soil is not normally destined for agricultural use, which make transfer of *Epitrix* to host plants unlikely.
Given that the volume of soil moved long distances is likely to be low, the risk presented by this pathway

seems to be very low.

<u>Very unlikely/impossible pathway</u>

- *Washed ware potato tubers*

Although potato tubers are considered a possible pathway for *E. tuberis* (EPPO, 1997), *E. cucumeris* (EPPO, 2005) and *E. similaris* (EPPO, 2008)*,* available literature and experience indicate that this is not the case for washed tubers free from soil. The fact that symptoms occur on the tubers does not mean that the tuber as such can be a pathway. Presence of larvae in potato tubers is not reported in the literature and has never been observed during 20 years of experiments on *Epitrix* sp. in Canada (Vernon, pers. comm., 2010). In addition Glendering & Fulton (1948), Fulton & Banham (1962) and Schmidt (1987) state that *Epitrix* larvae are not known to be spread via potato tubers. Glendering & Fulton (1948) and Fulton & Banham (1962) state that the larvae are active and leave tubers immediately after potatoes are lifted (and even that *"the tubers may safely be used as seed").* This is also supported by experience with the Portuguese outbreak where no larvae were detected in the tubers harvested (Oliveira *et al.* 2008; Boavida & Germain, 2009). Following the appearance of the first symptoms on tubers in 2004 several causes were investigated (including viruses and fungi) and it was only in 2008 when symptoms were recognized as possibly caused by *Epitrix* species, that targeted sampling of adults and larvae were conducted which allowed the identification of *E. cucumeris* and *E. similaris* (Oliveira *et al.*, 2008).
Seed potatoes are not normally washed but washing of ware potatoes prior to marketing is common practice in many countries.

1.3 - Pathway: Potato tubers for planting with soil attached originating from areas where the pests occur

1.3a - Is this pathway a commodity pathway?
yes
Comments:

1.3b - How likely is the pest to be associated with the pathway at origin taking into account factors such as the occurrence of suitable life stages of the pest, the period of the year?
likely
Level of uncertainty: low
Comments:
Adults spend the winter within the soil, and immature stages of *Epitrix* occur in the soil. Females of *Epitrix* species enter the ground near potato plants and lay their eggs (Glendenning & Fulton 1948). The pest completes one or more life cycles during the period of crop development so larvae, pupae and adults can be present when tubers are harvested and possibly eggs, although this seems less likely. Tubers for planting are usually harvested in autumn (September).
Larvae size ranges between 1 mm to 5 mm long and pupae size is 2.5 mm long, adults are 1.5-2.2 mm long. These stages can easily go undetected especially if tubers are covered by soil at harvest.

Farm-saved seeds are considered as much higher risk for movement within countries compared to certified seeds because there is less official control and the presence of more soil and plant debris (Boavida and Giltrap, pers. comm. 2010). Farm-saved seed cannot be legally marketed and so long distance movement is less common than with officially certified seed. Most farm saved seed stays on the same place of production.

1.4 - How likely is the concentration of the pest on the pathway at origin to be high, taking into account factors like cultivation practices, treatment of consignments?
unlikely
Level of uncertainty: low
Comments:
For certified seeds, the quantity of soil accompanying a potato consignment is usually limited. According to the UNE-CE Standard for Seed Potatoes (UN-ECE, 2008), tolerance for "earth and extraneous matter" in a lot of seed potatoes is 2%. In the EU, the seed potato certification scheme/ marketing directive requires 1% earth and extraneous matter but some national requirements are even lower.
About 1-1.5 tons of seed potatoes are planted per ha, which represents potentially, 20-30 kg of soil being introduced with the seed (with a tolerance of 2%). Seed potatoes are also normally inspected prior to marketing and there are quality standards for the presence of external damage so if Epitrix damage were to result in tolerances being exceeded, seriously affected stocks will not be marketed.

In Canada and in USA, insecticide treatment programs during seed potato production to limit virus transmission by aphids will also control *Epitrix* species. A strict certification program is in place in Canada for the production and export of seed potatoes (CFIA, 2010). Although the EU Directive (EU, 2003) does not require it, the instructions provided to Canadian exporters of potato to the EU by CFIA state that the "tubers must be practically free from soil and packaged in new containers" (unpublished Canadian Food Inspection Agency data, 2009).
Only *E. cucumeris* is reported to be present in the Eastern Canadian provinces (Prince Edward Island and New Brunswick) concerned by the derogation (EU, 2003; EU, 2008)). Nevertheless, this should be considered with care because of the great morphological similarity of these Epitrix species which makes identification in the field very difficult. Systematic surveys on *Epitrix* species in North America have not been performed since Gentner (1944).

In the EPPO region, insecticide treatments are variable according to countries and pest pressure (see question 1.23).

Farm-saved seeds will be higher risk but trade will be limited to local movement.

1.5 - How large is the volume of the movement along the pathway?

minimal

Level of uncertainty: low

Comments:

The current trade of seed potatoes coming from infested zones is minimal compared to the total trade of seed potato.

Import of seed potatoes from countries outside the EPPO region is prohibited by most EPPO countries. There is an exemption in the European Union for the import of seed potato from Canada (New Brunswick and Prince Edward Island) (EU, 2005). Since 1999, only Portugal imports seed potatoes from Canada (only Kennebec variety), see Table 1. Import is price sensitive and the quantity imported varies largely over years. Recently the popularity of the main imported variety, Kennebec has decreased and there was no import in 2009.

From the Canadian export data (http://cansim2.statcan.gc.ca/cgi-win/cnsmcgi.pgm), it can be noted that other EPPO countries import seed potatoes from Canada (Algeria, Armenia, Croatia, Georgia, Russia, Serbia, Turkey), but not necessarily every year. The biggest importer in the last 5 years was Turkey with imports varying between 500 and 2700 tons.

The USA export data (http://www.fas.usda.gov/gats/default.aspx) does not always differentiate between seed and ware potatoes. Some EPPO countries import potato from USA (Russia, Israel) but in limited quantities.

Table 1. Import of seed potato in EU countries from Canada and USA in 1995-2008 (in 100 kg). Eurostat, extracted in 2010-01.

		Canada					United states			
Year	Month	Total Eu	Greece	Italy	Portugal	Romania	Uk	Ireland	Italy	Netherlands
1995		**102948**	**1250**	**63416**	**38282**	**:**	**:**	**:**	**1000**	**:**
	Jan.			7						
	Feb.			54410	38282					
	Mar.		1250	8999						
1996		**102080**	:	**81000**	**21080**	:	:	:	:	:
	Jan.			42000	15580					
	Feb.			38500	5500					
	Mar.			500						
1997		**9162**	:	:	**9162**	:	:	:	:	:
	Feb.				1080					
	Mar.				8082					
1998		**55642**	:	**34272**	**21370**	:	:	:	:	:
	Jan.			3						
	Feb.			18053	18872					
	Mar.			16216	2498					
1999		**27501**	**:**	**:**	**26001**	**1500**	:	:	:	:
	Jan.	7750	:	:	7750	:	:	:	:	:
	Feb.	17001	:	:	17001	:	:	:	:	:
	Mar.	1250	:	:	1250	:	:	:	:	:
	Apr.	1500	:	:	:	1500	:	:	:	:
2000		**2820**	**:**	**:**	**2820**	**:**	:	:	:	:
	Feb.				2070					
	Mar.				750					
2001		**1026**	**:**	**:**	**1026**	**:**	:	400	:	:
	Feb.				1026					

2002		**1560**	**:**	**:**	**1560**	:	:	:	:	:
	Jan.				1560					
2003		**:**	**:**	**:**	**:**	**:**	**:**	**:**	**:**	**2**
2004		**6242**	**:**	**:**	**6242**	:	:	:	:	:
	Jan.	1332	:	:	1332	:	:	:	:	:
	Feb.	1530	:	:	1530	:	:	:	:	:
	Mar.	3380	:	:	3380	:	:	:	:	:
2005		**4640**	**:**	**:**	**4640**	:	180	:	:	:
	Feb.	750	:	:	750	:	:	:	:	:
	Mar.	3890	:	:	3890	:	:	:	:	:
2006		**520**	**:**	**:**	**520**	:	:	:	:	:
	Feb.	520	:	:	520	:	:	:	:	:
2007		**2865**	**:**	**:**	**2865**	:	:	:	:	:
	Feb.	2865	:	:	2865	:	:	:	:	:
2008		**780**	**:**	**:**	**780**	:	:	:	:	:
	Feb.	780	:	:	780	:	:	:	:	:

Information has been requested from Mediterranean countries:
Morocco and Tunisia do not import seed potato from North America (NPPO 2009-12-31 and NPPO 2010-01-02, respectively).

Seed production in infested areas of the EPPO region
Portugal is not a big exporter of seed potatoes. There are no reports of seed potatoes production in Portugal in the document 'Potato sector in the European Union (EU, 2007)'. This information is not consistent with data retrieved from EUROSTAT (see Table 2) where it is noted that most export of seed potatoes goes to Spain. This data is considered doubtful by Ms Afonso (NPPO, Portugal, pers. comm., 2010): only one company currently produces seed potatoes in Portugal which may have been exported to Spain but in this case the seed was not officially certified since the Portuguese services did not receive any demand for labels.
Export of seed potatoes from Spain to other EU countries is limited (see Table 3).

Table 2. Export of Seed potatoes from Portugal (quantity in 100 kg) (source: Eurostat, 2010)

Reporter	PERIOD/PARTNER	EU27_INTRA	Spain
Portugal	Jan.-Dec. 1995	245	245
Portugal	Jan.-Dec. 1996	10750	5306
Portugal	Jan.-Dec. 1997	1549	1549
Portugal	Jan.-Dec. 1998	10760	4538
Portugal	Jan.-Dec. 1999	10497	10101
Portugal	Jan.-Dec. 2000	12909	10275
Portugal	Jan.-Dec. 2001	17841	14116
Portugal	Jan.-Dec. 2002	19918	19614
Portugal	Jan.-Dec. 2003	20272	19402
Portugal	Jan.-Dec. 2004	30824	30582
Portugal	Jan.-Dec. 2005	27768	27268
Portugal	Jan.-Dec. 2006	41633	40675
Portugal	Jan.-Dec. 2007	48961	48391
Portugal	Jan.-Dec. 2008	44725	44377

Table 3. Export of seed potatoes from Spain to other EU countries (quantity in 100 kg) (source: Eurostat, 2010)

Partner	2001	2002	2003	2004	2005	2006	2007	2008
Germany	:	1113	777	13980	3624	3235	606	445
Austria	:	:	:	:	:	:	2	2
Belgium	:	1014	2528	475	:	:	:	543

Bulgaria	:	:	:	:	:	:	:	:
Cyprus	:	:	:	:	:	:	:	:
Denmark	2430	40	1422	:	:	1633	:	:
Spain	:	:	:	:	:	:	:	:
Estonia	:	:	:	:	:	:	:	:
Finland	:	:	:	:	:	:	:	:
France	3802	20058	6208	4555	5526	6175	1938	7008
Greece	:	:	:	:	:	:	:	:
Hungary	:	:	:	:	:	:	:	:
Ireland	1160	:	:	:	7130	:	:	:
Italy	22	:	360	740	1449	1305	35	:
Latvia	:	:	:	:	:	:	:	:
Lithuania	:	:	:	:	:	:	:	:
Luxembourg	:	:	:	:	:	:	216	:
Malta	:	:	:	:	:	:	:	:
Netherlands	18323	309	7323	24	1702	10709	693	8234
Poland	42	:	:	:	:	:	414	:
Portugal	5045	2219	8654	2471	3395	2398	16778	13063
Rumania	:	:	:	:	:	:	:	:
United-kingdom	3424	24623	1658	250	28405	4184	250	6574
Slovakia	:	:	:	:	:	:	:	:
Slovenia	:	:	:	:	:	:	:	:
Sweden	50	:	:	51	:	:	:	:

1.6 - How frequent is the movement along the pathway?

rarely

Level of uncertainty: low

Comments:

Imports of seed potatoes from Canada: Imports to some EU countries occur nearly every year between January and April (see Table 1). Since 2006, it has occurred only once per year in Portugal.
Imports to Turkey have occurred every year over the last 5 years.
Imports to other EPPO countries (Russia, Algeria) are not regular (e.g. only once in 2009 over the last 10 years for Russia)

Imports from USA are not regular.

1.7 - How likely is the pest to survive during transport /storage?

very likely

Level of uncertainty: low

Comments:

Storage and transport of seed potatoes is at 4-5° C (Plissey, 1993), which is suitable for survival of adults and possibly of pupae (the reference to pupae is added as pupae could be observed during mild winter in Canada; Vernon, pers. comm. 2010)

1.8 - How likely is the pest to multiply/increase in prevalence during transport /storage?

impossible/very unlikely

Level of uncertainty: low

Comments:

Pupae cannot evolve at 5°C.
Adults are not active at 5° C which is the temperature for storage of certified seed potatoes.
Farm-saved seeds will normally be stored at the same temperature as ware potatoes. The actual temperature of storage is often dictated by the eventual market but is rarely lower than storage temperatures for seed potatoes. It can be as high as 10°C but it is not expected that beetles will be able to complete their life cycle on tubers at this temperature. If temperatures are too high tubers sprout limiting the potential for long term storage.

1.9 - How likely is the pest to survive or remain undetected during existing management procedures (including phytosanitary measures)?
likely
Level of uncertainty: low
Comments:
Adults are not active at 5° C which is the temperature for storage of certified seed potatoes, so they will be difficult to detect.
The amount of soil attached to seed potatoes is usually limited but insects are small (less than 2 mm) and black so they will not be easily observed on tubers with soil attached. Nevertheless they can be found if a detailed inspection is undertaken.

Presence of symptoms on tubers will be an indication for presence of *E. tuberis* and *E. similaris* but not necessarily for other species. As seed potatoes are not usually washed, symptoms are more difficult to observe than on washed tubers for consumption.

In the EU, there are no specific requirements for *Epitrix* species. Seed potatoes are however normally inspected prior to marketing and there are standards for external tuber damage so if Epitrix damage were to result in tolerances being exceeded, seriously affected stocks may not be marketed.

1.10 - How widely is the commodity to be distributed throughout the PRA area?
limited
Level of uncertainty: low
Comments:
See answer to question 1.5.
The derogation for import of seed potato from Canada is limited to some EU member states: Cyprus, Greece, Italy, Malta, Portugal and Spain (EU, 2003; EU, 2008). Since 1999, only Portugal has made use of this derogation.

Seed potatoes from Portugal are mainly exported to Spain (see Table 2 in question 1.5)
Seed potatoes from Spain are exported to different EU countries (see Table 3 in question 1.5)

Other EPPO countries import seed potatoes from USA and Canada: Turkey, Russia

1.11 - Do consignments arrive at a suitable time of year for pest establishment?
yes
Level of uncertainty: low
Comments:
Seed potatoes are imported at appropriate periods for planting: usually January-April (see question 1.5). This is also an appropriate time for establishment of *Epitrix* species.

1.12 - How likely is the pest to be able to transfer from the pathway to a suitable host or habitat?
very likely
Level of uncertainty: low
Comments:
Seed potatoes are intended to be planted in potato fields, soil attached to the tubers will not be brushed, so they are very likely to favour the transfer of the pest to potato fields.

1.13 - How likely is the intended use of the commodity (e.g. processing, consumption, planting, disposal of waste, by-products) to aid transfer to a suitable host or habitat?
very likely
Level of uncertainty: low
Comments:
Seed potatoes are intended to be planted in potato fields, so they are very likely to favour the transfer of the pest to potato fields.

1.3 - Pathway: Potatoes for consumption with soil and/or plant debris attached originating from areas where the pests occur

1.3a - Is this pathway a commodity pathway?
Yes

1.3b - How likely is the pest to be associated with the pathway at origin taking into account factors such as the occurrence of suitable life stages of the pest, the period of the year?
likely
Level of uncertainty: low
Comments:
Adults spend the winter in the soil, with all immature stages occurring in the soil. Cusson *et al.* (1990) noted from observed edge effects, field colonisation pattern and higher beetle density on edges that *E. tuberis* probably overwinters within or near potato fields. Females of *Epitrix* species enter the ground near potato plants and lay their eggs (Glendenning & Fulton 1948). Consequently larvae, pupae and adults can be present when tubers are harvested, and possibly eggs although this seems less likely. Tubers are usually harvested in summer and autumn, except for early potatoes.
According to Rules for Inter-European Trade in Potatoes (RUCIP, 2006), a tolerance of 1% of earth adhering to the tubers is allowed for ware potatoes.

1.4 - How likely is the concentration of the pest on the pathway at origin to be high, taking into account factors like cultivation practices, treatment of consignments?
moderately likely
Level of uncertainty: medium
Comments:
The amount of soil that is deemed acceptable depends on the end market and is often subject to contract between the suppliers and the buyers. It can be very variable, the largest amount being allowed for starch potatoes and other industrial processing.

According to Rules for Inter-European Trade in Potatoes (RUCIP, 2006):
- ware potatoes should be "practically clean", i.e. a tolerance of 1% of earth adhering to the tubers is allowed,
- industrial potatoes for processing into products for human consumption should be free of earth "according to agreement between the parties"
- industrial potatoes for the production of alcohol or animal feed stuffs should be free of earth with a tolerance for waste (including earth) of 2%

Complete dessication or killing of haulms and subsequently leaving the potato crop for at least a week in the field before harvesting will lower the number of adults present at harvest.
The longer the growing season of the crop, the higher the population of *Epitrix* adults and immature stages that will be present at harvest.

Presence of *Epitrix* in ware potatoes will be more likely than for seed potatoes, as insecticide treatments will not be routinely applied for ware potatoes. Ware potatoes also receive much fewer official inspections that certified seed potatoes.

1.5 - How large is the volume of the movement along the pathway?
minor
Level of uncertainty: low
Comments:
Import of potato tubers for consumption from countries outside the EPPO region is prohibited by EU and most EPPO countries. Morocco and Tunisia does not potato for consumption from North America (pers. comm. with NPPO 2010). There are derogations in the European Union for the import of potato from third countries to the EU. Occasional import from USA and Canada occur to some EPPO countries according to US data (see tables 4 and 5 below) but usually not every year, and are very limited (domestic uses of potato per year in the EU was about 72 million tons in 2001-2003, EU, 2007).
Data on trade from the USA to EU are not consistent between Eurostat (where import is null) and data

from US Foreign Trade Statistics database (see below)

Table 4: Export of potato (except seeds) (code 0701900000) in tons from USA to EPPO Countries (Source: Department of Commerce, U.S. Census Bureau, Foreign Trade Statistics, 2010)

Partner	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Azerbaijan	0	19	0	0	0	0	0	0	0	0	0
Belgium-Luxembourg	17	0	0	0	0	0	0	0	0	0	0
Cyprus	0	0	0	0	0	0	0	0	0	0	36
Denmark	25	0	0	0	0	0	0	0	0	0	0
France	0	186	0	0	0	0	0	0	31	13	0
Germany	0	235	0	0	0	0	0	0	0	0	0
Ireland	0	0	0	0	0	0	18	0	0	0	0
Israel	0	60	0	0	0	0	0	0	0	0	0
Italy	0	0	41	7	0	0	0	0	0	0	0
Montenegro	0	0	0	0	0	0	0	0	0	23	0
Netherlands	21	172	0	6	37	147	0	0	0	33	0
Norway	39	0	18	0	0	0	0	0	0	0	0
Russia	5	39	2 346	0	381	1 588	2 591	102	1 896	1 678	1 431
Spain	0	0	19	48	0	24	2	0	0	0	0
Sweden	19	37	18	19	0	0	0	0	0	0	0
Ukraine	0	0	0	0	0	0	0	0	48	0	41
United Kingdom	1 068	1 458	684	260	924	639	7 329	0	0	0	0

Table 5: Value of Export of potato (except seeds) in Canadian dollars from Canada to EPPO Countries (Source: Statistics Canada, 2010). *(The quantity in tons is given for the biggest values)*

Value in Canadian dollars	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
France	--	--	--	4 672	2 721	3 245	459	22 533	2 026	12 280
Algeria	434 145	--	--	--	--	--	--	562 923 *(3629 tons)*	--	--
Azerbaijan	--	--	--	--	--	--	--	--	16 261	--
Croatia	--	--	--	--	28 800	--	--	--	--	--
Finland	--	--	--	--	--	--	--	--	--	270
Greece	--	--	--	--	2 925	--	--	--	--	--
Netherlands	--	--	--	--	1 798	--	--	31 788	66 879	--
Norway	--	--	--	--	--	--	--	1 796 197 *(4055 tons)*	--	--
Portugal	--	--	--	--	9 037	--	--	--	--	--
Russia	--	--	--	--	949 201 *(6804 tons)*	--	--	--	373 240	--
Serbia and Montenegro	--	--	--	--	63 465	25 409	--	--	--	--
Spain	--	--	--	--	--	--	12 358	--	--	--
Tunisia	--	--	--	--	--	--	--	--	13 824	--
Turkey	--	--	--	--	--	--	--	--	138 335	--
United Kingdom	--	--	--	92 120	--	--	--	--	--	--

Exports of potato from Portugal are mainly to EU countries. In 2007, potatoes were mainly sold to Spain, Germany, Netherlands, France and UK. On the period 1999-2009, exports occurred to the following EPPO countries: Belgium, Denmark, France, Germany, Italy, Morocco, the Netherlands, Spain, and UK)

Exports are low (about 25000 tons) compared to imports (about 200000 tons) (Eurostat, 2010).
Exports of potato from Spain are mainly to EU countries. About 60% is sold to Portugal (Eurostat, 2010).

1.6 - How frequent is the movement along the pathway?

Rarely
(see answer to question 1.5)

Level of uncertainty: low

Comments:

Imports to EPPO countries from the USA and Canada do not occur every year (except for Russia).
Export of potatoes from Portugal to other EPPO countries occurs every year for a few countries (Spain, Germany, Netherlands, France, UK, Belgium) but the other countries have not imported potatoes (or only once or twice) over the last 5 years.

1.7 - How likely is the pest to survive during transport /storage?

very likely

Level of uncertainty: low

Comments:

Storage and transport conditions are favourable for the conservation of ware potatoes, which is also suitable for the survival of the pest (adults and possibly pupae). During transport, potatoes are protected from extremes of frost or high temperatures with the use of ventilation systems and/or refrigeration.
Adults may be active at 10° C which is a common temperature for storage of ware potatoes to be processed (Plissey, 1993). Active beetles were observed in a storage facility in Portugal in November 2009, after a 2-month period of storage (Boavida, pers. comm. 2010).

Early potatoes can be harvested with green haulms, as well as potatoes for processing (to increase dry matter content). Adults can feed on these green parts in the field. Presence of green plant material will allow feeding by adults in the field and in storage if haulm material is present in storage.

1.8 - How likely is the pest to multiply/increase in prevalence during transport /storage?

unlikely

Level of uncertainty: low

Comments:

Pupae can not evolve at 5°C.

Adults may be active at 10° C which is a common temperature for storage of ware potato to be processed (Plissey, 1993). It is not expected, however, that beetles will be able to reproduce as adults need to feed before they can reproduce, and no food is available in a store house. Nevertheless green parts of foliage can be found in store, in particular if haulms are not killed before harvest which might allow for reproduction. However, because of the relatively low temperature for adult activity and the general absence of food, reproduction is considered unlikely.

1.9 - How likely is the pest to survive or remain undetected during existing management procedures (including phytosanitary measures)?

moderately likely

Level of uncertainty: medium

Comments:

Insects are small (less than 2 mm) and black so they will not be easily observed, but they are visible if they are looked for specifically. Presence of symptoms on tubers would be an indication for presence of *E. tuberis* and *E. similaris* but not necessarily for other species. If tubers are not washed, symptoms of damage are more difficult to observe.

Detection will mainly depend on storage temperature and on the level of infestation.
- At 5°C, adults are not active and will be difficult to detect.
- Adults are active above 10° C which is the temperature for storage of ware potatoes to be processed. Beetles were observed in a store house in Portugal and were attracted to host plants placed in the store

house (Boavida, pers. comm. 2010).

In the EU, there are no specific requirements for *Epitrix* species.

1.10 - How widely is the commodity to be distributed throughout the PRA area?
limited
Level of uncertainty: low
Comments:
Importation of potatoes from USA, Canada and Portugal is limited to a few countries of the EPPO region (see answer to question 1.5): from Portugal, potatoes have been traded to 9 countries since 1999, from USA, 17 since 1999, from Canada 15 since 2000.

1.11 - Do consignments arrive at a suitable time of year for pest establishment?
yes
Level of uncertainty: medium
Comments:
Export of potatoes from Portugal (and Spain) to EU countries occurs all year round (Eurostat, 2010). If beetles are moved with potatoes in the spring and summer, and can escape to find host plants, they will be able to establish.

Importation of US potatoes to Russia occurs mainly between September and December, which is not a suitable period for pest establishment. Nevertheless, beetles may survive being dormant.

1.12 - How likely is the pest to be able to transfer from the pathway to a suitable host or habitat?
moderately likely
Level of uncertainty: medium
Comments:
Adults were observed in a store house in Portugal at 10°C, 2 months after harvest (Boavida, pers. comm. 2010), which shows that *Epitrix* can be transported from the field to the storage place with the harvested tubers. Transfer to a suitable host may occur during transport to the storage place, or during handling.
Transfer will be more likely if potatoes are harvested with green haulms or plant debris, which may occur for potato for processing (to have higher dry matter content) or for early potatoes. Active adults may be present on green haulm and will be able to escape during storage and transport. They will be attracted to potato crops or wild hosts.

Tubers with soil can be exported as such and then packaged or processed in the country of destination (Silva, 2008). Adults could escape during transport or at the packing or processing station. Handling of potatoes before processing will allow adults to escape (see answer to 1.13).

Transfer to hosts will vary according to the period and conditions of transport: it will be favoured if temperature is high enough for the adults to be active, if hosts are available, if potatoes are transported in an open vehicle.

1.13 - How likely is the intended use of the commodity (e.g. processing, consumption, planting, disposal of waste, by-products) to aid transfer to a suitable host or habitat?
unlikely
Level of uncertainty: medium
Comments:
The end use of ware potatoes is to be consumed, which will not aid transfer to a suitable host.
Nevertheless some stages of handling and packing may aid transfer:
- During grading at harvest, some potato tubers are rejected. Piles of these tubers might be a source of infestation if they are disposed of in fields with host plants.
- When potatoes from an infested field are brushed, soil and potato material containing *Epitrix* will be collected. This material will be a source of infestation if it is disposed of in or near fields/gardens with host plants. In the Netherlands. it is common practice for waste soil to be stored in piles at processors, and these companies are usually located in potato growing areas (Potting, pers. comm., 2010). The risk of transfer and establishment of a sustainable population will be high in such situations. The option of disposing soil for landscaping even carries some risk because Solanaceous hosts are widely grown in

urban areas.

Potatoes with soil attached used for consumption are generally locally produced. Composting of green waste is increasingly a common practice. Potato waste with soil will be a risk, especially if people have potatoes or other Solanaceous hosts (e.g. tomato) in their gardens.

1.14c - The overall probability of entry should be described and risks presented by different pathways should be identified

Comments:

The EWG considered that the main pathways are:

-potato tubers for planting with soil and/or plant debris attached coming from areas where the pests are present,

-potato tubers for consumption or processing with soil and/or plant debris attached coming from areas where the pests are present.

The probability of entry through these pathways is high with a low uncertainty, so these should be given priority.

Concerning plants for planting, the EWG recognized that a risk exists but association and concentration of the pest on the pathway, whilst considered very low, is very difficult to assess because of lack of data. The risk associated with host plants for planting is higher than for non-host plants for planting.

Concerning soil as such, and soil attached to machinery, the risk is mainly associated with local spread.

Stage 2: Pest Risk Assessment - Section B: Probability of establishment

1.15 - Estimate the number of host plant species or suitable habitats in the PRA area.

moderate number

Level of uncertainty: low

Comments:

In general, *Epitrix* spp. are associated with Solanaceae, the adults feeding on the foliage and the larvae feeding on the roots. *E. tuberis* and *E. cucumeris* are known to prefer potatoes, feeding on other hosts only when potatoes are not available (e.g. after lifting of an early crop). At this stage, the beetles may feed on a great variety of hosts, even non-solanaceous (cabbages, cucumbers, *Beta*, lettuces, *Phaseolus*, various weeds) (see also answer to question 6).

1.16 - How widespread are the host plants or suitable habitats in the PRA area? (specify)

very widely

Level of uncertainty: low

Comments:

Potato and tomato are grown extensively by professional growers and individuals in private gardens. Although it is decreasing, commercial production of potato in the EPPO region was still about 7 million hectares in 2008 (it was 9.7 million in 1999, see Appendix 2; FAOstat, 2010). Other host plants (aubergine, Capsicum) are also of economic importance.

Some hosts are very common weeds (e.g. *Chenopodium album, Datura stramonium, Solanum nigrum*).

Some solanaceous plants are also used as ornamental plants in private gardens and amenity areas (e.g. *Brugmansia* spp., *Solanum jasminoides, Petunia* sp.).

1.17 - If an alternate host or another species is needed to complete the life cycle or for a critical stage of the life cycle such as transmission (e.g. vectors), growth (e.g. root symbionts), reproduction (e.g. pollinators) or spread (e.g. seed dispersers), how likely is the pest to come in contact with such species?

N/A

Level of uncertainty: low

1.18a - Specify the area where host plants (for pests directly affecting plants) are present (cf. QQ 1.15-1.17).

This is the area for which the environment is to be assessed in this section. If this area is much smaller than the PRA area, this fact will be used in defining the endangered area.

Host plants are present in the entire PRA area.

Comments:

Potato is grown in all EPPO countries.

Europe has for a long time been the world leader in potato production and is now second after Asia. Seven European countries are among the top 10 global producers. Morocco, Algeria and Turkey are also important potato producers in the EPPO region. (source: FAO 2008)

1.18b - How similar are the climatic conditions that would affect pest establishment, in the PRA area and in the current area of distribution?

largely similar

Level of uncertainty: low

Comments:

A comparison of climate using CLIMEX (see Appendix 3) shows that climates of countries of the EPPO region are similar to zones where *Epitrix* species occur, and therefore all EPPO countries have a climate suitable for at least one species of *Epitrix*.

It should be noted that literature for species distribution is not fully reliable (see answer to question 7) so extrapolation of distribution of *Epitrix* species in the EPPO region should be taken with care.

E. cucumeris

The very wide distribution of *E. cucumeris* especially in North America and its establishment in Azores and Portugal indicate that it could readily find suitable climatic conditions in Europe and the Mediterranean part of the EPPO region. One could expect it to establish in all of the potato-growing areas of central and northern Europe.

E. similaris
This species is only reported from California but it has been introduced in Portugal where it is present in almost all potato growing areas (Boavida & Germain, 2009). This indicates that the pest can establish in at least the Mediterranean Basin.

E. subcrinita
This species is present in the north western part of North America, from South California (USA) to British Columbia (Canada), as well as in Peru. The CLIMEX study shows that this pest could find a similar climate in the entire EPPO region.

E. tuberis
This species is present in the north western part of North America, from California (USA) to British Columbia (Canada). The climate is similar, in the EPPO region, except in the Mediterranean Basin.

1.19 - How similar are other abiotic factors that would affect pest establishment, in the PRA area and in the current area of distribution?
largely similar
Level of uncertainty: medium
Comments:
The time of emergence, or the numbers of adults of *E. tuberis* that emerge from different soil types, does not vary significantly according to the mineral, inorganic or organic nature of the soil in which eggs are deposited (Vernon and Thomson, 1993).
Nevertheless, there are contradictory reports on effects of soil types: Metzger (1934) cited in Gentner (1944) notes that damage by *E. tuberis* is worse in heavy, moist soils. Oliveira (pers. comm., 2010) noted that damage in Portugal (likely *E. similaris*) appeared heavier in sandy soils.

1.20 - If protected cultivation is important in the PRA area, how often has the pest been recorded on crops in protected cultivation elsewhere?
never
Level of uncertainty: low
Comments:
Epitrix sp. are reported as secondary pests of tomato in California (Lange & Bronson, 1981) but there is no report of these pests under protected cultivation. In British Colombia, there is extensive protected cultivation of tomato but no species of flea beetles have ever been recorded (Vernon, pers. comm. 2010).

1.21 - How likely is it that establishment will occur despite competition from existing species in the PRA area, and/or despite natural enemies already present in the PRA area?
very likely
Level of uncertainty: low
Comments:
The outbreak and further spread in Portugal proved that the presence of natural enemies was not sufficient to prevent establishment.

Weeden *et al.* (2009) mention *Podisus maculiventris* (Hemiptera: Pentatomidae) as a predator of flea beetles, but it does not occur in the PRA area.

No predators or parasites of *E. tuberis* are reported in British Columbia (Campbell et al., 1989). Observations in the field have shown that spiders can feed on adult tuber flea beetles (Vernon, pers. comm., 2010) but will not prevent establishment.

1.22 - To what extent is the managed environment in the PRA area favourable for establishment?
highly favourable
Level of uncertainty: low
Comments:
Management practices appear quite similar between North America and the PRA area.
Factors favoring the pest:

- presence of host plants in gardens where no management is applied and close rotation is practiced
- Poor management of host weeds and potato volunteers in the field (Wallis, 1957)
- Close rotation with Solanaceous crops, in particular with potato (Kabaluk & Vernon, 2000)
- Presence of Solanaceous crops all year round in areas where climate is mild
- Short distance between two crops in the current year, in subsequent years (Several generations of *Epitrix* may occur in the same year, so if host crops are cultivated at short distance, migration may occur from one field to another; *Epitrix* species probably overwinter within or near potato fields (Cusson *et al.,* 1990), so if potato field are located in the same zone in subsequent years, they will be more likely infested).
- Poor management of host weeds around the field or in hedgerows (it may not be allowed to treat hedgerows when fields are close to waterways for example)
- Poor management of potato culls in the following year (flea beetle population can survive on the culls or adults may feed on volunteers from culls from previous year; Wallis, 1957). It is common practice in many EPPO countries to have unattended culls in fields.
- Presence of wooded headlands around the field favor hibernation as well as contain alternative hosts for feeding
- Late harvest coincident with warmer winter months may favor survival of immature populations through to adults the following spring
- Establishment of early populations on early crops or volunteers can transfer to main crops when early crops are harvested

1.23 - How likely is it that existing pest management practice will fail to prevent establishment of the pest?
likely
Level of uncertainty: low
Comments:
Pest establishment did occur in Portugal, which shows that existing pest management measures were not sufficient to prevent establishment of the pest in this area. Nevertheless, once the cause of damage to tubers was identified and farmers were made aware of possible treatments, management measures were implemented (e.g. an additional early spray) and damage appeared to be less severe in 2009 than in previous years (Oliveira, pers. comm., 2010). In Italy, the introduced species *E. hirtipennis* did establish but is not reported to cause damage to potato crops (Bugiani, Italian NPPO, pers. comm., 2010).
Epitrix sp. are observed on potato plants as soon as early crops emerge in Portugal in March (Boavida, pers. comm. 2010). No insecticide treatments are usually applied at this time, as insecticide treatments target larvae of Colorado beetle later in the season. In Portugal, 2-3 insecticide treatments are applied against Colorado beetle during the growing season if necessary. It is considered that these treatments are effective in reducing *Epitrix* populations, but that an additional early spray is also required to cover the first emerging adults (Oliveira, pers. comm., 2010).

The insecticide armory is much larger in North America than in the EU: e.g. in furrow application of granular systemic insecticides (phorate) and in-furrow sprays (thiamethoxam, fipronil, imidacloprid) as well as seed treatments (thiamethoxam, imidacloprid, clothianidin) are extensively used in parts of North America to prophylactically control first generation flea beetles, Colorado potato beetles and aphids (Vernon & Mackenzie JR, 1991a, Hollingsworth, 2009). Some of these insecticides are no longer registered in the EU. In Portugal, 2 products were authorized in 2009 to control *Epitrix similaris*: bifenthrin and acetamiprid (NPPO of Portugal, 2009).

Status in the EU and in Russia of the different active ingredients used against *Epitrix* species in Northwestern USA (according to Hollingsworth, 2009):

Active Ingredient	**Chemical familly**	**Application (in US)**	**Authorised (included in Annex I of EU Directive 91/414)**	**Russia** (registered for potato)
acetamiprid	neonicotinoid	foliar spray	YES, Authorised in: AT, BE, BG, CY, CZ, DE, DK, EL, ES, FR, HU, IE, IT, LT, MT, NL, PL, PT, RO, SE, SI, SK, UK. In progress for: FI Authorized for *E similaris* in Portugal	YES

			since 2009	
aldicarb	carbamate	in furrow at planting	NO	NO
azadirachtin		foliar spray or soil drench	NO (national authorization up to 12/2011. Application resubmitted for inclusion)	NO
azinphos-methyl	organophosphate	foliar spray	NO	NO
Beauveria bassiana		foliar spray	YES, Authorised in: CY, EL, ES, FR, IT, NL, SE, SI, UK. In progress for: HU	
bifenthrin	pyrethroid	in furrow at planting/ foliar spray	NO (Use of existing stocks possible until 2011). Authorized for *E similaris* in Portugal since 2009	NO
carbaryl	carbamate	foliar spray	NO	NO
carbofuran	carbamate	at planting/foliar spray	NO	NO
chlorantraniliprole	Anthranilic diamide	foliar spray	pending, Authorised in: AT, DE, EL, HU, IE, IT, PT, RO;. In progress for: CY, ES, NL, PL, SI, UK	NO
clothianidin	neonicotinoid	in furrow, seed treatment, side-dress or foliar spray	YES, Authorised in: AT, BE, BG, CZ, DE, DK, EE, EL, ES, FI, HU, IE, IT, LT, NL, PT, RO, SK, UK. In progress for: SI, on sugarbeet and maize	YES
cyfluthrin	pyrethroid	foliar spray	YES	NO
deltamethrin	pyrethroid	foliar spray	YES, Authorised in: AT, BE, BG, CY, CZ, DE, EE, EL, ES, FI, FR, HU, IE, IT, LT, LU, LV, MT, NL, PL, PT, RO, SE, SI, SK, UK	YES
dinotefuran	neonicotinoid	seed treatment, side-dress or foliar spray	NO (new substance; Never notified and authorised in the EU)	NO
diazinon	organophosphate	preplant broadcast	NO	YES
disulfoton	organophosphate	in furrow, preplant broadcast	NO	NO
endosulfan	cyclodiene	yes ?	NO	NO
esfenvalerate	pyrethroid	foliar spray	YES, Authorised in: AT, BE, BG, DE, DK, EL, ES, FI, FR, HU, IE, IT, LT, LU, LV, NL, PL, RO, SE, UK. In progress for: PT, SK	YES
imidacloprid	chloro-nicotinyl	in furrow, seed treatment or foliar spray	YES, Authorised in: AT, BE, BG, CY, CZ, DE, DK, EE, EL, ES, FI, FR, HU, IE, IT, LT, LU, LV, MT, NL, PL, PT, RO, SE, SI, SK, UK	YES
lambda-cyhalothrin	pyrethroid	foliar spray	YES, Authorised in: AT, BE, BG, CY, CZ, DE, DK, EE, EL, ES, FI, FR, HU, IE, IT, LT, LU, LV, MT, NL, PL, PT, RO, SE, SI, SK, UK	NO
methamidophos	organophosphate	foliar spray	NO	YES
oxamyl	carbamate	in furrow or foliar spray	NO	NO
permethrin	pyrethroid	foliar spray	NO	NO
phorate	organophosphate	in furrow	NO	NO
phosmet	organophosphate	foliar spray	YES, Authorised in: AT, EL, ES, FR, IT, PT, RO	
thiamethoxam	neonicotinoid	in furrow, seed	YES, Authorised in: AT, BE, BG, CY,	YES

		treatment, side-dress or foliar spray	CZ, DE, DK, EE, EL, ES, FI, FR, HU, IT, LT, LU, LV, MT, NL, PL, PT, RO, SI, SK, UK. Foliar spray only	
zeta permethrin	pyrethroid	foliar spray	YES, Authorised in: AT, BE, CY, CZ, DE, EL, ES, FR, HU, IT, LT, LV, PL, RO, SK, UK	YES

Current plant protection practices for potato are quite different within the EPPO region:
Italy: Potatoes are often sprayed with fungicides (late blight is the target) but also with insecticides, primarily pyrethroids, against Colorado potato beetle and aphids, and neonicotinoids against noctuids and the new target *Phthorimaea operculella*. The numbers of insecticides applied are roughly 5 per growing season and it is considered that such strategy also controls *E. hirtipennis*. (Bugiani, Italian NPPO, pers. comm., 2010)

Poland (Sahadjak, Polish NPPO, pers. comm., 2010): Farmers typically apply 1 to 2 treatments per season against Colorado beetle, as needed. In exceptional cases 3 treatments are used (an insecticide is applied in combination with a fungicide), and very small plantations often are not protected at all. The most common products are neonicotinoids and pyrethroids. In farms specializing in large-scale potato production and seed production, a seed dressing (containing imidacloprid) is used against the Colorado beetle. Additionally, the following products are also used against aphids in seed production: mineral oil, lambda-cyhalothrin, pirimicarb. Typically potatoes are grown in a 4-year rotation (in ca. 80% of case), less frequently in a 2-3-year rotation (10-15%). About 2-3% of potato plantations are grown in monoculture but with vegetables intercrops (in regions specialized in growing very early potatoes). Waste/downgraded potatoes are typically used as animal feed and not let as culls in the fields. Farm-saved seeds are largely used, in particular in small farms.

Portugal (Boavida, pers. comm., 2010): Potatoes in commercial fields are sprayed on average 3 times during the growing season.

Russia (Popovich, Russia NPPO, pers. comm., 2010): potato is often grown in monoculture. Insecticides target primarily Colorado beetle, one treatment is applied against each generation. A larger range of chemicals is available in Russia compared to the EU, as more organophophates and carbamate are still registered (e.g. dimethoate, malathion, carbosulfan). Waste/downgraded potatoes are typically used as animal feed and not let as culls in the fields.

UK (Giltrap, Fera, pers. comm., 2010): as Colorado beetle is not present in the UK, ware potatoes received an average of 1 insecticide spray per year.

Insecticide treatments against *Phthorimaea operculella,* which is a growing concern in Mediterranean countries, will not be effective against *Epitrix* sp. as they aim at preventing tuber infestation and are therefore applied shortly before vine kill (Rondon, 2010). Nevertheless cultural controls recommended against *P. operculella* (elimination of cull piles and volunteers, high hilling) will help reduce *Epitrix* populations (Rondon, 2010; Miller *et al*., 2008)

Other host plants
Host plants are grown in private gardens and also occur in the wild where pest management practices are not applied.
Pest management options currently available in organic farms will fail to prevent establishment.

1.24 - Based on its biological characteristics, how likely is it that the pest could survive eradication programmes in the PRA area?
very likely
Level of uncertainty: low
Comments:
Based on the following characteristics, it seems very likely that the pest could survive eradication programmes in the PRA area:
- In the literature, it is often stated that *E. tuberis* has 2-3 generations per year and the other *Epitrix* species have 1 generation per year (EPPO, 1997; EPPO, 2005, Senanayake *et al*. 1993) but this is not

supported by detailed biological studies. In addition, field experience may not readily be used because of difficulties in identification. Although detailed studies are not yet available, it seems that *E. similaris* has more than one generation in Portugal (Oliveira, pers. comm. 2010)
- *Epitrix* species have a high reproductive capacity with a long period of oviposition; beetles can reinvade fields, which makes chemical control against the pest difficult if the first generation of beetle is not correctly controlled.
- *Epitrix* species are polyphagous (see question 6), which will help survival of adults. Host plants are very widely distributed with the presence of host plants year round.
- Symptoms are visible on tubers but the recognition of this is too late for effective treatment, therefore a population can establish before its presence is noticed. Symptoms associated coincident with *E. similaris* and *E. cucumeris* were not recognized easily in the first years of infestation in Portugal. The presence of adults is difficult to spot by non experienced people (Vernon et al., 1990): the threshold for treatment against the 1st generation of *E. tuberis* in Canada is only 1 adult observed in 60 plants. Adults have a dormancy period in the soil or plant debris during which they can not be detected.
- Efficient plant protection products for the control of *Epitrix* are available in the PRA area, but it will not be possible to treat some host plants (e.g. in the wild). Resistance to insecticide was observed in *E. cucumeris* (Kring, 1958; Morrisson et al., 1967) which questions the sustainability of chemical control of the pest.

1.25 - How likely is the reproductive strategy of the pest and the duration of its life cycle to aid establishment?

likely

Level of uncertainty: low

Comments:

Epitrix spp. only reproduces sexually but its reproductive rate is high. One overwintering female of *E. tuberis* can lead to the presence of up to 20000 larvae by the end of the growing season in British Columbia (Noronha *et al*., 2008). Depending on the species there can be up to 3 generations per year.

1.26 - How likely are relatively small populations to become established?

likely

Level of uncertainty: medium

Comments:

In principle, one male and one female should be sufficient to start a population.

1.27 - How adaptable is the pest? Adaptability is:

moderate

Level of uncertainty: medium

Comments:

Adults of *E. tuberis* and *E. cucumeris* were recorded from plants as diverse as cabbage, cucumber, Beta, lettuce, maize, Phaseolus, and various weeds when the preferred solanaceous hosts are absent (EPPO 1990 and 2005). In Azores (PT), *E. cucumeris* was collected by beating technique and malaise trap on citrus, banana, apple and pear plantations (Santos *et al.,* 2009) but the collecting methods used do not allow for evidence that they would feed on these plants.
E. cucumeris is found in a large part of North America as well as in Central and South America (see answer to question 7). It seems, therefore, to be able to adapt to different types of climates. *E. subcrinita* is present both in North-western USA and in different areas of Peru, which have different climates. *E. tuberis* has a more limited range (see answer to question 7), and *E. similaris* has only been reported in California (Gentner, 1944) and in Portugal.
E. cucumeris has shown resistance to insecticides (Kring, 1958; Morrisson *et al.,* 1967). IRAC (Insecticide Resistance Action Committee) lists it as a pest with high risk of resistance to cyclodiene organochlorines which are GABA-gated chloride channel antagonists (http://www.pesticideresistance.org/search/22/8/)
All species have dormancy in soil in the adult stage, which allows them to survive when conditions are not favorable.
E. cucumeris is reported to have only one generation per year (Senanayake *et al*. 1993). Although no detailed study was conducted, it seems that *Epitrix* species present in Portugal have more than one generation per year, beetles being observed between early spring to late autumn (Oliveira, pers. comm. 2010).

E. cucumeris seems more adaptable than the other species on the basis of current known distribution and host range, and insecticide resistance.

1.28 - How often has the pest been introduced into new areas outside its original area of distribution?
rarely
Level of uncertainty: low
Comments:
Gentner (1944) reports that *E. tuberis* was first found in Northern Colorado in 1904. It then spread to western Nebraska and Washington State where control measures were needed from the late 1920's. It also spread to Oregon where it caused economic damage around 1935. In 1972, Seeno & Andrews noted its presence in Idaho, Arizona, New Mexico, Wyoming, California.
E. tuberis became a significant pest of potatoes in British Columbia in the 1940s (Glendenning & Fulton, 1948), particularly in the lower Fraser Valley near Vancouver, and the interior regions including the Okanagan, Similkameen and Kootenay valleys (Vernon, pers. comm. 2010).
Elliott (2009) notes that *E. tuberis* was first reported in Alberta in 1974, but it has not yet become a significant pest there.
Typical *E. tuberis* damage on tubers was observed in 2004 in mainland Portugal, but since *E. tuberis* has never been identified from samples associated with these fields, it is not known if this species is actually present in Portugal. Where damage has been reported on tubers in potato fields in Portugal, *E. similaris* but not always *E. cucumeris* have been collected and positively identified (Germain & Boavida, 2009).
E. cucumeris has been introduced to the Azores Islands (PT) where it was first found circa 1979 (Gruev, 1981). It was also introduced into mainland Portugal and found in potato fields (positively identified in 2008).
E. similaris was introduced into Portugal and found coincident with potato damage (positively identified in 2008) (Germain & Boavida, 2009).

1.29a - Do you consider that the establishment of the pest is very unlikely ?
no
Comments:
The pest is already established in Portugal.

1.29c - The overall probability of establishment should be described.
Establishment has already occurred for *E. similaris* and *E. cucumeris* in a limited part of the PRA area (Portugal). The overall probability of establishment in other areas is high with a low uncertainty for the following reasons: hosts are abundant, environment is favorable for establishment, current management practices are not expected to prevent establishment.

Stage 2: Pest Risk Assessment - Section B: Probability of spread

1.30- How likely is the pest to spread rapidly in the PRA area by natural means?
moderately likely
Level of uncertainty: high
Comments:
Some authors (e.g. Glendenning & Fulton, 1948, Fulton & Banham, 1962) note that *Epitrix* beetles can fly freely on fine days and cover long distances when searching for their hosts. Some others (e.g. Elliot 2009), referring to *E. cucumeris,* say that "the beetle jump actively, particularly when disturbed, but they seldom, if ever, fly". Döberl (1994) cited by Bennen, 2005 mentions trade wind as a possibility to explain the spread of *E. hirtipennis* in Italy, Greece and Turkey (in addition to spread with trade) but this is not supported by other references.

1.31 - How likely is the pest to spread rapidly in the PRA area by human assistance?
likely
Level of uncertainty: medium
Comments:
Spread within the EPPO region can occur with the movement of plant or plant products with soil attached (e.g. plants for planting, potato tubers).

The only information to support that the spread is likely to be rapid is derived from the experience with the outbreak in Portugal: Within the space of 4 years (between 2004 and 2008) tuber damage associated with *E. similaris* has been detected in the northern part of Portugal, Porto, and then southward to Setubal, the two cities being approximately 300 km apart. The spread of damage to the North seems much more limited (ca 100 km) (Oliveira, *et al.*, 2008). It is difficult to know which part of this spread is due to natural spread or to human-mediated spread. No further spread was reported in 2008 (Boavida, pers. comm., 2010). Natural speed of dispersal can not be directly extrapolated from these observations, as the pest may have been present and spread for several years before damage was first noticed. In addition reports may have been more numerous after the pest was identified (in 2008) and public awareness rose.

1.32 - Based on biological characteristics, how likely is it that the pest will not be contained within the PRA area?

unlikely

Level of uncertainty: low

Comments:

As natural spread seems to be limited, specific measures applied to the movement of potatoes or other host plants could help contain the pests.

1.32c - The overall probability of spread should be described.

Comments:

Spread occurred in Portugal: over the last 4 years damage was observed in areas up to 300 km away place where the pests are presumed to have been introduced (Porto).
Probability of spread is high with a medium uncertainty.

Stage 2: Pest Risk Assessment - Section B: Conclusion of introduction and spread and identification of endangered areas

1.33a - Conclusion on the probability of introduction and spread.

Comments:

E. similaris and *E. cucumeris* have already entered and established in a limited part of the PRA area (Portugal). The overall probability of establishment in other areas is high for the following reasons: hosts are abundant, environment is favorable for establishment, current management practices are not expected to prevent establishment. It is considered that other *Epitrix* species have a similar probability of introduction.

Spread occurred in Portugal when no phytosanitary measures were applied.
From the current data (Boavida & Germain, 2009), *E. cucumeris* appears less widespread than *E. similaris*, but the data was based on a reduced number of samples taken and not on a country-wide survey.
Probability of spread is high.

1.33b - Based on the answers to questions 1.15 to 1.32 identify the part of the PRA area where presence of host plants or suitable habitats and ecological factors favour the establishment and spread of the pest to define the endangered area.

Comments:

The endangered area is the entire PRA area for at least one of the species. It is difficult to assess where each species would establish because of the current uncertainties of the pest distribution in North America (especially *E. similaris*) [see answer to question 7].

E. similaris is only known to be present in California and Portugal. If this limited distribution is due to climatic requirements, its establishment in Northern Europe is not likely, and the endangered area will be limited to the Mediterranean countries.
E. cucumeris has a very wide distribution. Its establishment in Azores and Portugal indicate that it could readily find suitable climatic conditions in the Mediterranean part of the EPPO region. Considering its distribution in Eastern North America, one could expect it to establish in all of the potato-growing areas of

central and northern Europe.

E. tuberis is present in the north western part of North America, from North California (USA) to British Columbia (Canada). The climate there is quite similar to the EPPO region, except in the Mediterranean Basin.
E. subcrinita species is present in the north western part of North America, from South California (USA) to British Columbia (Canada), as well as in Peru. The CLIMEX comparison of climate shows that this pest could find a similar climate in the entire EPPO region.

Stage 2: Pest Risk Assessment - Section B: Assessment of potential economic consequences

2.1 - How great a negative effect does the pest have on crop yield and/or quality to cultivated plants or on control costs within its current area of distribution?

major

Level of uncertainty: low

Comments:

Most of the negative impact by *E. cucumeris* and *E. similaris* is due to the impact on cosmetic quality, as *Epitrix* damage does not affect gustative quality. In Canada, IPM programs are designed to have less than 5% of tubers with symptoms. Leaf damage can also lead to a yield reduction, in particular if potato plants are already stressed by defoliation due to other pests or by drought.

E. tuberis is a major pest of potato and is considered the most damaging flea beetle on potato in the Pacific Northwest region of North America, as larvae feed on tubers and roots and damage the skin and surface layers of the tubers. The last generation of larvae causes the most economic damage by feeding on mature tubers. The nature of larval feeding where holes are made up to 1 cm into the tuber flesh cause problems in ware potatoes for home consumption and processing, particularly chips (Hoy *et al*, 2008). In potatoes with thin skin, larval feeding may be a combination of surface channels and holes into the tuber. All commercial varieties in the Pacific Northwest are attacked by *E. tuberis*. Even if the pest is well known, complete crop loss occurs in British Columbia if no or insufficient measures are applied (Vernon, pers. comm., 2010; Miller *et al.,* 2008). Damaged potatoes are downgraded and heavy infestations may result in complete crop loss. Insecticide treatments are generally applied against this pest, targeting the first generation. When the first generation is not correctly controlled, up to 7 insecticide treatments may be required during the growing season (Gentner, 1944; Fulton & Banham, 1962; EPPO, 1990; Ferro & Boiteau, 1993, Vernon & Mackenzie, 1991; Noronha *et al*., 2008; Hollingsworth, 2009).

E. cucumeris. Damage results mainly from adults feeding on leaves and larvae feeding on roots. Damage on tubers is discussed but may be of economic concern under certain conditions (Hill, 1948; Morrisson *et al.,* 1967; Granovsky & Peterson, 1954). Foster & Obermeyer, 2009, describe that larval feeding on potato tubers may cause roughness, pits, and trails on the surface or in the tuber itself.
In Portugal, tuber damage observed is only in the form of superficial channelling, but it is not conclusively known if this damage is due to *E. cucumeris* or *E. similaris*. Where damage has been reported on tubers in potato fields in Portugal, *E. similaris* but not always *E. cucumeris* have been collected and positively identified (Germain & Boavida, 2009).
Epitrix-related damage to tubers was observed on a range of common European varieties (Désirée, Spunta, Mona Lisa, Stemster, Agria, Asterix) with no obvious differences.
Yield loss due to foliar damage by *E. cucumeris* occurs when there is high flea beetle density. In the case of simultaneous attacks by Colorado beetle or drought stress, losses may be important (Senanayake *et al.,* 1993; Hoy *et al.*, 2008). In Canada, yield losses up to 15% have been reported on Russet Burbank cultivar (Senanayake *et al.,* 1993). *E. cucumeris* is considered the most common destructive flea beetle in Indiana (Foster & Obermayer, 2009) but a minor pest in other states like Maryland and New York. It is considered a major pest of potato in Bolivia (Anonymous, 1996). In the Azores (PT) *E. cucumeris* is not considered as a pest of potato or other crops (Borges, pers. comm. 2010).

E. similaris is only present in California. Gentner (1944) reports that *E. similaris* is one of the most economic species of flea beetles in California, in particular on tomato plants, but Lange & Bronson (1981)

mention *Epitrix* spp. only as secondary pests of tomato.
In Portugal, tuber damage is observed (but it is not conclusively known if this is due to *E. cucumeris* or *E. similaris*). Damage is only superficial (serpentine wormtracks several 2-5 cm long and punctures) but this damage resulted in lot rejection at export (Silva, 2008). Such damage was observed on a range of common European varieties (Désirée, Spunta, Mona Lisa, Stemster, Agria, Asterix) with no obvious differences. There is no detailed data on the crop losses, nor on the increase of control cost in Portugal.

E. subcrinita
Damage due to *E. subcrinita* to potato tubers is discussed: Glendenning & Fulton (1948) state that in British Columbia, it feeds chiefly on root fibres and causes little damage. Hoy *et al.*, 2008 note that larvae of *E. subcrinita* burrow just under the peel and seldom penetrate over ¼ inch (i.e. 0.6 cm), which does not necessarily make the tuber unsuitable for processing.
E. subcrinita is considered as a major pest of potato in Peru (Anonymous, 1996). Alcazar (1997) notes that in Peru, the pest causes small holes in the tubers and in the case of severe attacks may cause sinuous canals under the epiderm on the surface of the tuber.

Epitrix sp. are included in crop management guidelines for sugarbeet: Hirnyck & Downey (2005) report that *E. cucumeris* is responsible for leaf damage caused by adult feeding, root damage by larvae being minor; Hollingsworth (2009) reports damage by *E. tuberis* and *E. subcrinita*. *Epitrix* sp. are also included in crop management guidelines for tomato (Hollingsworth, 2009), Capsicum (Hollingsworth, 2009), eggplant (Maletta *et al.*, 2004) but there is no quantification on the level of damage.
All species can transmit or favor pathogen entry which may have an additional negative impact on yield: Ferro & Boiteau (1993) note that "damaged tubers are often invaded by soft rot bacteria or *Fusarium* dry rot fungi", Hoy *et al*., 2008 report that "flea beetles can transmit potato pathogens, such as the Spindle tuber viroid and bacteria, and leaf wounds caused by their feeding may allow additional pathogens to enter the plant. The following viruses have been reported as transmitted by *Epitrix* sp.: *Physalis mottle virus* PhyMV on tomatillo (*Physalis ixocarpa*)(Can et al, 1994); *Andean potato latent virus* on potato (experimental works, Jones & Fribourg (1977).

2.2 - How great a negative effect is the pest likely to have on crop yield and/or quality in the PRA area without any control measures?
major
Level of uncertainty: low
Comments:
Without any control measures, it can be expected that damage on potato would be major, similarly to what was observed in Portugal and in North America. In Portugal up to 2008, no specific control measures were applied and some potato lots were downgraded as a consequence of *Epitrix* symptoms on tubers, and resulted in complete crop losses (Oliveira *et al.*, 2008; Silva, 2008).

In Canada IPM programs are designed to have less than 5% of tubers with symptoms. However in Europe, quality standards appear much stricter but may vary with market demand. According to Rules on inter-European trade in potatoes (RUCIP, 2006), "cracks, fissures, cuts, bites, bruises, pricks" are allowed for ware potatoes within a tolerance of 6% by weight if they are deeper than 5 mm, and allowed if less than 5 mm. Commercial contracts exist governing quality requirements between buyer and supplier and can vary between seasons and are affected by availability of products.
Superficial blemishes are a particular concern for washed potatoes entering the domestic market. *Epitrix* damage would be another, and very conspicuous element added to the list of superficial damage.

Epitrix spp. have the potential to cause losses in non commercial solanaceous production (backyard potato production for example, or ornamental species in amenity areas).

2.3 - How easily can the pest be controlled in the PRA area without phytosanitary measures?
with some difficulty
Level of uncertainty: low
Comments:
If no phytosanitary measures are taken on the main pathways (seed potatoes, ware potato, plants for

planting) the pests will spread further as observed in Portugal, or as was observed with *E. tuberis* spread in North America (see answer to 1.28). When damage is observed on tubers, populations are already high and establishment has probably already occurred.

As noted in the answer to questions 1.23 and 2.4, efficient plant protection products currently exist and if well-timed treatments are applied (i.e. targeting the first generation of adults), they are likely to reduce the risk of economic damage by *Epitrix* down to an acceptable level. However this requires a monitoring programme to be in place.
In addition, crop protection practices in the EPPO region are variable. No insecticide treatments are performed in some areas of the EPPO region (e.g. where Colorado beetle is not present, or aphid pressure is low) and in backyard gardens or small farms where most production is for personal consumption. Additional sprays to control *Epitrix* spp. would, however, be necessary in potato growing regions, and in particular very early in the growing season. Control of flea beetles might be more challenging in areas where potatoes or other solanaceous plants are cultivated nearly all year long thanks to mild climates (e.g. Portugal, Italy - Pedersen *et al*., 2005).
It is worth noting that the insecticide armory is much larger in North America than in the EU (e.g. in-furrow application of granular systemic insecticides which are considered most efficient in North America, are no longer registered in EU), see answer to question 1.23 for details. The process of re-evaluation of plant protection products may further limit the availability of some active substances (PSD, 2008). Hoy *et al.*, 2008 underlined that the decrease of active substances available in North America makes the control of flea beetles more challenging: "in the past, broad-spectrum insecticides applied to control Colorado potato beetles and aphids usually kept flea beetle populations in check. With increased dependence on systemic insecticides for the control of the Colorado potato beetle, flea beetle populations requiring control occur more frequently. In the eastern United States and Atlantic Canada, monitoring is recommended in June and then again from late July through August".

Research will be necessary to identify the most effective active substances, define the best timing of treatments and find alternative control strategies for the EPPO region.
Current good potato production practices which are encouraged to control other pests and diseases (potato blight, Colorado beetle) will help manage flea beetles, including: crop rotation, proper management of culls and volunteers in the field.
Control in organic production or in ecological friendly production would be more challenging. In Western USA, growers manage *E. tuberis* by planting far from sources such as winter potatoes and solanaceous weeds. Growers also carefully monitor and take control measures along their field borders. By making extra high hills at the base of potato plants, growers make oviposition more difficult for the beetles (Miller, *et al*., 2008)

Organic potato production is increasing in the EU (see Table 6 Eurostat, 2010) although quite limited (about 15000 ha out of 2 million, i.e. less than 1% of the area).
In addition, host plants are present in the wild (weeds) and in gardens where no measures are applied.

Table 6. Surface (in ha) for organic production of potato (including early and seed potatoes) in the EU (Eurostat, 2009)

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Belgium	:	:	:	:	:	:	101	193	195	223	262	:
Bulgaria	:	:	:	:	:	:	:	:	:	14	21	10
Czech Republic	:	:	:	:	:	:	:	114	:	96	220	238
Denmark	:	756	935	1099	973	892	1030	1073	892	968	1072	1268
Germany	:	:	:	:	:	:	:	:	:	:	:	:
Estonia	:	:	:	:	:	:	:	:	254	241	213	187
Ireland	:	:	:	:	:	:	:	:	:	:	:	:
Greece	:	7	:	:	:	47	42	29	9	103	29	100
Spain	:	:	:	:	:	:	:	:	:	:	:	:
France	:	580	:	:	:	:	:	:	:	:	:	901
Italy	:	:	693	797	1723	23411	888	1203	1361	1219	1326	1013

Cyprus	:	:	:	:	:	:	:	7	7	7	7	:
Latvia	:	:	:	:	:	:	:	705	5358	1375	1394	1185
Lithuania	:	:	:	:	:	:	:	390	419	512	420	365
Luxembourg	:	12	14	14	18	17	20	22	:	:	:	:
Hungary	:	:	:	:	:	130	114	58	:	:	46	69
Malta	:	:	:	:	:	:	:	0	0	0	:	:
Netherlands	:	820	920	1216	1310	1175	1175	1175	:	1281	1227	1271
Austria	:	:	1587	1652	:	2019	:	2162	2301	2426	2827	:
Poland	:	:	:	:	:	:	:	:	1376	1127	1591	1861
Portugal	:	:	:	:	:	:	:	:	0	:	:	:
Romania	:	:	:	:	:	:	:	:	:	15	:	142
Slovenia	:	:	:	:	:	:	:	100	76	83	74	71
Slovakia	:	:	:	:	:	:	24	77	17	37	129	39
Finland	:	:	:	:	:	:	:	:	:	:	:	284
Sweden	:	1007	:	1569	1296	:	:	:	:	734	838	920
United Kingdom	:	:	:	2081	:	:	1776	2050	2040	2360	2873	3270
Norway	:	144	162	166	189	195	190	180	179	175	210	230
		3326	**4311**	**8594**	**5509**	**27886**	**5259**	**9231**	**14289**	**12663**	**14276**	**13176**

2.4 - How great an increase in production costs (including control costs) is likely to be caused by the pest in the PRA area?

major

Level of uncertainty: low

Comments:

In Europe, insecticide treatments are applied against aphids and/or Colorado beetle (see question 1.23) and may partially control the pests. Specific surveillance (to identify the best treatment period) and additional sprays will be needed, and in particular early in the growing season.

If these pests are to become established, growers will probably apply insecticides at high frequency at least in the first years, to be sure not to have quality problems, as growers might not be ready to accept the risk of IPM. Vernon & Mackenzie (1991a) note that the routine 10-day spray schedule would not be adequate to control high overwintered beetle populations, and pyrethroids should be applied every 7 days for a good efficacy, whereas organophosphates should be applied every 4 days. Applications of pyrethroids make aphid management more difficult and can lead to outbreaks of spider mites (Hollingsworth, 2009)

Time and money will be needed before IPM programs are adapted to European and Mediterranean conditions, and will imply an additional cost for surveillance/monitoring (scouting) and advice. Action thresholds will likely vary greatly in different areas, depending on the species involved: Hoy *et al.*, 2008 note that "*The relationship between the number of flea beetle shotholes per leaflet and potato yield is quite variable, and thus recommended action thresholds are variable. In Atlantic Canada, an action threshold of 50 shotholes per leaflet is considered conservative, but an action threshold of 15 is recommended in Maine. The recommendation on Prince Edward Island is to estimate the area of defoliation caused by shotholes: less than 5% of leaf surface with shotholes is considered low, 5-10% is moderate, and more than 10% is high. Management action is recommended if the average defoliation is greater than 10%*".

In other regions (e.g. zones where Colorado beetle is not present), insecticides are not generally used and sprays for *Epitrix* will greatly increase production cost.

Extending crop rotation is an effective measure (Kabaluk & Vernon, 2000), and it has been found that *E. tuberis* populations increase linearly with years fields are not rotated. For some growers, the need to rotate fields more frequently would have an economic impact. To be truly effective, rotation should be applied over a large area, and volunteer potatoes would have to be removed.

It is not known how much production costs increased in Portugal.

2.5 - How great a reduction in consumer demand is the pest likely to cause in the PRA area?
moderate
Level of uncertainty: medium
Comments:
Seed potato
It is likely that demand for seed potatoes coming from countries where the pests are present will decrease or seed exporters will be asked to justify and give the proof of *Epitrix* free seeds. Eventually, it is possible that seed potato production is relocated to countries where the pests are not present.

Potato for consumption
Potato is an important food in many EPPO countries (EU, 2007). No reduction in potato consumption is expected but supermarkets will not buy potatoes with symptoms. The same is the case for the processing industry.
Production costs may increase (or shortage in potato supply may occur), which can result in consumer reduction.

In Western Europe and in other developed areas, the demand for table potatoes is falling because of several factors (competition with substitute products such as rice and pasta, consumers have less time for home-prepared meals, etc). The share of washed tubers is increasing, which makes the visual appearance of tubers more important. On the other hand, the consumption of processed potato products has been gaining ground (EU, 2007).

Potatoes for the fresh market, in particular in northern Europe, have more and more quality requirements. In Portugal, damaged tubers could not be marketed (Oliveira *et al.*, 2008; Silva, 2009). For local market in Portugal potato tubers are not washed, therefore cosmetic damage has less influence on the consumers than in other EU countries.

Sensitivity of consumers to plant protection products is an increasing trend. Organic production of potato may be affected by the presence of new pests such as *Epitrix* species.

2.6 - How important is environmental damage caused by the pest within its current area of distribution?
minimal
Level of uncertainty: low
Comments:
No direct environmental damage is reported in the literature.

2.7 - How important is the environmental damage likely to be in the PRA area?
minimal
Level of uncertainty: high
Comments:
No environmental problems have been reported so far from mainland Portugal or Azores.

2.8 - How important is social damage caused by the pest within its current area of distribution?
minimal
Level of uncertainty: low
Comments:
No social damage recorded currently.

2.9 - How important is the social damage likely to be in the PRA area?
minor
Level of uncertainty: high
Comments:
In areas where the profitability of potato production is marginal, the additional management options required may lead to abandonment of potato production. *Epitrix* symptoms may result in an unmarketable crop and affect the viability of a potato enterprise. This will particularly be an issue for organic production.
Social impact was considered minor with a high uncertainty at the level of the PRA area because it was

considered that profitability of potato production will be affected only in some places.

2.10 - How likely is the presence of the pest in the PRA area to cause losses in export markets?
very likely/certain
Level of uncertainty: low

Comments:
Even if *E. similaris* is not mentioned in the regulations, presence of symptoms on tubers will cause rejections, because it is not possible to distinguish the species on the basis of symptoms.

E. tuberis is a quarantine pest in a number of EPPO countries: at least in Kazakhstan, Israel, Jordan, Morocco, Russia, Serbia, Tunisia, Turkey, and Ukraine as well as in Peru.
E. cucumeris is a quarantine pest at least in Kazakhstan, Jordan, Morocco, Russia, and Tunisia.

Most EPPO potato production for consumption is traded within the region - 87% for main crop potatoes in 2004/05 (EU, 2007) but the pest has the potential to restrict the movement of potatoes within the region.
Seed potatoes: EU-15's total trade of seed potatoes amounted to about 822 000 tons in the average of the period 2004/05, of which 45% are originated by exports and 55% by intra EU-15 trade. EU-15 exports are more fluctuating than intra-EU trade. The main destination markets are situated in North Africa, *in primis* Egypt and Algeria that receive 35–40% of EU exports (EU, 2007)

2.11 - How likely is it that natural enemies, already present in the PRA area, will not reduce populations of the pest below the economic threshold?
very likely
Level of uncertainty: low
Comments:
Natural enemies did not reduce population of the pest below an economic threshold in Portugal.
Few natural enemies are reported in the native area (see answer to question 1.21)

2.12 - How likely are control measures to disrupt existing biological or integrated systems for control of other pests or to have negative effects on the environment?
likely
Level of uncertainty: medium
Comments:
Pyrethroids are broad-spectrum insecticides and may affect natural enemies. Applications of pyrethroids make aphid management more difficult and can lead to outbreaks of spider mites (Hollingsworth, 2009), which can disrupt IPM.

2.13 - How important would other costs resulting from introduction be?
moderate
Level of uncertainty: low
Comments:
Additional costs include the cost for research to find appropriate control methods (e.g. IPM, biological control), extension (advice to producers), monitoring of the pests to target treatments and evaluate its spread, public awareness.

2.14 - How likely is it that genetic traits can be carried to other species, modifying their genetic nature and making them more serious plant pests?
Impossible/very unlikely
Level of uncertainty: low
Comments:
There are no known examples of such events on flea beetles in the available literature.

2.15 - How likely is the pest to cause a significant increase in the economic impact of other pests by acting as a vector or host for these pests?
likely
Level of uncertainty: low

Comments:

Epitrix spp. are vectors of virus and bacteria, and leaf wounds may allow the entry of airborne or waterborne disease organisms (Can *et al*, 1994.; Christie *et al*, 1993; Ferro & Boiteau, 1993; Foster & Obermeyer, 2009)

2.16 - Referring back to the conclusion on endangered area (1.33) :
Identify the parts of the PRA area where the pest can establish and which are economically most at risk.

Comments:

Epitrix species could establish throughout the PRA area: *E. cucumeris* and *E. subcrinita* could probably establish in the entire PRA area, but *E. similaris* will probably only establish in Mediterranean countries whereas *E. tuberis* could establish in most of the EPPO region in the Mediterranean Basin Potato and other host crops are economically important throughout the PRA area, which is therefore at risk. It may be noted that the economic impact associated to *E. tuberis* appears higher than for the other species.

Stage 2: Pest Risk Assessment - Section B: Degree of uncertainty and Conclusion of the pest risk assessment

2.17 - Degree of uncertainty: list sources of uncertainty

Origin of the Portuguese outbreak.
Species distribution and pest status (presence of *E. similaris* in North America, pest status of *E. cucumeris*)
Data of other species of *Epitrix*
Species responsible for damage in Portugal
Biology and population dynamics of *Epitrix*, in particular *E. similaris* (number of generations, capacity of dispersal, adaptability, building of small population)
Host range, in particular impact in tomato
Difference of behaviour in North America and Europe.

2.18 - Conclusion of the pest risk assessment

Potato and other host plants of *Epitrix* species are widely grown across the EPPO region, both as commercial crops and in gardens. The pests are likely to be moved undetected in soil attached to plants or plant products.
Considering its host plants and its area of origin, it is likely that *E. cucumeris, E. similaris, E. subcrinita* and *E. tuberis* can establish in the EPPO region. Control is possible but will increase production costs in commercial production. Control in non commercial production will be problematic and will maintain a certain level of pests. As *Epitrix tuberis* is quarantine pest in numerous countries worldwide, this may affect export markets.
The economic impact if introduced in the EPPO region is evaluated as high by the EWG.

The other pathways are considered to present lower risk, and the EWG recommended that they should not be considered for risk management at this stage but might be reconsidered if necessary. In particular Solananaceous plants for planting with soil attached may pose a risk of introduction and spread within the EPPO region but it is difficult to evaluate because of the lack of data.

Stage 3: Pest Risk Management

3.1 - Is the risk identified in the Pest Risk Assessment stage for all pest/pathway combinations an acceptable risk?
no

The two main pathways (P*otato tubers for planting with soil attached originating from areas where the pests occur*, and *Potatoes for consumption with soil and plant debris attached originating from areas where the pests occur*) are considered together as most of the answers are valid for both of them. When necessary, specific answers are given for each pathway.

3.2 - Is the pathway that is being considered a commodity of plants and plant products?
yes

3.12 - Are there any existing phytosanitary measures applied on the pathway that could prevent the introduction of the pest?
no

Comments:

Seed potatoes coming from outside of the EPPO region

Prohibition of import of seed potatoes from outside of the EPPO region exist for many countries in the EPPO region (e.g. for the EU in the Plant Health Directive 2000/29 (EU, 2000)), but some minimal trade may exist: e.g. in the EU regulation, a derogation exists for seed potatoes from certain provinces of Canada (EU, 2003; EU, 2008), see also answer to question 1.5. This derogation does not include any specific requirements that would ensure freedom from *Epitrix* species.
E. tuberis and *E. cucumeris* are quarantine pests for a certain number of countries in the EPPO region (e.g. Russia and CIS countries, Israel, Jordan, Morocco, Serbia, Tunisia, Turkey) but not for countries in the EU.
EPPO Standard PM 8/1 (EPPO, 2004) recommends that seed potatoes coming from countries where *E. tuberis* and *E. cucumeris* are present should be practically free from soil (tolerance of 0.1% for soil).

Seed potatoes originating from infested areas in the EPPO region (e.g. Portugal)

Most seed potato producing countries require that marketed seed potatoes are officially certified and within the EU, a mandatory certification scheme (EU Directive 66/403/EEC) is in place for seed potatoes (Reed *et al.*, 2002). The label given under the seed potatoes legislation also functions as a plant passport which is the guarantee that phytosanitary requirements for internal movement within the EU of seed potatoes are fulfilled. These involve inspections during the growing season, and inspection of tubers as well as a soil tolerance of 2%, but there is no specific mention of *Epitrix* species.
For some EPPO non-EU countries, requirements for *E. tuberis* and/or *E. cucumeris* exist, as they are quarantine pests.

These current phytosanitary measures applied in the EU are not considered sufficient to cover the risk.
There are no specific phytosanitary measures for *E. similaris* or *E. subcrinita* in the EPPO region.

Potatoes for consumption with soil and plant debris attached originating from areas where the pests occur

Prohibition of import of ware potato from outside the EPPO region exists for many countries in the EPPO region.
In the EU, import of tubers of species of *Solanum* L., and their hybrids is prohibited from third countries other than Algeria, Egypt, Israel, Libya, Morocco, Syria, Switzerland, Tunisia and Turkey, and other than European third countries which are recognised as being free from *Clavibacter michiganensis* ssp. *sepedonicus* (Plant Health Directive 2000/29 (EU, 2000)).

Some bilateral agreements may exist: for example, import of ware potatoes from USA to Russia is allowed provided that:
1. each potato consignment shall be free from the pests;
2. each potato consignment shall not contain soil and plant debris;
3. potatoes shall be exported in new boxes or new bags on which there will be stated the consignment composition and origin;
4. each potato consignment shall be accompanied by a Phytosanitary certificate;

5. in the "additional declaration" of the PC there shall be a statement that the potato consignment is free from *E. tuberis,* and *E. cucumeris* (Russian NPPO, 2010)

EPPO Standard PM 8/1(EPPO, 2004) recommends that ware potatoes coming from countries where *E. tuberis* and *E. cucumeris* are present should be substantially free from soil (tolerance of 1% for soil).

Within the EU
The potato producers (or a collective, warehouse or dispatching facility) who market potatoes have to be registered and consignments labelled with the registration number (Plant Health Directive 2000/29 (EU, 2000) point 18.5)
Existing phytosanitary measures in the EU do not address the risk associated with movement of potatoes from Portugal.

3.13 - Can the pest be reliably detected by a visual inspection of a consignment at the time of export, during transport/storage or at import?
no
Comments:
Adults may be detected but not larvae and pupae. Adults are small (less than 2 mm) and black so they will not be easily observed because of the presence of soil, but they are visible if they are looked for specifically.
Adults are not active at 5° C which is the usual temperature for storage of certified seed potatoes, and detection will therefore be more difficult. In addition, seed potatoes are not washed, so symptoms are more difficult to detect.

Potato tubers for consumption may be transported and stored at a warmer temperature, and adults may not be dormant which makes detection easier, but it is likely that there will be more soil attached to tubers for consumption than to seed potatoes, and tubers for consumption are often transported in bulk. Therefore detection will be more problematic.

Absence of damage symptoms or non detection of the pest is not sufficient to ensure that the consignment is free from the pest.

3.14 - Can the pest be reliably detected by testing (e.g. for pest plant, seeds in a consignment)?
No

3.15 - Can the pest be reliably detected during post-entry quarantine?
no
Comments:
Adults were observed on the surface layers of ware potatoes in storage rooms in Portugal at 10°C, 2 months after harvest and it was possible to trap them on a trap plant (e.g. potato) (Boavida, pers. comm. 2010). So if temperature is raised to a temperature at which adults are active, it will be possible to observe them.
Nevertheless this is not practical as keeping seed potatoes at such temperatures will affect their germination ability, and such measure will not be practical nor economical for potato for consumption.

3.16 - Can the pest be effectively destroyed in the consignment by treatment (chemical, thermal, irradiation, physical)?
yes
possible measure: specified treatment.
Comments:
Physical treatment: brushing and/or washing the tuber to remove practically all of the soil will remove all live stages of *Epitrix*. Studies are being conducted in the Netherlands that show that brushing and/or washing is efficient to make potato tubers practically free of soil (99.9%) (Runia, *et al.*, 2009). There is no study available to confirm that such a method applied under commercial conditions would be effective.
Washing is known to increase the risk of soft rot so careful management of the seed will be needed (Plissey, 1993).

Brushing and washing is common practice for ware potatoes before marketing in some countries (but it might be done once in the country of import).

Quarantine treatments against other potato pests may be applied post-harvest. In the USDA Treatment Manual (USDA, 2009), fumigation schedules with methyl-bromide are recommended for potato tubers against *Phthorimaea operculella, Ostrinia nubilalis* (Treatment T101-v-2) and *Graphognathus* spp*. (= Naupactus* spp*.)* (Treatment T101-u-2). A dosage rate of 3 lbs/1000 ft^3 ($48g/m^3$) for 0.5-2 hours at atmospheric pressure (Treatment T104-a-1) is considered efficient in destroying hitchhikers and surface pests on potato. EPPO Standard PM 3/13(1) *Methyl bromide fumigation of potatoes to control Phthorimaea operculella* recommends lower dosages of methyl-bromide (between 14 and 24 g m^{-3} according to temperature) for a longer time (6 to 14 hours).
Nevertheless such treatments may not be used in practice, as methyl-bromide is being phased out and its use is not favored in many EPPO countries, see IPPC Recommendation *Replacement or reduction of the use of methyl bromide as a phytosanitary measure* (FAO, 2008).

In some countries (e.g. USA), potato tubers may be irradiated to prevent sprouting (International Consultative Group on Food Irradiation, 1999) with dosage between 0.05 and 0.15 kGy. Such irradiation costs were estimated to range from US $10 to $15 per tonne in 1999. Saout & Makee (2004) showed that an irradiation treatment with doses between 0.1 and 0.15 kGy could affect larval development.of *Phthorimaea operculella.* It could be investigated if such treatments would be effective against *Epitrix* sp. Irradiation is not appropriate for use in seed potatoes.

Other treatments have been investigated against potato storage diseases and may also destroy insect pests (steam treatments, Afek & Orenstein, 2002; hot water dipping treatment, Ranganna *et al.*, 1998). These treatments could be investigated for effectiveness against *Epitrix* sp. They are unlikely to be appropriate for seed potatoes as they will damage them.

3.17 - Does the pest occur only on certain parts of the plant or plant products (e.g. bark, flowers), which can be removed without reducing the value of the consignment?
No. The pest is present in the soil attached to the tubers. It is possible to remove soil (see answer to 3.16).

3.18 - Can infestation of the consignment be reliably prevented by handling and packing methods?
yes in combination
possible measure in combination: specific handling/packing methods
Comments:
Containers/bags for transportation should be new or cleaned and disinfected. This will avoid (re)infestation of the consignment with pests that might remain from their previous utilisation.

3.19 - Could consignments that may be infested be accepted without risk for certain end uses, limited distribution in the PRA area, or limited periods of entry, and can such limitations be applied in practice?
no
Comments:
The only intended use of seed potatoes is to be planted.

Potato for consumption
It is possible to brush and/or wash tubers to remove soil in the importing country, provided the tubers are contained before and during the whole process of treatment, and that the wastes are properly disposed of. Importation occurring when temperatures are very low (<5°C) may reduce the risk of escape of adults. The EWG considered that there is a risk of escape of the pest.

3.20 - Can infestation of the commodity be reliably prevented by treatment of the crop?
no
Comments:
Insecticide treatment of the growing crop will lower pest pressure. Killing of haulms and leaving the crop for at least a week before harvesting will decrease the probability of adults remaining in the field. In the production of seed potatoes, regular insecticide treatments are applied to avoid aphid-transmitted viruses,

and these sprays will also control *Epitrix* species in the field. Nevertheless, there is always a risk that adults may reinfest fields from neighbouring areas and establish between aphid sprays. For potato for consumption, treatments are less frequent and only aim at reducing the population to an acceptable economic level.
Therefore chemical treatments are not fully reliable in ensuring crop freedom from *Epitrix*.

3.21 - Can infestation of the commodity be reliably prevented by growing resistant cultivars?
no
Comments:
Some cultivars show less damage than others (Hoy *et al.*, 2008 note that "early maturing cultivars, such as Superior, are less tolerant of late season feeding injury by flea beetles than later maturing cultivars such as Russet Burbank") but this does not necessarily mean that the number of dormant flea beetles or pupae in soil will be lower.
The possibility of transgenic potatoes altered for resistance to *E. cucumeris* was explored by Stewart *et al.*, 1999 but was not successful.

Choice of potato cultivar will probably be driven by other objectives than resistance to *Epitrix* species: e.g. resistance to *Phytophthora infestans,* or improved characteristics for processing.

3.22 - Can infestation of the commodity be reliably prevented by growing the crop in specified conditions (e.g. protected conditions such as screened greenhouses, physical isolation, sterilized growing medium, exclusion of running water, etc.)?
no
Comments:
Seed potatoes are mostly produced outdoors. Only minitubers are produced in greenhouses as high grade seed potatoes. It is not economically practical to produce all seed potatoes in greenhouses in the EPPO region.
Potatoes for consumption are only produced outdoor.

3.23 - Can infestation of the commodity be reliably prevented by harvesting only at certain times of the year, at specific crop ages or growth stages?
no
Comments:
Potatoes are usually harvested when there are *Epitrix* stages present in the soil.

3.24 - Can infestation of the commodity be reliably prevented by production in a certification scheme (i.e. official scheme for the production of healthy plants for planting)?
no
Comments:
Certification schemes are usually established to address viruses/pathogens that are transmitted by the mother plant. They do not address insect pests specifically, but general inspections required in this framework may allow the pest to be detected. This approach is considered under the option of “pest-free place of production” (see answer to question 3.28).

3.25 - Has the pest a very low capacity for natural spread?
no

3.26 - Has the pest a low to medium capacity for natural spread?
Yes (see answer to 1.30)
possible measures: pest-free place of production or pest free area.

3.28 - Can pest freedom of the crop, place of production or an area be reliably guaranteed?
yes
Comments:
Area freedom
Establishment of a pest free area should follow ISPM 4 (FAO, 1996) and EPPO Standard PM 3/61 *Pest-free areas and pest-free production and distribution systems for quarantine pests of potato* (EPPO, 2004).

This would normally include (depending on whether the PFA is established as the entire country or part of the country) for at least 2 years:
-Monitoring at harvest for *Epitrix* damage symptoms on tubers
-Monitoring of the growing crop for characteristic *Epitrix* shotholes on leaves
-Visual scouting of young potato crops and sweeping larger-sized potato plants for adults during the growing season
-Monitoring of alternative hosts (e.g. tomatoes) for foliage damage in commercial fields and backyard gardens

Pest free place of production
Given the lack of reliable information on capacity of natural spread of the pest by walking or flying, and the presence of potential wild hosts, it is not possible to define an adequate size for a buffer zone. No trapping methods are available so extensive monitoring of all fields and field margins will be necessary, which will not be economically viable.

3.29 - Are there effective measures that could be taken in the importing country (surveillance, eradication) to prevent establishment and/or economic or other impacts?
no
Comments:
It is possible to brush and/or wash tubers after import to remove soil, provided the tubers are contained before and during the whole process of treatment, and that the waste material is properly disposed of.
The EWG considered that there is a serious risk of escape of the pest at this stage.

3.31 - Does each of the individual measures identified reduce the risk to an acceptable level?
No. The measure requiring that containers for transportation should be new or cleaned and disinfected does not reduce the risk to an acceptable level on its own but will avoid (re)infestation with pest present in soil or plant debris.

3.34 - Estimate to what extent the measures (or combination of measures) being considered interfere with international trade.
Comments:
International trade of potato tubers is already prohibited and/or regulated for a number of pests in most countries of the EPPO region. In countries where *E. tuberis* or *E. cucumeris* are not quarantine pests (e.g. the EU), there are currently no requirements for *Epitrix* species.
Trade between EU countries will be more complicated from areas where the pests are established.
International trade will not be stopped but additional measures will be required that will likely result in some additional costs.
Brushing and/or washing of tubers will have to be done in the exporting country rather than in the importing country because of possible escape of the adults. The safe disposal of infested soil will require very special measures that are likely to be prohibitively expensive.

3.35 - Estimate to what extent the measures (or combination of measures) being considered are cost-effective, or have undesirable social or environmental consequences.
Comments:
Measures required will result in additional costs (especially for the establishment of Pest Free Areas as surveys, monitoring and inspections will be needed)
Brushing tubers is a measure already in use in some countries for removing excess soil. In such case there will be no additional cost.

3.36 - Have measures (or combination of measures) been identified that reduce the risk for this pathway, and do not unduly interfere with international trade, are cost-effective and have no undesirable social or environmental consequences?
yes
Comments:
The measures envisaged interfere with international trade, but not unduly.

Pathway 3: Soil or growing medium attached to rooted host plants (Solanaceae) from countries where the pests occur

3.1 - Is the risk identified in the Pest Risk Assessment stage for all pest/pathway combinations an acceptable risk?
no

3.2 - Is the pathway that is being considered a commodity of plants and plant products?
Yes. Solananaceous plants for planting with soil attached.

3.12 - Are there any existing phytosanitary measures applied on the pathway that could prevent the introduction of the pest?
Not for all situations.

Plants of Solanaceae are generally subjected to measures in the PRA area, but these measures are not targeting *Epitrix* species. The measures would ensure general inspections for a PC, but detection of the pest would be difficult for dormant stages (adults, pupae) in the soil.

Measures in place
For the EU, import of plants for planting of *Solanaceae* is prohibited (except from European countries and countries in the Mediterranean region) (EU Directive 2000/29/EC). This pathway is also closed for Norway and Switzerland.
The pathways seem to be open for some countries in the PRA area from some origins (checked from EPPO collection of phytosanitary regulations summaries, for non-EU countries, 1999 to 2003 depending on countries), with phytosanitary requirements against other pests.
- Albania, Jordan, Moldova, Morocco, Tunisia (general requirements for all plants)
- Algeria (general requirements for all plants, free from *Xanthomonas vesicatoria* for tomato, free from stolbur phytoplasma for all Solanaceae plants).
- Israel (general requirements for all plants, prohibition for all plants for planting (except seeds, bulbs and tubers) originating in tropical or subtropical countries)
- Kyrgyzstan (general requirements for all plants and freedom from A1 A2 pests, specific requirements for Solanaceae plants in relation to several pests)
- Russia (general requirements and specific requirements for all plants in relation to specific pests)
- Turkey (general requirements for all plants, and specific requirements for *Solanaceae*, tomato and *Capsicum annuum*)
- Ukraine (general requirements for all plants and freedom from A1 A2 pests)

There are no specific phytosanitary measures for *E. similaris* or *E. subcrinita* in the EPPO region.

Within the EU
Existing phytosanitary measures in the EU do not address the risk associated with movement of Solananaceous plants for planting with soil attached from infested zones within EU (i.e. Portugal, Spain)

3.13 - Can the pest be reliably detected by a visual inspection of a consignment at the time of export, during transport/storage or at import?
Yes in combination
Comments:
Larvae and pupae are in the soil and therefore will not be easy to observe.
Adults may be detected. They are small (less than 2 mm) and black, and jump if disturbed. Adults are not active at low temperature (e.g. 5° C) and may then be present in the soil.

Absence of damage symptoms or non-detection of the pest is not sufficient to ensure that the consignment is free from the pest.

3.14 - Can the pest be reliably detected by testing (e.g. for pest plant, seeds in a consignment)?
No

3.15 - Can the pest be reliably detected during post-entry quarantine?
Yes in combination
Comments:
If adults are present, and temperature is raised to a temperature at which adults are active, it will be possible to observe them.
If the plants for planting are kept long enough at an appropriate temperature, larvae and pupae will complete their development and emerge.
This option may not be realistic for commercial consignments of seedlings but might be possible only for small quantities of high value material of large host plants.
The Panel on Phytosanitary measures considered that post-entry quarantine should not be allowed as a sole phytosanitary measure. The risk to introduce potentially infested plants was not acceptable in general. Post-entry quarantine should only be considered within a systems approach (e.g. with pest-free areas).

3.16 - Can the pest be effectively destroyed in the consignment by treatment (chemical, thermal, irradiation, physical)?
No (but see 3.17 for the growing media attached to plants)
possible measure: specified treatment.
Comments:
Treatment with insecticide prior to export will only kill adults. There is no experience with insecticides applied on soil to kill larvae or pupae but this could be investigated.
Methyl bromide treatment at export is possible but its long term use is uncertain as methyl-bromide is being phased out and its use is not favoured in many EPPO countries, see IPPC Recommendation *Replacement or reduction of the use of methyl bromide as a phytosanitary measure* (FAO, 2008).

Thermal or irradiation treatments will damage the viability of the plants.

3.17 - Does the pest occur only on certain parts of the plant or plant products (e.g. bark, flowers), which can be removed without reducing the value of the consignment?
Yes. The pest is present in the growing media attached to the plants. It is possible to remove it. This measure may not be appropriate for small seedlings.

3.18 - Can infestation of the consignment be reliably prevented by handling and packing methods?
No

3.19 - Could consignments that may be infested be accepted without risk for certain end uses, limited distribution in the PRA area, or limited periods of entry, and can such limitations be applied in practice?
No. The only intended use of plants for planting is to be planted.

3.20 - Can infestation of the commodity be reliably prevented by treatment of the crop?
Yes in combination with grown under protection conditions (see question 3.22)
Comments:
A wide range of insecticide exist and treatments are effective to control the pest (see question 1.23) but cannot guarantee complete absence of the pest. Treatments should target the first generation to avoid large infestation. Scouting should be performed to monitor the pest and apply timely insecticide applications as adults may reinfest fields (or possibly greenhouses) from neighbouring areas and establish between sprays.

3.21 - Can infestation of the commodity be reliably prevented by growing resistant cultivars?
No, there are no known resistant varieties.

3.22 - Can infestation of the commodity be reliably prevented by growing the crop in specified conditions

(e.g. protected conditions such as screened greenhouses, physical isolation, sterilized growing medium, exclusion of running water, etc.)?
Yes in combination
Comments:
It is possible to grow the plants under protected conditions excluding *Epitrix* spp. Screened greenhouses with a net of a mesh less than 2 mm can be used for propagative material or high value crops on a small scale. It should be noted that maintenance of screened glasshouses is very expensive and cost may be prohibitive on a large scale.

A combination of measures for 'normal' greenhouses can be envisaged but the Panel on Phytosanitary Measures did not consider that sufficient data was available to judge on the efficacy of such combination (this could be an acceptable measure in a case by case evaluation):
It is considered that in greenhouses the presence of the pest can be better monitored and control measures better applied and there is little evidence of the presence of the pest in greenhouse which may indicate that conditions are not optimal for its development. Treatments could be applied during the growing period if the pest is detected. Stringent sanitation measures should be applied, including treatment of growing media, removal of plant debris from earlier crops and management of host plants around the greenhouse. Monitoring and inspection should be performed to check pest freedom.

3.23 - Can infestation of the commodity be reliably prevented by harvesting only at certain times of the year, at specific crop ages or growth stages?
no
Comments:
Not relevant: if conditions are suitable for plants for planting they will be suitable for the pest. Some stages of the pest may be present in soil at any period of the year.

3.24 - Can infestation of the commodity be reliably prevented by production in a certification scheme (i.e. official scheme for the production of healthy plants for planting)?
no
Comments:
Certification schemes are usually established to address viruses/pathogens that are transmitted by the mother plant. They do not address insect pests specifically, but general inspections required in this framework may allow the pest to be detected. This approach is considered under the option of "pest-free place of production" (see answer to question 3.28).

3.25 - Has the pest a very low capacity for natural spread?
no

3.26 - Has the pest a low to medium capacity for natural spread?
Yes (see answer to 1.30)
possible measures: pest-free place of production or pest free area.

3.28 - Can pest freedom of the crop, place of production or an area be reliably guaranteed?
yes
Comments:
Area freedom
Establishment of a pest free area should follow ISPM 4 (FAO, 1996). This would normally include (depending on whether the PFA is established as the entire country or part of the country) for at least 2 years:
-Monitoring of the growing crop for characteristic *Epitrix* shot holes on leaves
-Visual scouting of young crops for adults during the growing season
-Monitoring of alternative hosts (e.g. potatoes) for foliage and tuber damage in commercial fields and backyard gardens

Pest free place of production
Establishment of a pest free area should follow ISPM 10 (FAO, 1999). Given the lack of reliable

information on capacity of natural spread of the pest by crawling or flying, and the presence of potential wild hosts, establishment of a pest-free place of production will only be possible in protected cultivation, i.e. a greenhouse. Growing media should be treated to avoid presence of larvae/pupae. Only pest-free plants should be introduced in the greenhouse. Monitoring should be performed in the greenhouse to confirm absence of the pest. Host plants in the surrounding (in particular weeds) should be removed.

3.29 - Are there effective measures that could be taken in the importing country (surveillance, eradication) to prevent establishment and/or economic or other impacts?

no

Comments:

There are no pheromones trapping methods for early detection. It is likely that the pest would be established in solanaceous crops long before it is detected and that it could not be eradicated.

3.31 - Does each of the individual measures identified reduce the risk to an acceptable level?

No. The following measures do not reduce the risk to an acceptable level: Visual inspection of the consignment, Post-entry quarantine, Grown under protected conditions (apart from screened greenhouses).

3.32 For those measures that do not reduce the risk to an acceptable level, can two or more measures be combined to reduce the risk to an acceptable level?

Yes. The plants for planting may be produced under screened greenhouse conditions and with appropriate monitoring to ensure that only pest-free plants/growing medium are introduced in the screened greenhouse.

A Systems approach can be elaborated on a case by case study.

3.34 - Estimate to what extent the measures (or combination of measures) being considered interfere with international trade.

Comments:

International trade of solanaceous plants for planting tubers is already prohibited and/or regulated for a number of pests in most countries of the EPPO region. In countries where *E. tuberis* or *E. cucumeris* are not quarantine pests (e.g. the EU), there are currently no requirements for *Epitrix* species.

Measures are likely to have an impact on trade from areas where the pests are established within the EPPO region.

International trade will not be stopped but additional measures will be required that will likely result in some additional costs.

3.35 - Estimate to what extent the measures (or combination of measures) being considered are cost-effective, or have undesirable social or environmental consequences.

Comments:

Measures required will result in additional costs (especially for the establishment of Pest Free Areas as surveys, monitoring and inspections will be needed)

3.36 - Have measures (or combination of measures) been identified that reduce the risk for this pathway, and do not unduly interfere with international trade, are cost-effective and have no undesirable social or environmental consequences?

yes

Comments:

The following measures have been identified:

- Pest-Free Areas
- Pest-Free Places of production (in protected conditions)
- Removal of growing medium
- Production under screened greenhouse conditions and with appropriate monitoring.

A systems approach may be developed on a case by a case basis.

The measures envisaged interfere with international trade, but not unduly.

3.41 - Consider the relative importance of the pathways identified in the conclusion to the entry section of the pest risk assessment

The EWG considered that the main pathways are:
-potato tubers for planting with soil and plant debris attached coming from areas where the pests are present,
-potato tubers for consumption or processing with soil and plant debris attached coming from areas where the pests are present.
These pathways should be given priority. Additionally, there is a risk associated with Soil or growing medium attached to rooted host plants from countries where the pests occur although this is difficult to quantify it. Measures are also recommended.

The following measures are recommended:

Pathway 1: Potato tubers for planting with soil and/or plant debris attached coming from countries where the pests occur	Phytosanitary certificate and, if appropriate, Phytosanitary certificate of re-export • Production in pest-free areas

Pathway 2: Potato tubers for consumption or processing with soil and/or plant debris attached coming from countries where the pests occur	Phytosanitary certificate and, if appropriate, Phytosanitary certificate of re-export • Production in pest-free areas or • Treatment

Pathway 3: Soil or growing medium attached to rooted host plants from countries where the pests occur	Phytosanitary certificate and, if appropriate, Phytosanitary certificate of re-export • Production in pest-free areas or • Production in pest-free places of production (under protected conditions) or • Removal of growing medium

The other pathways are considered to present a lower risk, and the EWG recommended that they should not be considered for risk management in priority.
Concerning non-host plants for planting, the EWG recognized that a risk exists because some life stages may be found in the soil attached to these plants but association and concentration of the pest on the pathway, whilst considered very low, is very difficult to assess because of lack of data.
Concerning soil as such, and soil attached to machinery, the risk is mainly associated with local spread (e.g. between neighbouring farms sharing machinery) but it can not be excluded that longer distance spread occurs. This pathway is of importance only for *Epitrix* species already present in the EPPO region (*E. similaris* and *E. cucumeris*).

References

For all Internet references: last accessed in March 2010.

Afek U & Orenstein J (2002) Disinfecting potato tubers using steam treatments. Canadian Journal of Plant Pathology 24: 36–39

Alcazar J (1997) Principales plagas de la papa: Gorgojo de los Andes, Epitrix y Gusanos de Tierra. Fasciculo 3.6. Centro Internacional de la Papa (CIP), Lima, Peru. 7pp

Anonymous (1996). Inventario Subregional de Plagas y Enfermedades de los Vegetales de importancia economica para el Area Andina. *Gaceta Oficial del Acuerdo de Cartagena***.** Ano XIII - Numero 223 http://faolex.fao.org/docs/pdf/anc60466.pdf

Arnett RH Jr (2000) American Insects. A handbook of the insects of America North of Mexico, 2nd edition, CRC Press (US), 1003 pp.

Bennen R (2005) Translocation in Leaf Beetles (Coleoptera: Chrysomelidae). Bonner zoologische Beiträge 54: 179–199

Biondi M (1990). Checklist of the flea beetle species occurring in Italy (Coleoptera, Chrysomelidae, Alticinae). Fragmenta Entomologica 22:109–183.

Boavida C (2009) Presence in Portugal of *Epitrix similaris* Gentner (Coleoptera: Chrysomelidae: Alticinae), an exotic pest of potato tubers. *Boletín de Sanidad Vegetal Plagas* **35** (1), 73-74

Boavida C& Germain JF (2009) Identification and pest status of two exotic flea beetle species newly introduced in Portugal: *Epitrix similaris* Gentner and *Epitrix cucumeris* (Harris). *Bulletin OEPP/EPPO Bulletin* **39**, 501–508

Borges PB, coordinator (2008) *Terrestrial arthropods. Biodiversity Database of Azores.* Universidade dos Açores. INTERREG IIIB, http://www.azoresbioportal.angra.uac.pt/pesquisa.php?lang=en&sstr=8

Borowiec L (2004) The Leaf Beetles of Europe and the Mediterranean Subregion (Checklist and Iconography) http://www.biol.uni.wroc.pl/cassidae/European%20Chrysomelidae/index.htm.

Bousquet Y (1991) Checklist of beetles of Canada and Alaska. Ottawa, Canada: Research Branch Agriculture Canada Publication.

Briceno VA (1975) Lista preliminar de los Chrysomelidae (Coleoptera) de Los Andes Venezolanos; Serie: Agronomia Tropical (Venezuela). (Ene-Feb 1975). v. 25 (1) p. 39-47. http://sian.inia.gob.ve/repositorio/revistas_ci/Agronomia%20Tropical/at2501/arti/briceno_a2.htm

Bukenya-Ziraba R & Bonsu KO (2004) *Solanum macrocarpon* L. In: Grubben, G.J.H. & Denton, O.A. (Editors). PROTA 2: Vegetables/Légumes. [CD-Rom]. PROTA, Wageningen, Netherlands. http://database.prota.org/PROTAhtml/Solanum%20macrocarpon_EN.htm

CABI (2007a) Crop Protection compendium datasheet for *Epitrix cucumeris*

CABI (2007b) Crop Protection compendium datasheet for *Epitrix tuberis*

Can F, Valverde RA, Rush MC (1994) Two New Beetle Vectors of Physalis Mottle Virus. Plant Disease 78:432

Campbell JM, Sarazin MJ, Lyons DB, 1989. Canadian beetles (Coleoptera) injurious to crops, ornamentals, stored products, and buildings. Ottawa, Ontario, Canada: Agricultural Canada. Abstract

CFIA (2010) Seed Potato Quality Management Program (SPQMP). Directive D-06-04. Canadian Food Inspection Agency, Ottawa, CA. 35pp. http://www.inspection.gc.ca/english/plaveg/protect/dir/d-06-04e.pdf

Christie RD, Schulz JT & Gudmestad NC (1993) Potato flea beetle (Coleoptera: Chrysomelidae) evaluated as a possible vector *of* ring rot bacterium in potatoes. Journal of Economic Entomology, Volume 86 (4), 1223-1227(5)

Cusson M, Vernon RS, Roitberg BD, 1990. A sequential sampling plan for adult tuber flea beetles (Epitrix tuberis Gentner): dealing with "edge effects". Canadian Entomologist, 122(5-6):537-546. Abstract

Elliott B. (2009) Flea beetle management. *Guide to Commercial Potato Production on the Canadian Prairies -* Western Potato Council - Portage la Prairie. http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp9585

EPPO (1997) Data-sheets on quarantine pests. *Epitrix tuberis*. In Quarantine Pests for Europe. 2nd edition. eds. Smith, I.M., McNamara, D.G., pp 253-256

EPPO (2004) EPPO Standard PM 8/1 Commodity-specific Phytosanitary Measures for potato *Bulletin OEPP/EPPO Bulletin* **34**, 459–461. http://archives.eppo.org/EPPOStandards/commodity.htm

EPPO (2004) EPPO Standard PM 3/61 Pest-free areas and pest-free production and distribution systems for quarantine pests of potato *OEPP/EPPO Bulletin* **34**, 441–442.

EPPO (2005) Data sheets on quarantine pests. *Epitrix cucumeris*. *Bulletin OEPP/EPPO Bulletin* **35**, 363-364.

EPPO (2008) Alert List: *Epitrix similaris.* http://www.eppo.org/QUARANTINE/Alert_List/insects/epitrix_similaris.htm

EU (1966) Council Directive 66/403/EEC of 14 June 1966 on the marketing of seed potatoes http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31966L0403:EN:HTML

EU (2000) Council Directive 2000/29/EC on protective measures against the introduction into the Community of organisms harmful to plants or plant products and against their spread within the Community

EU (2003) COMMISSION DECISION 2003/61/EC of 27 January 2003authorising certain Member States to provide for temporary derogations from certain provisions of Council Directive 2000/29/EC in respect of seed potatoes originating in certain provinces of Canada. Official Journal of the European Communities L 23/31

EU (2007) Commission staff working document: The potato sector in the European Union http://ec.europa.eu/agriculture/publi/reports/fruitveg/potato/sec533_en.pdf

EU (2007b) Council Directive 2007/33/EC of 11 June 2007 on the control of potato cyst nematodes and repealing Directive 69/465/EEC. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:156:0012:0022:EN:PDF

EU (2008) Commission Decision 2008/891/EC of 26 November 2008 amending Decision 2003/61/EC authorising certain Member States to provide for temporary derogations from certain provisions of Council Directive 2000/29/EC in respect of seed potatoes originating in certain provinces of Canada. Official Journal of the European Union, L 319/71

EUROSTAT (2010) http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home/

FAO (1996) ISPM 4 Requirements for the establishment of pest free areas. Rome (IT)

FAO (2008) IPPC recommendation Replacement or reduction of the use of methyl bromide as a phytosanitary measure. Rome (IT)

FAOSTAT 2009 http://faostat.fao.org/

Fauske (2003) Common flea beetles of North Dakota. http://www.ndsu.edu/ndmoths/Fleabeetles/List%20of%20flea%20beetles.htm

Ferro DN & Boiteau G (1993) Management of insect pests. in *Potato Health Management*, p 103-116. Rowe RC ed. American Phytopathological Society Press, St. Paul, MN (US).

Foreign Trade Statistics, Department of Commerce US (2010) http://www.fas.usda.gov/gats/default.aspx

Foster RE & Obermeyer JL (2009) Vegetable Insects. Purdue Extension. http://extension.entm.purdue.edu/publications/E-74.pdf

Fulton HG, Banham FL (1962) The tuber flea beetle in British Columbia. Canada Department of Agriculture Publication No. 938.

Furth DG (2005) The Current Status of Knowledge of the Alticinae of Mexico (Coleoptera: Chrysomelidae). Bonner zoologische Beiträge 54, 209–237

Furth DG, Savini V (1996) Checklist of the Alticinae of Central America, including Mexico (Coleoptera:Chrysomelidae). Insecta Mundi, Vol 10, Nos 1-4, 45-68

Gentner LG (1944) The black flea beetles of the genus *Epitrix* commonly identified as *cucumeris* (Harris) (Coleoptera: Chrysomelidae). Reprinted from *Proceedings of the Entomological Society of Washington* **46** (6), 137-149. http://www.biodiversitylibrary.org/item/54899#10

Glendenning R & Fulton HG (1948) The tuber flea beetle and its control in the coastal areas of British Columbia. Canada Department of Agriculture Publication No. 48.

Granovsky AA; Peterson AG (1954) The evaluation of potato leaf injury caused by leafhoppers,flea beetles, and early blight. Journal of Economic Entomology 47, 894-902.

Gruev B (1981). A new species of *Epitrix* Foudras from the Azores (Insecta, Coleoptera, Chrysomelidae). *Boletim da Sociedade Portuguesa de Entomologia* **10**, 1-2.

Hill (1946) Influence of food plants on fecundity, larval development and abundance of the tuber flea beetle in Nebraska. Research Bulletin of the Nebraska Experimental Station, 143, 1-16.

Hill (1948) Research on potato insect problems—A review of recent literature. American Journal of Potato Research, 25 (4): 107-127

Hollingsworth CS, Editor (2009) Pacific Northwest Insect Management Handbook Insects

Flea beetle insecticide treatments for potato http://uspest.org/pnw/insects?23POTA03.dat

Flea beetle insecticide treatments for tomato http://uspest.org/pnw/insects?22VGTB62.dat

Hoy CW, Boiteau G, Alyokhin A, Dively G, Avarez JM (2008) Managing insect and mite pests in *Potato Health Management* 2nd Edition, Edited by Dennis A. Johnson. APS, Saint Paul, USA

Hirnyck R & Downey L (2005) Pest management Strategic plan for Western US Sugarbeet production. Workshop held on 2004-12-15/16. www.ipmcenters.org/pmsp/pdf/PNWSugarbeet.pdf

International Consultative Group on Food Irradiation (1999) Facts about food irradiation. 48pp. International Atomic Energy Agency, Vienna, Austria. www.iaea.org/nafa/d5/public/foodirradiation.pdf

IRAC (Insecticide Resistance Action Committee) (2010) http://www.pesticideresistance.org/search/22/8/

Jones RAC & Fribourg CE (1977) Beetle, contact and potato true seed transmission of Andean potato latent virus. Annals of Applied Biology. 1977. 86: 1, 123-128.

Kabaluk JT & Vernon RS (2000) Effect of Crop Rotation on Populations of *Epitrix tuberis* (Coleoptera: Chrysomelidae) in Potato. *Journal of Economic Entomology*. **93**: 315-322.

Kring JB (1958) Feeding behaviour and DDT resistance of *Epitrix cucumeris*. Journal of Economic Entomology, 53:823-828.

Lange WL & Bronson L (1981) Insect Pests of Tomatoes. *Annual Review of Entomology* **26**: 345-371

Maletta M, Holmstrom K, Tietjen W, Cowgill W, Ghidiu G (2004) Evaluation of Controls for Flea Beetle on Eggplant in an Organic Production System**.** Proc. XXVI IHC – Sustainability of Horticultural Systems. Eds. L. Bertschinger and J.D. Anderson. Acta Horticultura 638, ISHS.

Moreira J & Belchior A (2007) Estudo comparativo de cultivares de batata em dois modos de fertilização azotada, conduzido em sistema de produção integrada. http://www.drapc.min-agricultura.pt/base/geral/files/realtorio_batata_2007.pdf

Miller J, Hirnyck R, Downey-Blecker L (2008) *Pest Management Strategic Plan For Organic Potato Production in the West.* Summary of workshops held on February 16, 2006 Buhl, Idaho and January 9, 2008 Portland, Oregon. Issue Date: December 19, 2008. 108pp. www.ipmcenters.org/.../CA-CO-ID-OR-WAOrganicPotatoPMSP.pdf

Morrison HE, Gentner LG, Koontz RF & Every RW (1967) The changing role of potato pests attacking potato tubers. Special Report 229, Agricultural Experiment Station, Oregon State University, Corvallis. News and Reviews. *American Potato Journal* **44,** 137–144. http://www.springerlink.com/content/n75vw112q334x447/

Natwick ET & Trumble JT (2009) *UC IPM Pest Management Guidelines: Peppers.* UC ANR Publication 3460 http://www.ipm.ucdavis.edu/PMG/r604300611.html

Nault and Speese 2001 major insect pests of tomato (to edit properly)

Neilson CL & Finlayson DG (1953) Notes on the biology of the tuber flea beetle, *Epitrix tuberis* Gentner (Coleoptera: Chrysomelidae) in the interior of British Colombia. The Canadian Entomologist, 85:31-32.

Noronha C, Vernon RS, Vincent C (2008) Les insectes ravageurs importants de la pomme de terre au Canada. Cahiers Agricultures. Volume 17, Numéro 4, 375-81, Juillet-Août 2008, Synthèse

http://www.john-libbey-eurotext.fr/e-docs/00/04/40/6D/article.phtml

Oliveira R, Chatot C & Dedryver C-A (2008) [A new fleabeetle detected in Europe] *Potato Planet* **011**, juillet, 30-34 (in French).

Pedersen SM, Bizik J, Costa LD, Coutinho J, Dolezal F and Gluska A (2005) Potato production in Europe – a gross margin analysis. Report in the EU 5th framework programme project "Fertorganic"

http://www.foi.life.ku.dk/publikationer/~/media/migration%20folder/upload/foi/docs/publikationer/working%20papers/2005/5.pdf.ashx

Peel MC Peel, Finlayson BL, and McMahon TA (2007) Updated world map of the K¨oppen-Geiger climate classification Hydrology and Earth System Sciences, 11, 1633–1644. www.hydrol-earth-syst-sci.net/11/1633/2007/

Plissey ES (1993) Maintaining tuber health during harvest, storage, and post-storage handling. in *Potato Health Management*, p 41-53. Rowe RC ed. American Phytopathological Society Press, St. Paul, MN (US).

PSD (2008) Revised assessment of the impact on crop protection in the UK of the ‘cut-off criteria’ and substitution provisions in the proposed Regulation of the European Parliament and of the Council concerning the placing of plant protection products in the market. *www.pesticides.gov.uk/.../Revised_Impact_Report_1_Dec_2008(final).pdf*

Ramakrishna, B.; ed (1988). Programa Cooperativo de Investigación Agrícola para la Subregión Andina - PROCIANDINO/BID. Curso Corto Multiplicación Rápida de Semilla de Papa. Huancayo (Perú). 20-29 Ene 1988. Quito (Ecuador).1988.186 p.

Ranganna B, Raghavan GSV, Kushalappa AC (1998) Hot water dipping to enhance storability of potatoes. Postharvest Biology and technology, 13:3, 215-223. (Abstract)

Rasmussen C, Lagnaoui A, Esbjerg P (2003) Advances in the Knowledge of Quinoa Pests. Food reviews International Vol 19, Nos 1&2 pp 61-75, 2003. http://science.melipona.org/PDF/rasmussen2003_1075_quinoapests.pdf

Reed P, Bould A, Giltrap N, Dickens J (2002) Principle of certification and marketing schemes in *Principle of plant health and quarantine.* Ebbels CABI publishing Wallingford GB

Rondon SI (2010) The Potato Tuberworm: A Literature Review of Its Biology, Ecology, and Control. American Journal of Potato Research, 149-166. http://www.springerlink.com/content/u7m216w785617021/

RUCIP (2006) Rules & practices of the inter-European trade in potatoes.

http://www.europatat.eu/_files/downloads/rucip_rules2006_en.pdf

Runia W, van Gastel W& Molendijk L (2009) Cystenvrij (AM) maken van Aardappelpootgoed [Cyst free procedures for seed potatoes], in Dutch. 39pp. Project report, PPO - AGV. Lelystad, NL.

http://www.kennisakker.nl/kenniscentrum/document/cystenvrij-am-maken-van-aardappelpootgoed

Santos AMC, Borges PAV, Rodrigues AC & Lopes DJH (2009) Lista de espécies de artrópodes associados a diferentes culturas frutícolas da Ilha Terceira (Açores). Actas do I Workshop de Fruticultura – Contributo para o seu desenvolvimento (Angra do Heroísmo 21-23 Abril 2005), pp. 170-180. Angra do Heroísmo. http://cita.angra.uac.pt/biodiversidade/publicacoes/ver.php?id=166

Schmidt AC (1987) Potato flea beetle in the genus *Epitrix* (letter to EPPO). Agriculture Canada

Seeno TN & Andrews FG (1972) Alticinae of California, Part I: *Epitrix* spp. (Coleoptera: Chrysomelidae). *The Coleopterists Bulletin* **26** (2), 53-61.

Senanayake DG, Pernal SF & Holliday NJ (1993) Yield responses of potatoes to defoliation by the potato flea beetle (Coleoptera: Chysomelidae) in Manitoba. *Journal of Economic Entomology* **85** 1527-1533.

Senanayake DG & Holliday NJ (1989) Seasonal abundance of foliage-dwelling insect pests in commercial fields and insecticide-free plots of potato in Manitoba. Canadian Entomologist, 121: 3, 253-265

Stewart & Thomson (1989) The spatial distribution of spring and summer populations of adult potato flea beetles, *Epitrix cucumeris* (Harris) (Coleoptera: Chrysomelidae), on small plots of potatoes. Canadian Entomologist, 121:12, 1097-1101

Stewart JG, Feldman J, LeBlanc DA (1999) Resistance of transgenic potatoes to attack by *Epitrix cucumeris* (Coleoptera: Chrysomelidae). Canadian Entomologist, 131:4, 423-431

Sibaja Chinchilla G & Sanabria Ujueta C (2002) Principales plagas de insectos, ácaros y moluscos de cultivos agrícolas y forestales de Costa Rica. Ministerio de Agricultura y Ganaderia. Servicio fitosanitario del estado. http://www.protecnet.go.cr/laboratorios/Plagas.html

Silva N (2008) Nova praga ameaça batata portuguesa. *Frutas, Legumes e Flores*, no. 101, 12-13.

UN/ECE (2008) *Standard S1 concerning the marketing and commercial quality control of Seed potatoes. Revised Standard recommended by the Working Party on Standardization of Perishable Produce and Quality Development of the United Nations Economic Commission for Europe.* United Nations, Genève (CH). http://www.unece.org/trade/agr/standard/potatoes/pot_e.htm

USDA (2009) Treatment Manual. U.S. Department of Agriculture (USDA). 796pp.

http://www.aphis.usda.gov/import_export/plants/manuals/ports/downloads/treatment.pdf

Vernon RS, Mackenzie JR, Bartel DL, 1990. Monitoring tuber flea beetle, *Epitrix tuberis* Gentner (Coleoptera: Chrysomelidae) on potato: parameters affecting the accuracy of visual sampling. Canadian Entomologist, 122(5-6):525-535.

Vernon RS, Mackenzie JR, 1991a. Evaluation of foliar sprays against the tuber flea beetle, Epitrix tuberis Gentner (Coleoptera: Chrysomelidae), on potato. Canadian Entomologist, 123(2):321-331.

Vernon RS, Mackenzie JR, 1991b. Granular insecticides against overwintered tuber flea beetle, Epitrix tuberis Gentner (Coleoptera: Chrysomelidae), on potato. Canadian Entomologist, 123(2):333-343. Abstract

Vernon RS, Thomson DR, 1991. Overwintering of tuber flea beetles, *Epitrix tuberis* Gentner (Coleoptera: Chrysomelidae), in potato fields. Canadian Entomologist, 123(1):239-240. Abstract

Vernon RS, Thomson D, 1993. Effects of soil type and moisture on emergence of tuber flea beetles, *Epitrix tuberis* (Coleoptera: Chrysomelidae) from potato fields. Journal of the Entomological Society of British Columbia, No. 90:3-10. Abstract

Wallis RL (1957). Seasonal abundance and host plants of the tuber flea beetle in the Rocky Mountain region. Journal of Economic Entomology, 50(4):435-437.

Weeden CR, Shelton AM, and Hoffman MP. Biological Control (2009) A Guide to Natural Enemies in North America. http://www.nysaes.cornell.edu/ent/biocontrol/

Appendix 1

Import of plants for planting in EU countries countries where some Epitrix damaging tuber are present in 2004-2008 (in 100 kg), compared to global import from worldwide (EU27_extra). Source: Eurostat, 2010.

PRODUCT	Partner/period	2004	2005	2006	2007	2008
Dormant narcissi bulbs						
	EU27_extra	2898	5460	5203	4998	4138
	USA	5	0	0	0	0
Dormant tulip bulbs						
	EU27_extra	*9106*	*7910*	*9428*	*11111*	*10676*
	Canada	:	:	:	:	111
	USA	5	160	:	723	720
Dormant gladioli bulbs						
	EU27_extra	*6283*	*4439*	*4997*	*8961*	*6992*
	Canada	1	:	0	:	:
	USA	42	2	0	88	935
Dormant bulbs, tubers, tuberous roots, corms, crowns and rhizomes (excl. Those used for human consumption, hyacinth, narcissi, tulip, gladioli and chicory plants and roots)						
	EU27_extra	*99324*	*90171*	*117880*	*134480*	*152081*
	Canada	0	1	4	1	9
	Colombia	0	:	0	:	2
	Ecuador	6	37	65	49	:
	Jamaica	:	1	0	:	:
	Peru	1	:	:	0	4
	USA	5426	2774	3792	3099	3038
Orchid, hyacinth, narcissi and tulip bulbs, in growth or in flower						
	EU27_extra	*3457*	*6192*	*10838*	*18222*	*17136*
	Canada	0	0	0	1	0
	Colombia	1	1	3	2	5
	Dominican Republic	:	:	3	:	:
	Ecuador	9	7	5	10	9
	Jamaica	0	1	:	:	0
	Peru	1	2	1	4	2
	USA	4	12	3	4	5
Bulbs, tubers, tuberous roots, corms, crowns and rhizomes, in growth or in flower (excl. Those used for human consumption, orchids, hyacinths, narcissi, tulips and chicory plants and roots)						
	EU27_extra	*2058*	*2969*	*956*	*1770*	*890*
	Canada	:	:	0	0	2
	Colombia	:	:	0	2	:
	Peru	:	60	23	:	:
	USA	499	316	7	340	10
Vine slips, grafted or rooted						
	EU27_extra	*2010*	*614*	*1904*	*252*	*223*
	Canada	:	:	:	14	:
	USA	10	0	0	0	0
Trees, shrubs and bushes, grafted or not, of kinds which bear edible fruit or nuts (excl. Vine slips)						
	EU27_extra	*123917*	*82485*	*66748*	*23460*	*17983*
	Canada	11	0	223	1	:
	Dominican Republic	45	:	:	:	:
	USA	296	4680	691	473	3885

Rhododendrons and azaleas, grafted or not						
	EU27_extra	*339*	*264*	*95*	*109*	*274*
	Canada	:	:	2	:	:
	USA	20	7	4	9	13
Roses, whether or not grafted						
	EU27_extra	*:*	*:*	*:*	*:*	*13441*
	Canada	:	:	:	:	6
	Colombia	:	:	:	:	15
	Ecuador	:	:	:	:	9
	USA	:	:	:	:	48
Roses (excl. Budded or grafted)						
	EU27_extra	*5326*	*1150*	*528*	*749*	*:*
	Canada	2	19	2	2	:
	Colombia	51	:	:	:	:
	Ecuador	:	0	0	:	:
	USA	93	97	10	122	:
Budded or grafted roses						
	EU27_extra	*12126*	*6281*	*8804*	*10162*	*:*
	Canada	1	:	:	0	:
	Colombia	:	:	8	12	:
	Ecuador	1	:	1	:	:
	USA	50	66	197	40	:
Vegetable and strawberry plants						
	EU27_extra	*20448*	*21448*	*22990*	*21940*	*22864*
	USA	5154	4617	4778	4257	5007
Live forest trees						
	EU27_extra	*1865*	*1675*	*1610*	*994*	*664*
	Canada	73	:	0	:	:
	USA	0	123	:	0	38
Outdoor rooted cuttings and young plants of trees, shrubs and bushes (excl. Fruit, nut and forest trees)						
	EU27_extra	*16326*	*15203*	*8602*	*10191*	*11316*
	Canada	0	0	0	0	13
	Dominican Republic	:	5	:	:	:
	Peru	:	1	:	:	:
	USA	234	208	164	776	1534
Outdoor trees, shrubs and bushes, incl. Their roots (excl. Cuttings, slips and young plants, and fruit, nut and forest trees)						
	EU27_extra	*167001*	*139432*	*116493*	*138753*	*66876*
	Bolivia	15	:	:	10	:
	Canada	18	2	0	:	0
	Dominican Republic	:	:	90	170	:
	USA	688	3965	655	2292	1843
Live outdoor plants, incl. Their roots (excl. Bulbs, tubers, tuberous roots, corms, crowns and rhizomes, incl. Chicory plants and roots, unrooted cuttings, slips, rhododendrons, azaleas, roses, mushroom spawn, pineapple plants, vegetable and strawberry plants, trees, shrubs and bushes)						
	EU27_extra	*:*	*:*	*:*	*:*	*65892*
	Canada	:	:	:	:	6

	Peru	:	:	:	:	1
	USA	:	:	:	:	1062
Perennial outdoor plants						
	EU27_extra	*10460*	*16398*	*6419*	*7397*	*:*
	Canada	1	0	0	:	:
	Colombia	:	:	:	1	:
	Dominican Republic	136	:	:	1	:
	Ecuador	:	7	:	:	:
	USA	129	9	24	459	:
Live outdoor plants, incl. Their roots (excl. Bulbs, tubers, tuberous roots, corms, crowns and rhizomes, incl. Chicory plants and roots, unrooted cuttings, slips, rhododendrons, azaleas, roses, mushroom spawn, pineapple plants, vegetable and strawberry plants, trees, shrubs and bushes)						
	EU27_extra	*138871*	*169392*	*142821*	*98039*	*:*
	Canada	0	0	0	1	:
	Colombia	:	16	5	3	:
	Dominican Republic	:	120	430	6	:
	Ecuador	:	51	7	5	:
	USA	1191	1446	355	1945	:
Indoor rooted cuttings and young plants (excl. Cacti)						
	EU27_extra	*322861*	*346407*	*317239*	*372207*	*424006*
	Canada	2	5	0	1	22
	Colombia	49	12	2	18	66
	Dominican Republic	1150	1405	2948	1461	1716
	Ecuador	:	18	464	873	440
	USA	645	547	1413	446	1799
Indoor flowering plants with buds or flowers (excl. Cacti)						
	EU27_extra	*964*	*825*	*3841*	*3677*	*4598*
	Colombia	:	:	:	1	:
	Dominican Republic	117	9	:	:	:
	Ecuador	1	:	0	:	:
	USA	13	3	16	4	6
Live indoor plants and cacti (excl. Rooted cuttings, young plants and flowering plants with buds or flowers)						
	EU27_extra	*348852*	*335044*	*372768*	*399107*	*387385*
	Canada	0	7	2	1	2
	Colombia	13	6	3	14	4
	Dominican Republic	5746	2540	2205	2855	1813
	Ecuador	173	19	3	5	102
	Peru	:	2	8	2	11
	USA	11309	12839	9883	10545	7554

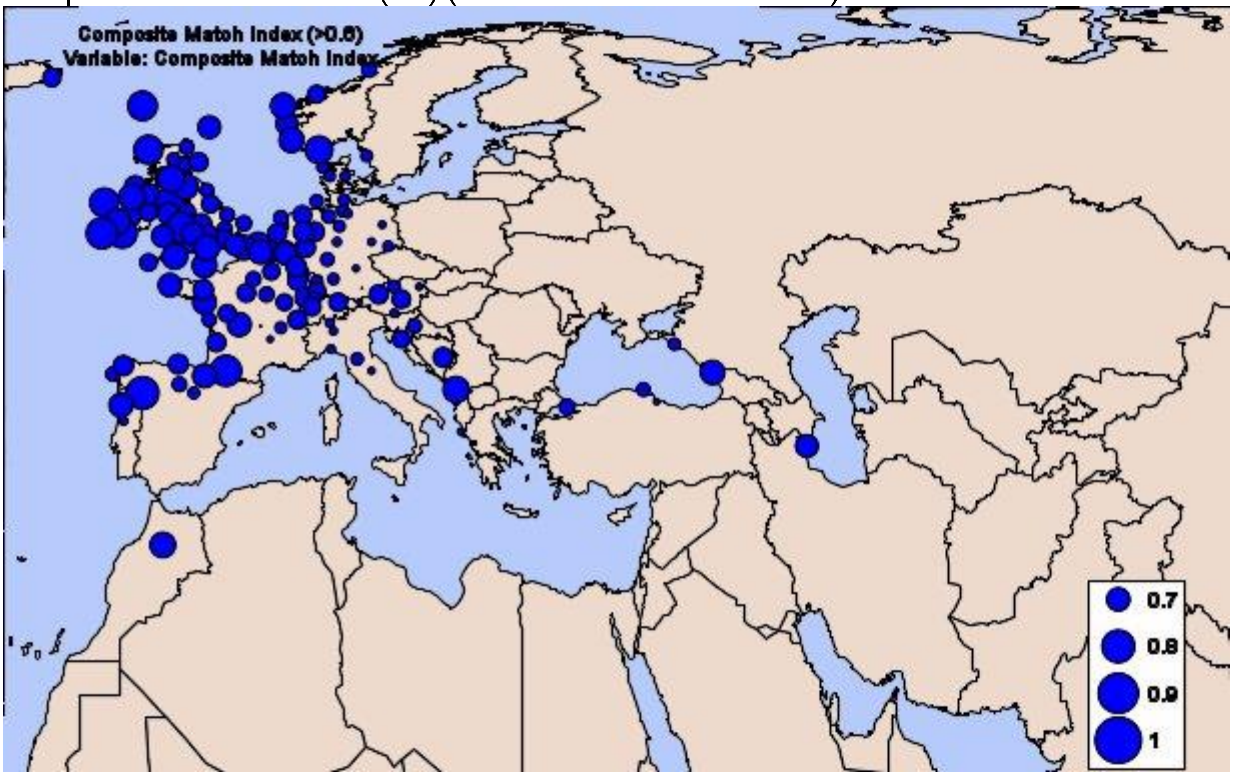
Appendix 2 Area harvested in potato (in ha) per country in the EPPO region (source FAOSTAT, 2010)

Countries	2000	2001	2002	2003	2004	2005	2006	2007	2008
Russian Federation	3229060	3216200	3198110	3175000	3130000	3070510	2962420	2851660	2098000
Ukraine	1631000	1604700	1592300	1586900	1556000	1515900	1461500	1453300	1408900
Poland	1250623	1194232	803384	765771	713250	588184	597230	569600	548884
Belarus	661000	636000	550000	526291	506610	461646	433922	412553	396341
Germany	304379	282100	284078	287264	295266	276900	274300	274961	259800
Romania	282700	276700	283200	281868	254005	285312	283089	272548	259744
Kazakhstan	159100	164400	162907	166014	168100	167900	153500	155000	163100
France	162644	162239	162207	157278	159753	156423	158315	158080	156200
Netherlands	180200	163900	165200	158644	163905	156000	155800	156900	151900
Turkey	205000	200000	198000	195000	179000	154300	159277	153612	149327
United Kingdom	166000	165000	158000	145000	148700	137400	141000	140200	144000
Algeria	72690	65790	72580	88660	93144	99717	98825	79339	90000
Spain	118754	115126	110146	101101	102120	94998	87199	89200	85100
Kyrgyzstan	68994	73846	52299	83219	85191	75910	81101	86430	85000
Serbia						84434	81379	81172	
Italy	81894	78000	76985	73975	72430	69912	72451	69513	70578
Azerbaijan	52487	55178	57365	59338	65795	70690	66847	67110	68856
Belgium	62200	61700	59299	66734	64953	67267	67942	63521	
Morocco	60510	61500	57520	64355	61320	62100	59600	57958	62800
Uzbekistan	52200	50800	48900	49200	52140	49810	52590	56008	59700
Lithuania	109300	102500	99200	93600	79300	73950	57800	52800	48400
Denmark	38724	38210	37693	36100	41000	40000	38600	42152	40664
Bosnia & Herzegovina	43736	45129	43362	42649	43282	41352	40670	41291	40110
Portugal	57345	49789	52600	48127	47906	41786	41386	41400	38900
Latvia	51300	55100	53600	54600	48900	45100	45100	40300	37800
Greece	48800	46800	46500	46200	45646	44440	45163	46600	33500
Moldova	65273	42659	45037	38476	34560	35871	34437	35400	31247
Czech Republic	69198	54137	46917	35982	35974	36071	30026	31908	29788
Sweden	32903	32236	31731	30540	31671	30453	28001	28522	26900
Finland	32200	30000	29800	28700	27300	28900	28000	27300	26200
Hungary	46743	36262	34004	31331	30950	25378	22583	25400	25300
Tunisia	20700	21300	22080	22300	24200	25080	24900	24550	24800
Austria	23737	23123	22523	21122	21924	22186	21920	22675	22800
Israel	11287	11400	12740	17110	16900	16990	15500	17000	15000
Croatia	65232	65641	64640	63097	20000	18903	16759	17355	15000
Norway	15310	15130	15120	14576	14186	13700	14046	14466	14388
Slovakia	27067	26200	26056	25703	24226	19101	18384	17769	14270
The FYR of Macedonia	13210	13000	14100	14096	14000	12893	13357	13799	13554
Ireland	13500	14300	15400	14200	13300	11800	11500	11700	12000
Estonia	30900	22100	16023	16979	16102	13959	11510	11150	11400
Switzerland	14150	13784	13457	13578	13335	12510	12081	11768	11120
Montenegro						10179	10190	10230	
Albania	11400	11000	10600	10456	10700	10134	9523	8200	8300
Jordan	3673	3764	3502	3797	4524	4848	5278	3543	5843
Cyprus	6500	5715	5600	5390	5380	6190	4290	6290	5661
Slovenia	8952	7785	7113	6832	6832	6306	5918	5736	4427
Malta	1783	1783	1152	1154	1100	820	820	700	700
Luxembourg	734	672	623	635	608	595	627	604	
Serbia & Montenegro	104454	93554	101703	98636	99400	95347			
Total	**9 773 241**	**9 511 046**	**8 967 806**	**8 860 131**	**8 646 696**	**8 293 241**	**8 058 993**	**7 863 884**	**6 971 829**

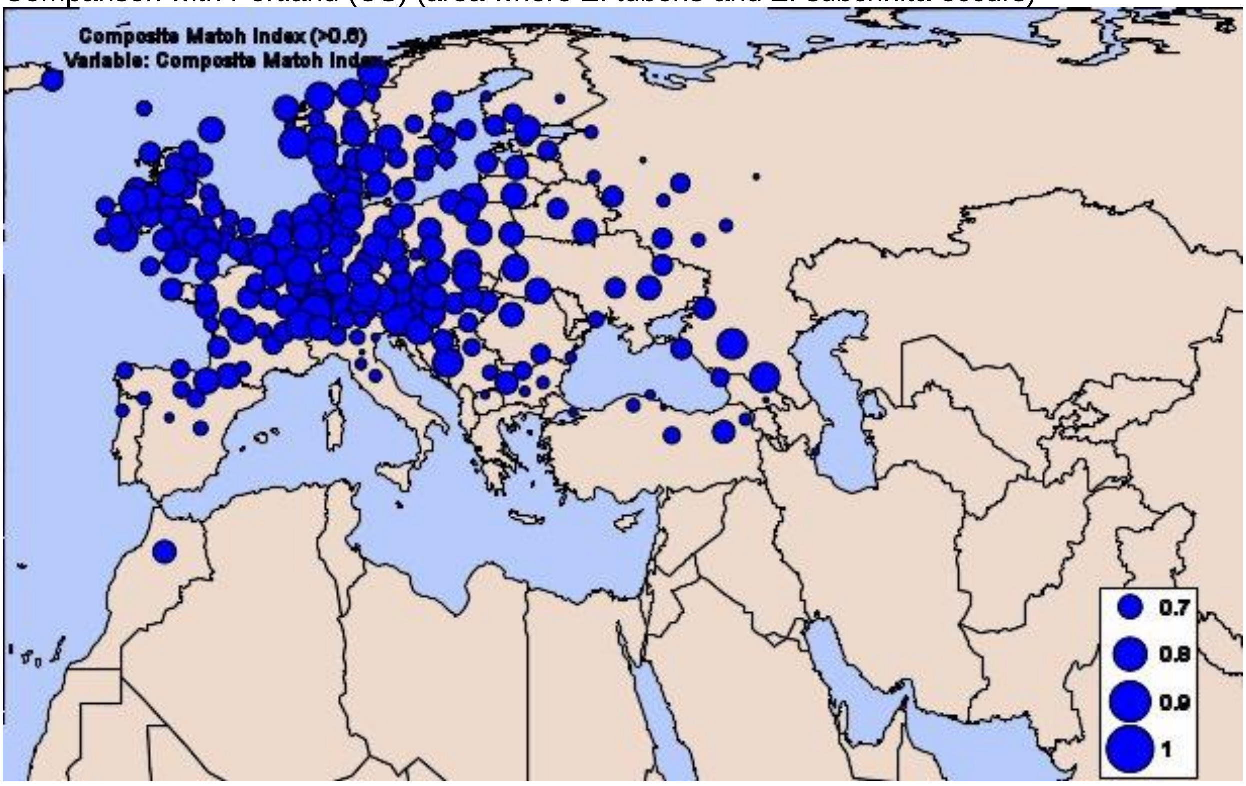
Appendix 3 Comparison of climate between zones where *Epitrix* species are present and the EPPO region.

This comparison of climate was performed using CLIMEX software, with a match index of 0.6. CLIMEX compares the weekly maximum, minimum or average temperatures, rainfall and relative humidity. *This comparison is not based on the biology of the pest.*

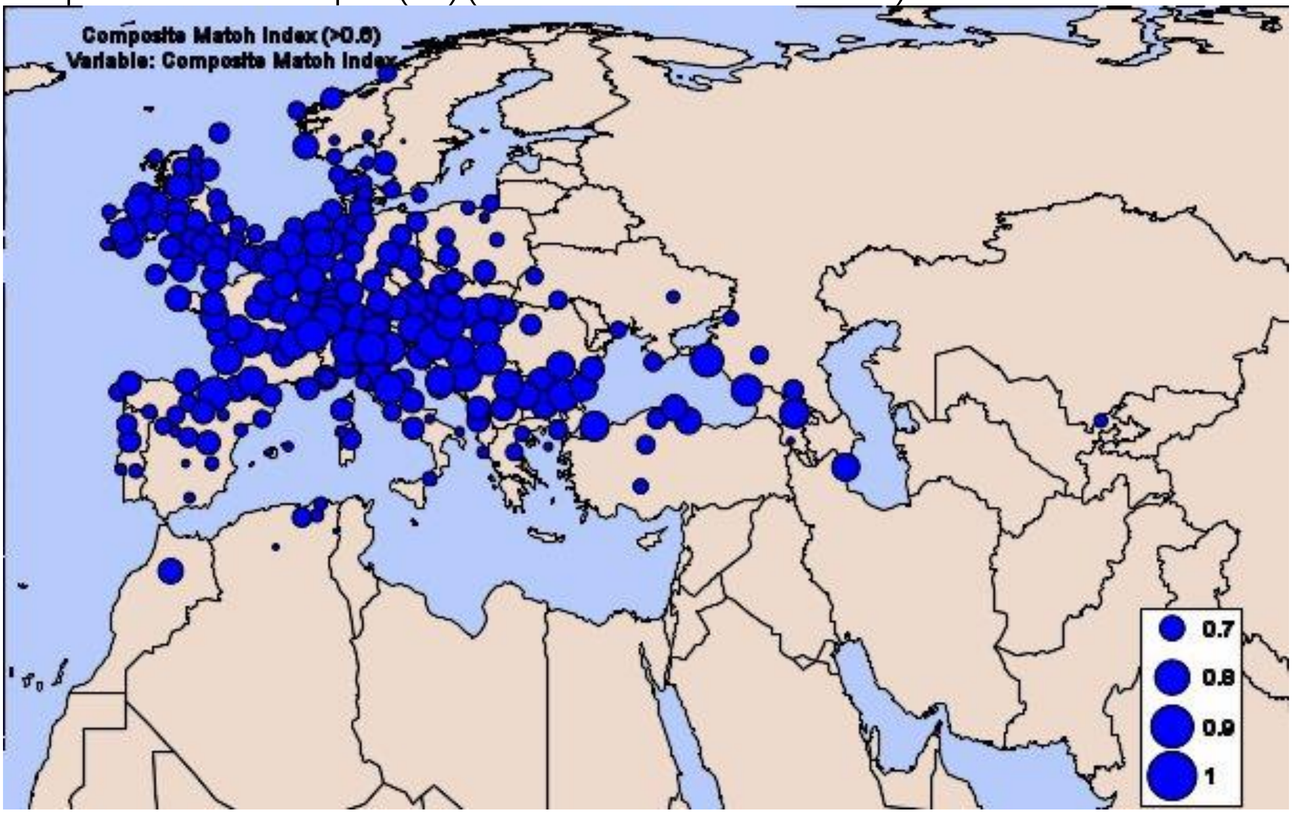
Comparison with Vancouver (CA) (area where *E. tuberis* occurs)



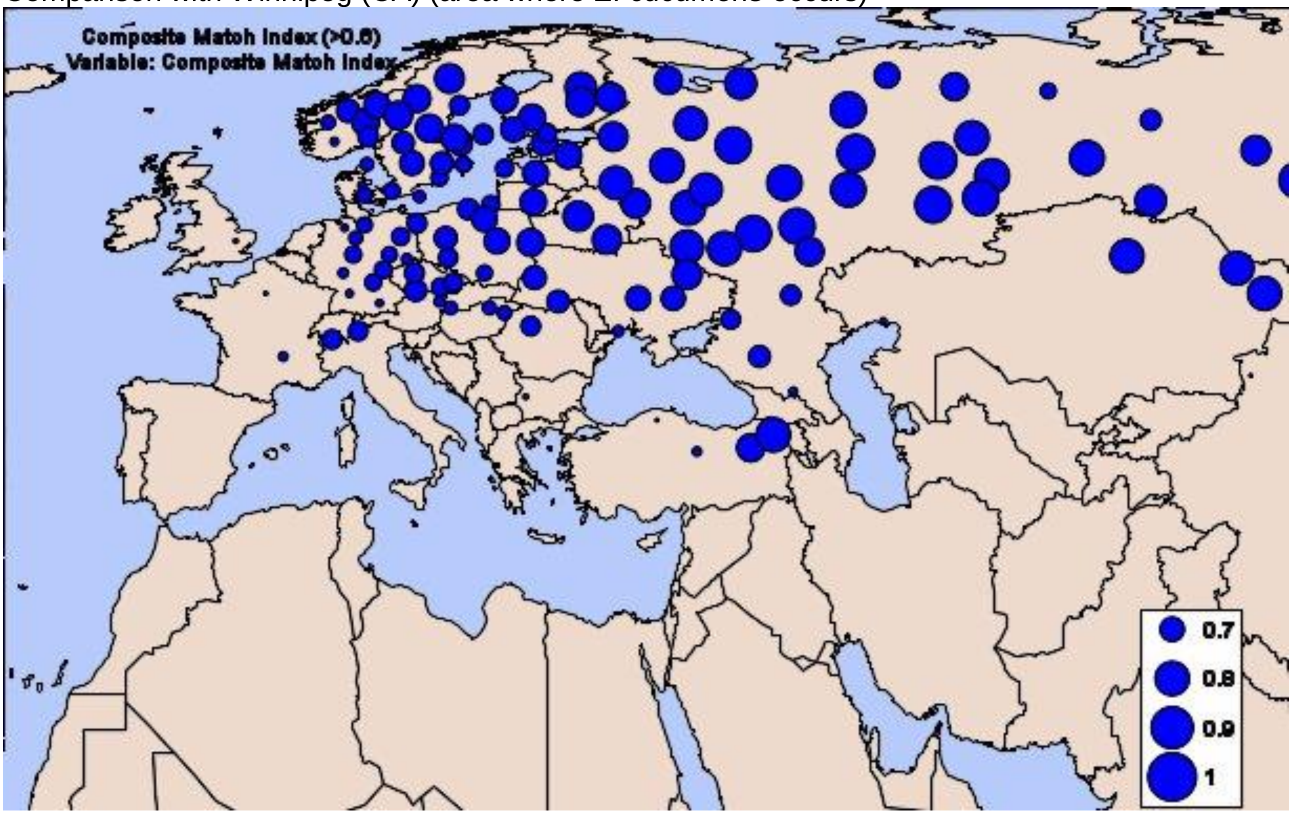
Comparison with Portland (US) (area where *E. tuberis* and *E. subcrinita* occurs)



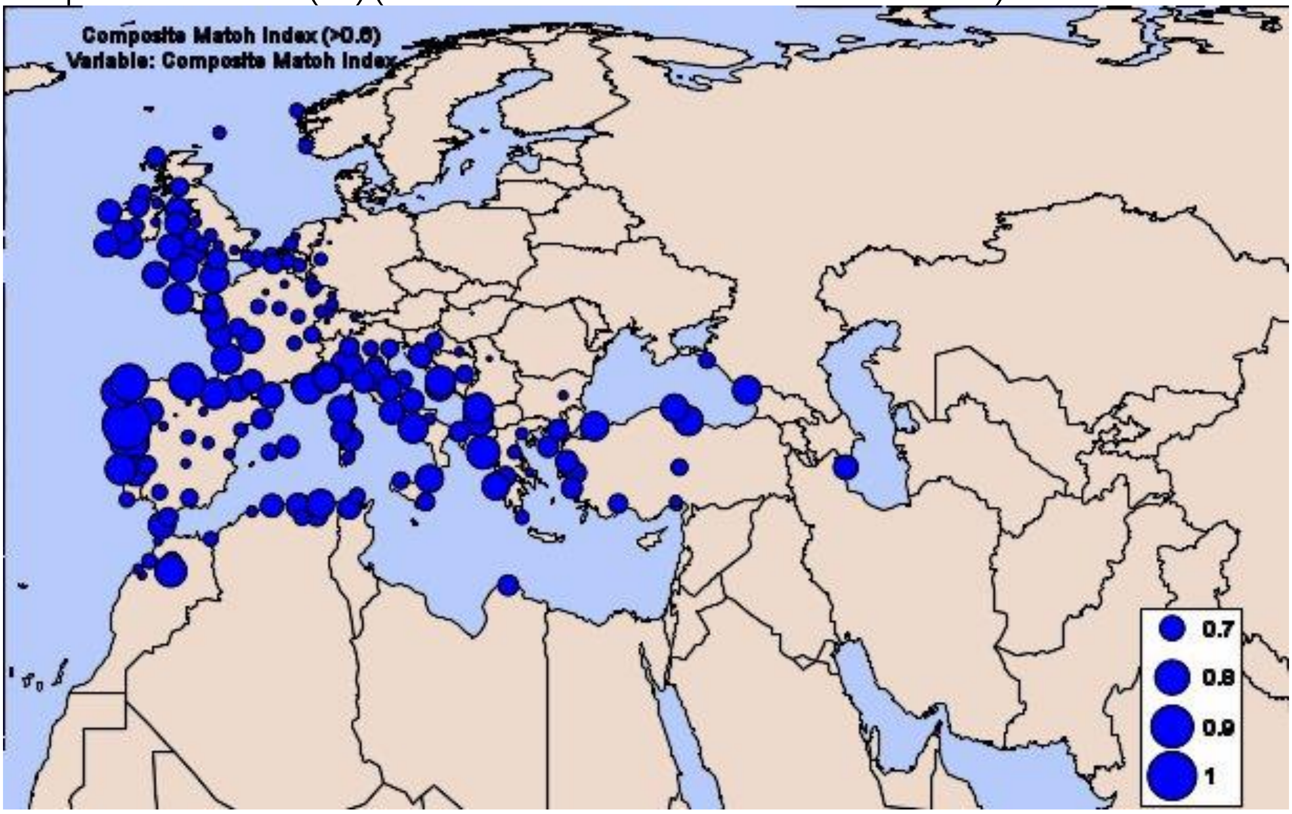
Comparison with Philadelphia (US) (area where *E. cucumeris* occurs)



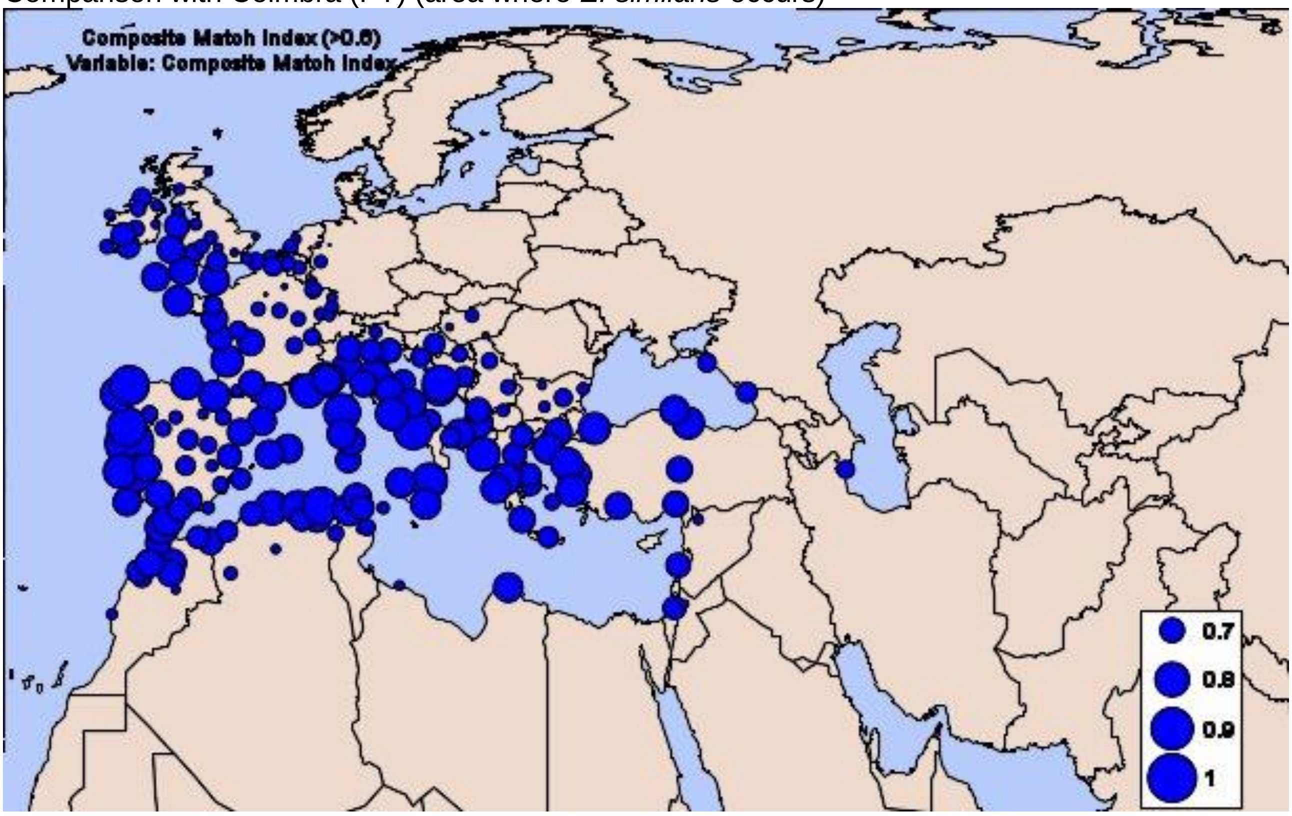
Comparison with Winnipeg (CA) (area where *E. cucumeris* occurs)



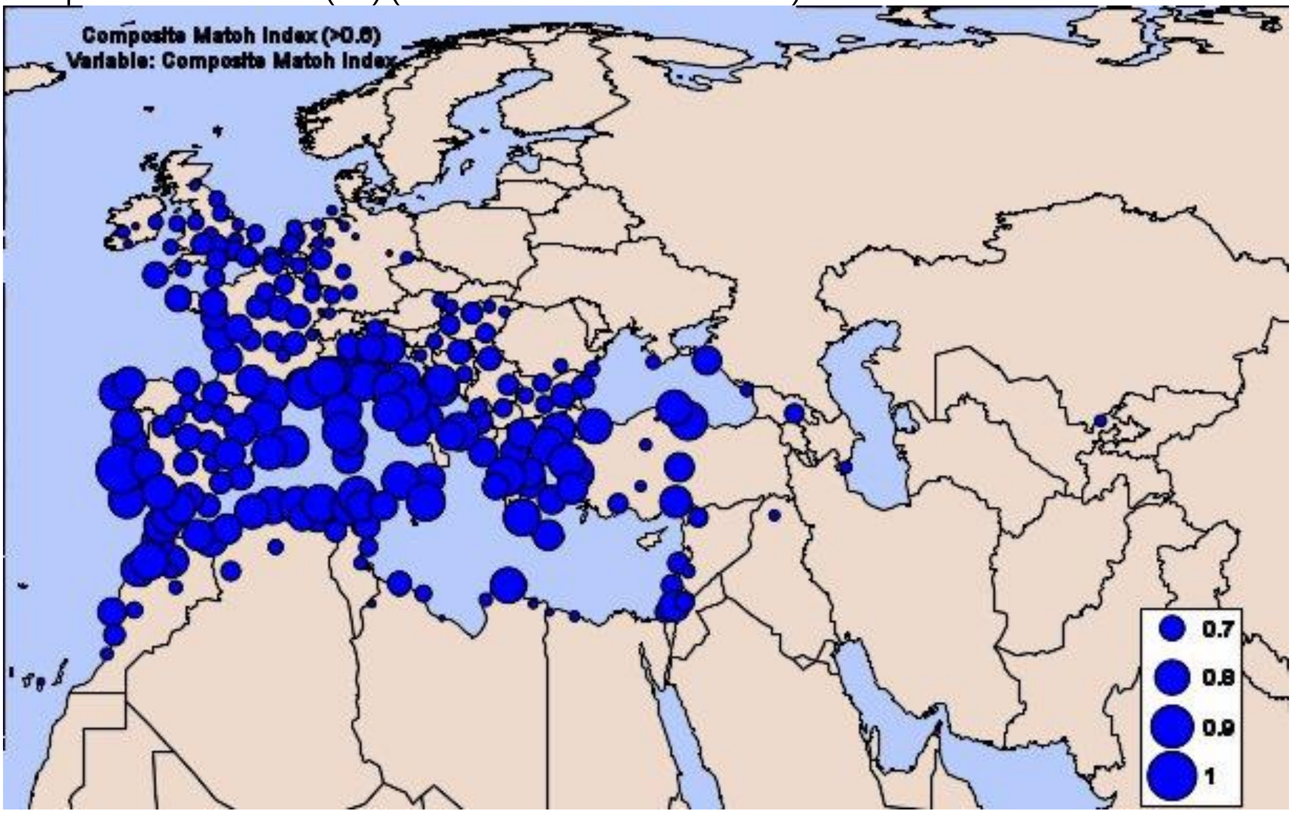
Comparison with Porto (PT) (area where *E. similaris* and *E. cucumeris* occur)



Comparison with Coimbra (PT) (area where *E. similaris* occurs)



Comparison with Lisboa (PT) (area where *E. similaris* occurs)



Comparison with Los Angeles (USA) (area where *E. similaris* and *E. subcrinita* occur)