



Department
for Environment
Food & Rural Affairs

Pest specific plant health response plan: Outbreaks of *Epitrix* potato flea beetles on potato crops

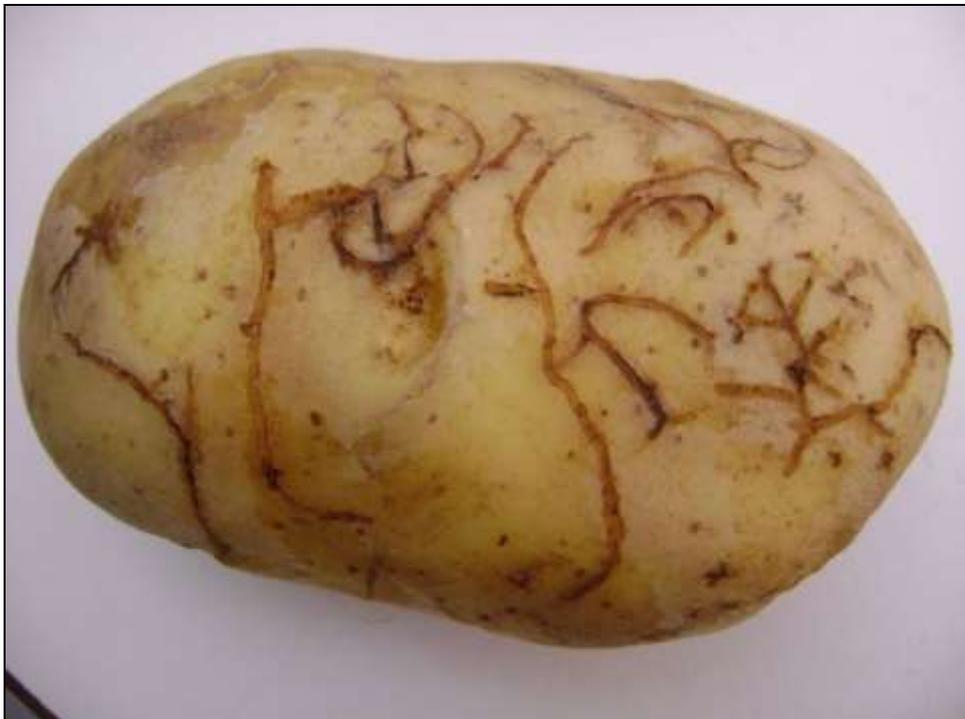


Figure 1. Potato tuber showing feeding damage by the larvae of a potato flea beetle in Portugal. © Conceição Boavida Instituto Nacional de Recursos Biológicos, Portugal

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1. Introduction and scope

- 1.1. This pest specific response plan has been prepared by the Defra Risk and Horizon Scanning team. It describes how the Plant Health Service for England will respond if an infestation of non-indigenous potato flea beetles of the genus *Epitrix* Foudras, and specifically the species *E. cucumeris*, *E. papa*, *E. similaris* and/or *E. tuberis* is discovered on potato (*Solanum tuberosum*).
- 1.2. This document will be used in conjunction with the Defra Contingency Plan for Plant Health in England, which gives details of the teams and organisations involved in pest response in England, and their responsibilities and governance. It also describes how these teams and organisations work together in the event of an outbreak of a plant health pest.
- 1.3. The aim of this response plan is to facilitate the containment and eradication of *E. cucumeris*, *E. papa*, *E. similaris* and *E. tuberis*.

2. Anticipate

- 2.1. *Epitrix cucumeris*, *E. papa*, *E. similaris* and *E. tuberis* belong to a group of six *Epitrix* species currently known to feed on potato. They are all North America in origin except for *E. papa*, which is of unknown origin. In 2004, potato tuber damage indicative of *Epitrix* was observed in Europe for the first time, in North Portugal, near Porto. *Epitrix cucumeris* and a second *Epitrix* species were subsequently confirmed as the cause of this damage in 2008. The second species was at first identified as *E. similaris*, but following a morphological investigation this species was recognised as *E. papa* (a new species) in 2015 (Orlova-Bienkowskaja, 2015). This new species has also been recorded in Spain, in Galicia (2010 – date of first record), Asturias (2014), and Andalucia (2015).
- 2.2. Adult *Epitrix* potato flea beetles feed on foliage and produce characteristic “shot-like” holes, while the larvae burrow underneath the surface of tubers, forming holes, serpentine tunnels and deep splinter lesions (Boavida *et al.*, 2013). Damage by larvae often leads to the rejection of tubers by potato packers in Europe and subsequent economic loss. The deeper holes and lesions can also render consignments unsuitable for processing.
- 2.3. In the UK, there have been no interceptions of live *Epitrix* potato beetles. However, there have been three interceptions of dead larvae on washed ware potatoes imported from Spain. *Epitrix* feeding damage has also been found on washed and unwashed ware potatoes originating from areas of Spain where the pest was not known to be present.

3. Assess

- 3.1. *Epitrix cucumeris*, *E. papa* and *E. tuberis* have a mitigated UK plant health risk register score of 30 (moderate risk). *Epitrix similaris* has a lower score of 10 (low risk) because of its very restricted distribution (localised areas in the United States) and very limited reporting of tuber damage. These scores are reviewed as and when new information becomes available (<https://secure.fera.defra.gov.uk/phiw/riskRegister/index.cfm>).

- 3.2. Following the introduction of *Epitrix* potato flea beetles into Portugal, the European and Mediterranean Plant Protection Organization (EPPO) Working Party on Phytosanitary Regulations decided that a Pest Risk Analysis for *E. cucumeris*, *E. similaris*, *E. subcrinita* and *E. tuberis* should be carried out. This was completed in 2011, with modifications in 2012 (http://www.eppo.int/QUARANTINE/Pest_Risk_Analysis/PRA_intro.htm). It should be noted that the PRA refers to *E. similaris* rather than *E. papa* in Portugal and Spain because it was written before *E. papa* was recognised.

4. Prepare

- 4.1. In the EPPO region, *E. tuberis* is an A1 listed pest and *E. cucumeris* is an A2 listed pest. These species are therefore recommended for regulation by EPPO member countries. *Epitrix similaris* is also an A2 listed pest for the EPPO region, but this may change following the recognition that the records of *E. similaris* from Europe were erroneous and were in fact records of *E. papa*, a previously unknown species. Therefore, *Epitrix similaris* has never been recorded in the EPPO region.
- 4.2. The Plant Health Service should be aware of the measures described in this plan and be trained in responding to an outbreak of *Epitrix* potato flea beetles. It is important that capabilities in detection, diagnosis, and risk management are available.

Plants of Solanaceae

- 4.3. Plants of Solanaceae intended for planting, other than seeds, ware and seed potatoes, and other stolon- or tuber-forming plants for planting, are prohibited from third countries other than European and Mediterranean countries (Annex III, Council Directive 2000/29/EC).
- 4.4. Prohibited solanaceous plants can be imported and held under a plant health licence in quarantine conditions (usually for research purposes). Once work on the plants has been completed, destruction of the plants is normally required. However, given adequate testing, the plants can, in some cases, be released from the terms of the licence if they are shown to be free of pests and pathogens.
- 4.5. Plants of stolon- or tuber-forming species of *Solanum* intended for planting (other than *Solanum tuberosum*) must also be tested and found free of harmful organisms (Annex IV part A section 2, Council Directive 2000/29/EC).

Potato

- 4.6. The import of *Solanum tuberosum* tubers for propagation (seed potatoes) into the EU from third countries other than Switzerland is prohibited under Annex III, Council Directive 2000/29/EC. There is a derogation to bring in tubers for trial, scientific or varietal selection purposes (Commission Directive 2008/61/EC), but they must be placed under quarantine conditions and tested for pests before being used for propagation purposes. There is also derogation for Canadian seed potatoes. This allows Greece, Spain, Italy, Cyprus, Malta and Portugal to import, under specified conditions, seed potatoes originating from certain provinces of Canada:

<http://eurlex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32014D0368&from=EN>

- 4.7. Ware potatoes and their hybrids are prohibited from third countries, with the exception of Algeria, Egypt, Israel, Libya, Morocco, Syria, Switzerland, Tunisia and Turkey, and other European third countries which are recognised as being free from *Clavibacter michiganensis* ssp. *sepedonicus*, or in which provisions recognised as equivalent to those of the EU territory for mitigating *C. michiganensis* spp. *sepedonicus* have been fulfilled (Annex III, Council Directive 2000/29/EC).
- 4.8. Movement of potato tubers within the EU from *Epitrix* demarcated to non-demarcated areas should be accompanied by a plant passport that is issued as per Commission Directive 92/105/EEC. The potato tubers should also meet the following conditions:
- That they have been grown in a registered place of production as per Commission Directive 92/90/EEC, or by a registered producer as per Commission Directive 93/50/EEC, or moved from a warehouse or dispatching centre registered as per Commission Directive 93/50/EEC.
 - That they have been washed or brushed before export so that no more than 0.1% of soil remains if they have been imported from a demarcated area in Portugal or Spain.
 - That they are packaged in material that is clean.
- 4.9. Ware tubers must be washed before export from non-demarcated areas of mainland Spain in order to kill or remove any *Epitrix* which might be present.
- 4.10. There is a requirement to notify the APHA at least 2 days in advance of the introduction into England of potatoes from Portugal or Spain. Further details are available from: <https://www.gov.uk/guidance/issuing-plant-passports-to-trade-plants-in-the-eu#history>.
- 4.11. Within the EU, potato tubers for planting must come from advanced breeding selections, have been produced within the EU, been maintained under appropriate conditions, and tested for harmful organisms, using appropriate methods (Annex IV part A section 2, Council Directive 2000/29/EC).
- 4.12. Seed potatoes can only be marketed in the EU if they meet the requirements of Council Directive 2002/56/EU (includes information on certification schemes to ensure healthy plant material).
- 4.13. National UK measures taken against potato tubers from Spain and Portugal are detailed in Appendix B.

5. Response

Official action to be taken following the suspicion or confirmation of *Epitrix* potato flea beetles on imported plants, including tubers and seeds

Holding consignments at interception points, including packhouses

- 5.1. If *Epitrix* potato flea beetles are suspected by the Plant Health and Seeds Inspectorate (PHSI) to be present on a consignment moving in trade, the PHSI should hold the consignment (ideally in a sealed cold store or covered in a way as to not allow the escape of the beetle) until a diagnosis is made. Samples should be sent in by the PHSI to Fera Science Ltd., National Agri-Food Innovation Campus, Sand Hutton, York, YO41 1LZ (01904 462000) in a sealed bag or container, within at least two other layers of containment, which are not liable to be crushed during transit. If an infestation of *Epitrix* potato flea beetles is confirmed, the PHSI will advise the client of the action that needs to be taken by way of an official plant health notice. The consignment should be destroyed by either incineration or deep burial, or re-exported to the place of origin in a sealed container (see also 5.47).
- 5.2. The consignment should also be destroyed or re-exported if dead larvae and/or feeding damage are found on unwashed potatoes. See Appendix B for full details of statutory action on potato tubers arriving from Portugal and Spain.
- 5.3. Any host plants (including any tubers, which should be held) should be surveyed on the site or in the immediate vicinity in the summer and again in the following year for signs of pest presence (see 5.15 -5.18). If the site is in a potato growing area, the two potato fields closest to the site and a field on the prevailing wind side should also be surveyed. Waste disposal processes and areas should likewise be inspected.
- 5.4. A Europhyt notification should be made upon confirmation of an interception of live *Epitrix* potato flea beetles. The European Commission should also be informed if a dead *Epitrix* beetle is found on a consignment from a non-demarcated area. See appendix B for full details of when a notification should be made.
- 5.5. In the event that all or part of the consignment has not been held and has been distributed to other premises prior to diagnosis, trace forward and trace back inspections should take place upon suspicion or confirmation of *Epitrix* potato flea beetles. Details of recent past and future consignments from the same grower/supplier should also be obtained.

Official action to be taken following the suspicion of an *Epitrix* sp.

- 5.6. Due to the potential for spread, if an infestation of *Epitrix* potato flea beetles is suspected in a potato field, an amber alert status should be given by the PHSI. An amber alert status refers to a serious plant pest/disease with potential for relatively slow, but extensive geographical spread leading to host death and/or major economic, food security or environmental impacts.

- 5.7. A Contingency Core Group (CCG), chaired by the CPHO or deputy and including specialists from APHA, Defra and other organisations, should subsequently be set up to assess the risk and decide on a suitable response at strategic and operation levels. This may include gathering more information on the suspected outbreak, notification of ministers and senior officials, and agreeing a communications strategy. An Incident Management Team (IMT) meeting, chaired by the Incident Commander, will follow the CCG. This will produce an Incident Action Plan to outline the operational plan. See the Defra Contingency Plan for Plant Health in England for full details.

Restrictions on movement of material, equipment and machinery to and from the place of production

- 5.8. Eggs, larvae, pupae and adults can be transferred in soil associated with non-host material, equipment and machinery, and adults can hitch hike on these (EPPO, 2010). Movement of material, equipment and machinery from infested areas (i.e. the field where the beetle was found) should therefore be restricted. However, if movement is necessary, the material, equipment and machinery should be thoroughly cleaned to remove any soil and life stage of *Epirix* potato flea beetles.

Preliminary trace forward / trace backward

- 5.9. Based on their biology, *Epirix* potato flea beetles are most likely to be associated with imports of seed and ware potatoes with soil attached (EPPO, 2010). These potatoes are likely to be from the EU (Portugal and Spain), as third countries apart from Canada (including those where the beetles are present) are prohibited from importing potato tubers (see point 4.6), and the potatoes are more likely to be for consumption, as seed potatoes undergo a rigorous selection and testing process prior to import (see point 4.10). In comparison to Spain, imports of ware potatoes from Portugal have been small in recent years. Potatoes from Portugal are also generally washed prior to export, minimising the risk of any live stages of *Epirix* potato flea beetles being present. The risk posed by Spanish ware is therefore of more concern. Several consignments of ware potatoes imported from Spain into the UK in 2015 showed *Epirix* feeding damage, and in three of these consignments of imported washed potatoes, dead larvae were found to be present in the serpentine tunnels under the skin of the tubers. There were also a number of consignments that had come in unwashed and all of these came from areas thought to be free of *Epirix* potato flea beetles, and so these areas had no official containment or eradication measures. Although, this risk has now been reduced by national measures introduced in 2015 which require potato tubers to be washed from non-demarkated zones of Portugal and Spain.
- 5.10. Information obtained regarding the origin of suspected tubers (or plants) should be used to find out locations where other potentially infested tubers (or plants) may be or where cross contamination may have occurred. Information should also be obtained on the location to which suspect tubers (or plants) have been sent. This process is particularly important for propagation or seed potato stocks.

Confirming a new outbreak

How to survey to determine whether there is an outbreak

- 5.11. Information to be gathered by the PHSI on the suspicion of an infestation of *Epitrix* potato flea beetles, in accordance with ISPM 6; guidelines for surveillance (http://www.acfs.go.th/sps/downloads/13717_ISPM_6_E.pdf):
- The origin of the potatoes and seed lot numbers etc.
 - Details of other premises or destinations where the potatoes have been grown or sent, where the beetles may be present.
 - The layout of the premises and surrounding area, including a map of the fields/cropping/buildings, at risk growers, and details of neighbouring crops, especially any commercial or non-commercial solanaceous crops in fields, allotments, gardens or glasshouses.
 - Details of the crop variety, growth stage and any other relevant information.
 - Description of the surrounding habitat.
 - Level of infestation, including a description of symptoms (as well as photos if possible). These would include shot-holes on foliage, and serpentine tunnels and holes in tubers.
 - The date and time the sample was taken, how it was identified and by whom.
 - Current treatments/controls in place e.g. chemical treatments.
 - Details on the movement of people, equipment, machinery etc. to and from the infested area.
 - Cultural and working practices.
 - If in a store, details of consignments stored next to the suspect consignment.
- 5.12. Further to information gathering, samples of other beetles and tuber feeding damage should be taken to confirm the extent of the infestation e.g. in surrounding lots or fields. This initial survey will be used to determine if it is an isolated finding or an established outbreak (see 5.23-5.27).
- 5.13. If at a processor/packer, any host plants (including any tubers, which should be held) should be surveyed on the site or in the immediate vicinity in the summer and again in the following year for signs of pest presence (see 5.15 -5.18). If the site is in a potato growing area, the two potato fields closest to the site and a field on the prevailing wind side should also be surveyed (crops in these fields should be held under notice pending inspection). Waste disposal processes and areas should likewise be inspected.
- 5.14. Finance for the surveys will depend on the individual circumstances of the outbreak, and will be subject to discussion, usually between Defra policy and the PHSI.

Sampling

- 5.15. Adult *Epitrix* beetles are small (1.5 – 2 mm in length), oval, convex and black, and feed on the foliage of host plants. Because they are difficult to see and jump when disturbed, sweep netting should be used to capture the adults. This would ideally be carried out in places where the foliage of host plants exhibits shot-hole like damage, which is indicative of adult presence. There are two methods of sweep netting, depending on the size of the vegetation:
- 1) Young potato plants and herbaceous vegetation surrounding the crop. To use a sweep net, swing it in an approximately 180° arc such that the net rim strikes the top 6 to 8

inches of vegetation. Hold the net slightly less than vertical so the bottom edge strikes the vegetation before the top edge. This will facilitate getting the insects into the net. A common practice is to take a sweep from right to left, walk a step, and take another sweep, left to right (see https://www.youtube.com/watch?v=c5dVt3n1_EE for an example). Do this quickly as *Epitrix* beetles drop off the vegetation when they see you approach. Try to avoid chopping the tops of the plants and filling your net with vegetation. After taking the desired number of sweeps (about four or five), grasp the net bag with a hand at about the mid-point. Shake the bag so that most of the insects fall to a bottom corner of the bag, quickly put an open plastic tube into the corner and pour in the insects caught. Seal the tube and label it. Some insect collectors prefer to put their head into the net and only catch specific target insects using an electronic aspirator or pooter. Take the tube containing the insect catch to the laboratory and cool it in a fridge before opening it and examining the contents. *Epitrix* can jump and move surprisingly fast, particularly in warm conditions, and can therefore be difficult to collect in the field. You may need to practice and modify your technique to suit the local circumstances. Do not sweep wet vegetation.

2) Larger potato plants. The sweep net can be used like a beating tray if inspecting mature potato plants. Place the net below the plant and strike it sharply with a stick or give it a quick shake. If there are *Epitrix* beetles present, they should fall into the net. Capture them into a plastic tube using the same procedure as described above.

5.16. Larvae normally feed externally and/or just underneath the surface of potato tubers. Tubers should be inspected for characteristic holes, serpentine tunnels, and black splinter lesion feeding damage (deeper holes with a trail of corky material inside the tuber).

5.17. Tuber inspections are best undertaken on tubers during harvesting, grading or in store because a large number of tubers can be inspected more easily than in the growing crop. Tuber symptoms are also likely to be more evident later in the growing season. Tubers discarded on grading or packing lines should be targeted for inspection.

5.18. Following the identification/capture of an adult, pupae, larva, and/or larval feeding damage, the samples should be sent for diagnosis as in point 5.1. Each sample should be labelled with full details of sample number, location (including grid reference if possible) and variety.

Diagnostic procedures

5.19. Morphological diagnosis of *Epitrix* potato flea beetles can only be done for adults and requires microscopic examination of genitalia. EPPO diagnostic protocol PM 7/109 (EPPO, 2011a) is recommended for the identification of *E. cucumeris* and *E. tuberis*. *Epitrix similis* is also included in the protocol, but this species was included prior to the description of *E. papa*. The use of Orlova-Bienkowskaja (2015) for the diagnosis of *E. similis* and *E. papa* is therefore preferred.

Criteria for determining an outbreak

5.20. If *Epitrix* potato flea beetles are detected at a location and are not confined to a particular consignment(s) then an outbreak should be declared. For example, if they are identified in a potato field, then this would be classified as an outbreak. However, if they are restricted to

recently imported potatoes within a cold store, then this would be classified as an interception. If only symptoms of *Epitrix* potato flea beetles are found, then the outbreak should be treated as suspected until live stages are found.

Official Action to be taken following the confirmation of an outbreak

5.21. The scale of the outbreak will determine the size and nature of the management team and action.

Communication

5.22. The Incident Management Team will assess the risks and communicate details to the IPPC, EU and EPPO, in accordance with ISPM 17: pest reporting (<https://www.ippc.int/en/publications/606/>), as well as within Government to Ministers, senior officials and other government departments and agencies (e.g., the Environment Agency) on a regular basis as appropriate; and to stakeholders.

Surveillance and demarcated zones

5.23. After an outbreak has been detected, a regulated area should be established that includes:

- An infested zone (i.e. the infested field or crops).
- A buffer zone, which should extend out at least 1 km radius from the edge of the infested zone.

5.24. Areas where machinery used was the same as that for the infested zone, and any other areas where there is a perceived risk should also be surveyed. If resources are limited, priority should be given to areas where there has been movement of large quantities of soil from the infested zone, though this should be agreed by the IMT on a case by case basis.

5.25. All host plants in the infested zone should be visually inspected, samples taken and suspect samples sent for diagnosis (see 5.15-5.18).

5.26. Potato fields neighbouring the infested zone should also be surveyed, and if resources allow, survey should be extended to potato fields and hosts within the buffer zone.

5.27. The regulated area should be adjusted in response to further findings. If *Epitrix* potato flea beetles are found within a field outside the infested zone, this should subsequently be designated as infested. If beetles are found within uncropped areas outside the infested zone, then any fields directly adjacent to these areas should normally be designated as infested.

Decontamination procedures

5.28. All non-disposable material, equipment and machinery, should be thoroughly cleaned (e.g. using water at high pressure) to remove the pest and any soil. Ideally, the cleaning should be carried out within the demarcated area.

- 5.29. Any waste (plant or other potentially infested material) should be removed and destroyed (via deep burial, incineration or other appropriate methods prescribed in 5.47-5.48).

Tracing forwards / backwards

- 5.30. Once other sites that are potentially infested by *Epitrix* potato flea beetles have been identified, these should be inspected as per 5.15-5.18.
- 5.31. Information, which is aimed at raising awareness of the pest and its symptoms, should be sent to affected and at risk growers e.g.
https://secure.fera.defra.gov.uk/phiw/riskRegister/plant-health/documents/notifiable_pests/epitrix-potato-flea-beetle-factsheet.pdf

Pest Management procedures (based on EPPO national regulatory control system)

Scenario 1: Outbreak in a potato crop at an early stage of growth (i.e. prior to tuber formation) – infested zone

- 5.32. The whole crop should be treated as soon as possible with a foliar insecticide. Foliar insecticides will kill adults above ground, but will have no effect on the eggs, larvae, pupae or adults within the soil. The Defra Risk and Horizon Scanning team should be consulted about the most appropriate treatments.
- 5.33. Sweep nets should be used to sample for adults before and after spraying to assess the efficacy of insecticide treatments (see 5.15). Sweep netting should not be carried out while the crop is still wet with insecticide, so it is best to leave the crop at least a couple of days after spraying.
- 5.34. When the level of adults is low (no beetles caught), the potato haulm should be destroyed (using methods in 5.47) to eliminate the food supply of *Epitrix* potato flea beetles and thereby reduce their ability to survive and multiply.
- 5.35. If the level of adults is high (beetles caught), the potato haulm should **not** be destroyed due to the high risk of adults dispersing to hosts in other fields/sites.
- 5.36. Even if the level of adults is low when the haulm is destroyed, there is still a risk of some adults (including newly emerging adults) spreading further afield. Several rows of crops should therefore be left at the edge of the field to act as trap crops. These should be treated regularly with insecticide and destroyed later in the season.
- 5.37. Any tubers which may have developed early should not be harvested due to the risk of pest dispersal with the tubers and any associated soil. Destruction of tubers in a way that does not risk further spread (e.g. exposure to frost) should be considered, and will be decided by the Incident Management Team.
- 5.38. Host plants, such as weeds, and other plant material in the infested zone, and uncropped areas, field boundaries and hedgerows in the immediate vicinity of the infested zone should be destroyed by herbicide or mechanical means.

Scenario 2: Outbreak in a growing potato crop (tubers have developed) – infested zone

- 5.39. This is the same as for scenario 1, but because tubers are present for the *Epitrix* potato flea beetle larvae to feed on, the benefit of destroying the potato haulm to remove the food supply for larvae is less clear cut. Furthermore, early destruction of the plant haulm may cause the dispersal of adults, which may be present in higher numbers at this stage of the season. The decision therefore will need to be made on a case by case basis.
- 5.40. The crop should not be harvested because of the risk of spread. Measures should be taken to reduce potential volunteer problems in the following year. This may include the application of a herbicide (e.g. Reglone) to the growing crop to prevent sprout development of progeny tubers. Any volunteer potato plants that grow in the field should be destroyed soon after emergence.

Scenario 3: Measures to be taken in the case of detection of infestation in tubers after harvest (e.g. in a grower's potato store or during processing/packaging when the tubers can be traced back to a known crop or farm)

- 5.41. The following should be designated as infested:
- The lot from which the sample was taken and lots that the *Epitrix* potato flea beetles may have spread to.
 - The waste from the infested lot, such as soil and processed waste.
 - The equipment and other articles (e.g. machinery and packing material) which have been in contact with the lot.
 - The field where the lot was grown.
- 5.42. As in point 5.23, a buffer zone should be created that extends out to 1km from the infested field and store.
- 5.43. Areas where machinery used was the same as that for the infested zone, and any other areas where there is a perceived risk should also be surveyed. If resources are limited, priority should be given to areas where there has been movement of large quantities of soil from the infested zone.
- 5.44. There is the risk that other potato stocks may have become infested after harvest. This could have been through the transfer of soil in grading lines or storage boxes. Any tubers in storage should therefore be inspected for symptoms and for the presence of *Epitrix* potato flea beetles.

Crops growing within the buffer zone (1km around the infested zone) in the year of the outbreak

- 5.45. If no infestation is found in the potato crops growing in the buffer zone following surveillance (5.23-5.26) then they should be treated with a programme of foliar insecticides until harvest and monitored for any sign of *Epitrix* potato flea beetles. Potato tubers should also be inspected during and/or immediately after harvesting.
- 5.46. All potato tubers that are harvested should be washed to remove soil and the pest prior to movement outside of the buffer zone. The potatoes will also only be marketed as ware potatoes and will not be used as farm saved seed.

Disposal plan

Infested growing host crops

- 5.47. The primary means of destruction of potato plants in a field is through herbicide application. Actives that can be used include glyphosate, diquat (e.g. Reglone), carfentrazone-ethyl (e.g. Spotlight plus) and glufosinate-ammonium (e.g. Harvest), but the Defra Risk and Horizon Scanning team should be consulted for appropriate treatments.

Infested harvested tubers

- 5.48. Adults, pupae and possibly larvae may be present with the harvested tubers, associated soil and plant debris. It is important that all of this material is disposed of safely so as to eliminate the pest. When deciding on the most appropriate method(s) of disposal, factors such as the likelihood of adults being present, the level of handling and transportation required, all need to be taken into account. For all methods, measures need to be taken to ensure that there is no risk of spread during transport and treatment or disposal. Tubers that can be moved safely should be destroyed by incineration at a licensed facility (if in small quantities) or deep burial. Disposal and/or destruction should be under the approval and supervision of the PHSI. If the material has to be moved off the premises, it should be contained within at least one sealed layer, and two layers if possible. Deep burial may be done at an approved landfill site, or on the site or nearby farm, but only in agreement with the local Environment Agency. Incineration must comply with appropriate waste management regulations, Environment Agency in England, Scottish Environment Protection Agency and Natural Resources Wales.
- 5.49. Other possible methods of destruction for potato tubers should be considered on a case by case basis and include heat sterilization, industrial processing (under official supervision), fermentation and composting, steaming and feeding to animals, and anaerobic digestion (minimum temperature of 55°C for 24 h without interruption with a hydraulic dwell time in the reactor of at least 1 day).
- 5.50. All objects designated as 'infested', such as equipment, machinery, storage facilities that may be contaminated with infested soil or potato material should be thoroughly cleaned (e.g. using water at high pressure) to remove the pest and any soil.

Measures in subsequent seasons

Infested zone

- 5.51. No host or root crop should be planted for at least 2 years and until no volunteer plants have been found for 2 consecutive years. Trap crops planted in the year following the outbreak are exempt from this rule.
- 5.52. Any volunteer plants should be destroyed early in the season following the outbreak. If the population of volunteer plants is low, they can be removed by hand, but if the population of

volunteer plants is high, they are best controlled by an application of an effective herbicide (see 5.47). Solanaceous weeds should also be controlled in a similar way.

- 5.53. 'Infested' fields may be maintained in permanent pasture with frequent close cutting or intensive grazing. This option has the advantage of providing effective control of potato volunteers and solanaceous weeds.
- 5.54. Following 2 years without volunteer plants, only ware potatoes should be produced (if potatoes are grown), with the growing crop and harvested tubers inspected for *Epitrix* potato flea beetles. If there are no finds of the pest following this, then seed potatoes can also be produced on the field.

Buffer zone (1km around the infested zone)

- 5.55. Host crops should not be planted outdoors for at least 2 years. Volunteer plants and weeds should be destroyed. Following this period, only ware potatoes should be produced with the growing crop and harvested tubers inspected for *Epitrix* potato flea beetles. If there are no finds of the pest, then either seed or ware potatoes can be produced on the field.
- 5.56. Host crops planted indoors should be monitored, and if *Epitrix* potato flea beetles found, the site (which may include outdoor fields) should be designated as infested and an appropriate programme of insecticides applied.

6. Criteria for declaring eradication / change of policy

- 6.1. *Epitrix* potato flea beetles can be declared eradicated (by the Chief Plant Health Officer) in potato after at least three years during which time no *Epitrix* potato flea beetles have been found. These three years must include 2 consecutive years without volunteer plants and then either a year with a ware potato crop or trap potato crop.

7. Evaluation and review of the contingency plan

- 7.1. The Defra Contingency Plan for Plant Health in England requires that the pest specific plan is reviewed following an outbreak. This pest specific contingency plan should also be reviewed annually to take into account of changes in legislation, control procedures, pesticides, sampling and diagnosis methods, and any other relevant amendments.
- 7.2. Lessons should be identified during and after any *Epitrix* or non-*Epitrix* outbreak, including what went well and what did not. These should be included in any review of the contingency plan leading to continuous improvement of the plan and response to outbreaks.

8. Appendix A

Data sheet for *Epitrix similaris*, *Epitrix tuberosa*, *Epitrix cucumeris* and *Epitrix papa*

Identity

PREFERRED SCIENTIFIC NAME	AUTHOR (taxonomic authority)
<i>Epitrix similaris</i>	(Gentner, 1944)
<i>Epitrix tuberosa</i>	(Gentner, 1944)
<i>Epitrix cucumeris</i>	(Harris, 1851)
<i>Epitrix papa</i>	(Orlova-Bienkowskaja, 2015)

CLASS: Insecta

ORDER: Coleoptera

SUBORDER: Polyphaga

SUPERFAMILY: Chrysomeloidea

FAMILY: Chrysomelidae

SUBFAMILY: Galerucinae

INTERNATIONALLY USED COMMON NAME/S & INTERNATIONAL LANGUAGE

***Epitrix similaris*:**

Amerikanische Kartoffelerdföhe (German)

Potato flea beetle (English)

Pulguilla de la patata (Spanish)

Altise américaine de la pomme de terre (French)

***Epitrix tuberosa*:**

Tuber flea beetle (English)

Altise des tubercules (French)

***Epitrix cucumeris*:**

Amerikanischer Kartoffelerdfloh (German)

Nordamerikanischer Kartoffelerdfloh (German)

Potato flea beetle (English)

Pulguilla del pepino (Spanish)

Pulguilla negra (Spanish)

Altise de la pomme de terre (French)

OTHER COMMON NAMES & COUNTRY WHERE USED

***Epitrix similaris*:**

Epitrix-da-batateira (Portuguese)

***Epitrix cucumeris*:**

Patetes toprak piresi (Turkish)

Notes on taxonomy and nomenclature

Epitrix is a large genus, which is composed of nearly 180 species (Doeberl, 2000). *Epitrix similis*, *E. tuberos*, *E. cucumeris* and *E. papa* are part of a group of six beetles that also includes *Epitrix subcrinita* and *Epitrix hirtipennis* (tobacco flea beetle) that are all reported to feed on potatoes.

Biology and ecology

Life history

The basic life cycle of the four *Epitrix* species is similar (see fig. 2). Most is known about the life cycle of *E. tuberos*, with fewer studies on the other three species.

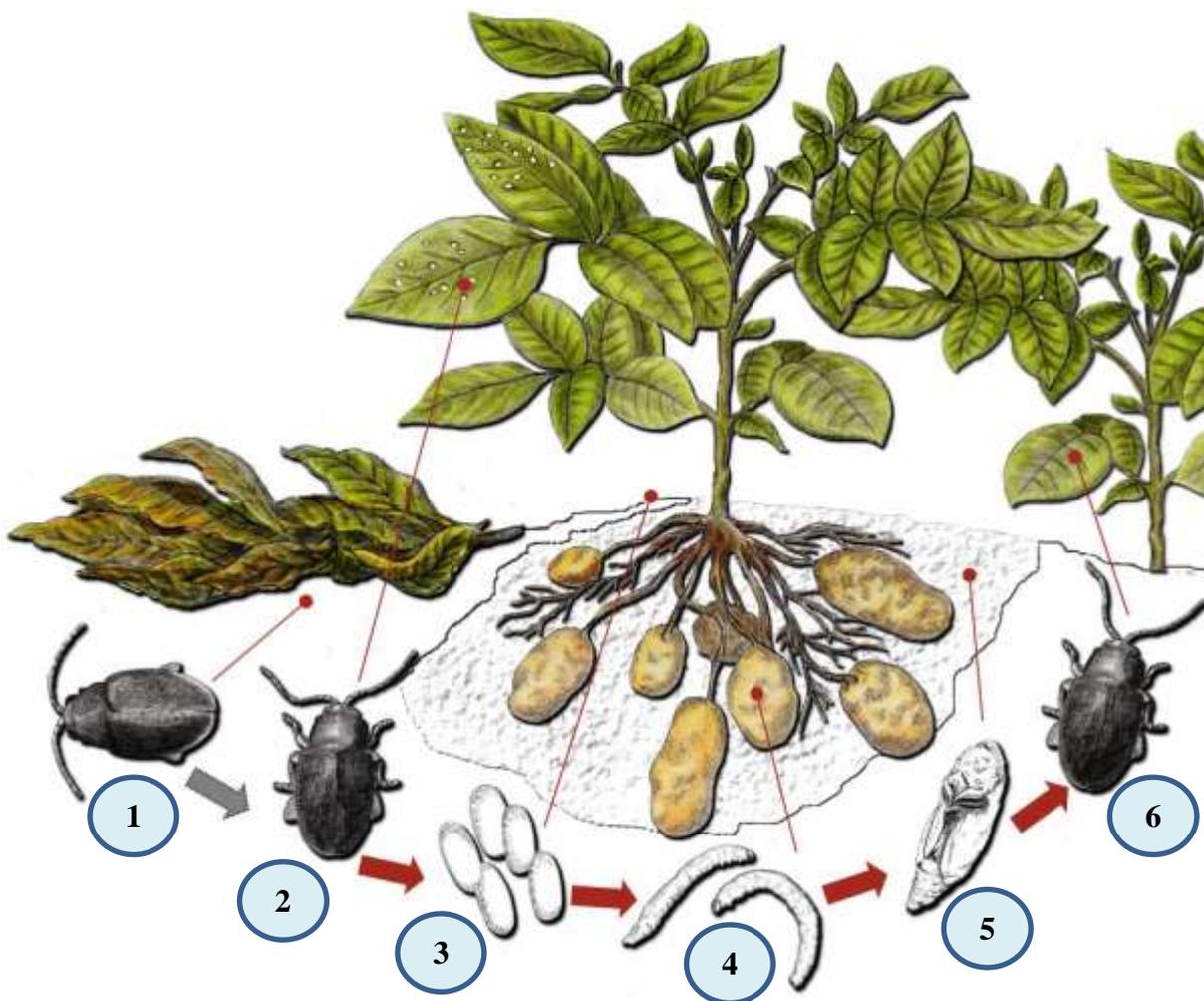


Figure 2. Life cycle of *Epitrix* potato flea beetles.

Adult *Epitrix* beetles overwinter in the soil, nearby to their host plants, and this often occurs in field margins, especially if solanaceous weed hosts are present (1 in fig. 2). Their survival in the soil depends partly on the depth at which they overwinter; *E. tuberos* adults survive well at 20-30 cm (Davis and Landis, 1947), and can survive down to depths of 60 cm (Campbell *et al.*, 1989). Following emergence in spring (or summer depending on location), adults feed on the upper leaf surfaces of the host plants (2). *Epitrix tuberos* has also been observed to move to the lower surface under windy conditions and at night (Bérubé, 2000). Adults usually colonise plants on the outer

edges of the potato crop first. Movement onto these plants, and those further inwards, can take place via walking, jumping or flying.

Mating occurs within 24 h of emergence in *E. tuberis*. After 5-6 days, adults lay up to 200 eggs over the next 12-55 days, either singly or in small batches of 11-15 in the soil or at the base of the host plant (3, Campbell *et al.*, 1989; Neilson and Finlayson, 1953). The number of eggs laid by any one adult varies depending on the host plant (Boavida *et al.*, 2013).

After an incubation period of 3-14 days, larvae of *E. tuberis* and *E. cucumeris* hatch from the eggs and feed on the roots and tubers of the host plant for 2-4 weeks (4). Pupation subsequently takes place in the soil, lasting around 4-10 days (5). The adults then emerge and begin feeding on the leaves (6). These adults mate and the life cycle begins once more. Up to 3 generations can occur within a single season. This means that thousands of progeny can potentially be derived from each female. Extensive tuber damage can therefore occur in potato crops where very low populations of adults were present at the start of the season.

Hosts/crops affected

The most significant host of all four *Epitrix* species is potato (*Solanum tuberosum*). A recent host preference study undertaken in Portugal also indicates that a further four plants are hosts for *E. papa* and *E. cucumeris* (Boavida *et al.*, 2013). Both species were demonstrated to feed and reproduce on aubergine (*Solanum melongena*), tomato (*Solanum lycopersicum*), and the weeds, black nightshade (*S. nigrum*) and thornapple (*Datura stramonium*). The highest number of progeny produced by *E. papa* was on *S. nigrum* and potato. *Epitrix cucumeris* likewise showed a greater number of progeny on *S. nigrum* than on the other host plants tested. These *Epitrix* species, along with *E. tuberis*, also regularly feed on other members of the nightshade family (Solanaceae), and occasionally feed on other plant families, and may feed on more species than are currently listed (e.g. sugar beet). It should be noted, however, that feeding does not necessarily imply completion of the life cycle on the species. The full list of plants on which feeding by the four species has been recorded are shown in table 1.

Table 1. Host plants of *Epitrix tuberis*, *E. cucumeris*, *E. similaris* and *E. papa* (marked with an X symbol) (CABI, 2014a, b, c; EPPO, 2010). The hosts on which the species have been confirmed to complete their life cycle are marked with the letter H.

Host plant	<i>E. tuberis</i>	<i>E. cucumeris</i>	<i>E. similaris</i>	<i>E. papa</i>
<i>Alcea rosea</i> (Hollyhock)	X			
<i>Allium cepa</i> (onion)		X		
<i>Armoracia rusticana</i> (horseradish)	X			
<i>Beta vulgaris</i> (beetroot)	X	X		
<i>Brassica oleracea</i> (cabbages, cauliflowers)	X	X		
<i>Capsicum annum</i> (bell pepper)		X		
<i>Capsicum frutescens</i> (chilli)	X			
<i>Chenopodium album</i> (fat hen)	X			
<i>Chenopodium spp.</i> (goosefoots)		X		
<i>Cirsium arvense</i> (creeping thistle)	X			
<i>Cucumis sativus</i> (cucumber)	X	X		
<i>Curcubita pepo</i> (ornamental gourd)		X		
<i>Datura stramonium</i> (thorn apple)		XH		XH
<i>Descurainia pinnata</i> (pinnate tansymustard, USA)	X			
<i>Helianthus annuus</i> (sunflower)		X		
<i>Lactuca sativae</i> (lettuce)	X	X		

<i>Medicago sativa</i> (lucerne)	X			
<i>Nicotiana tabacum</i> (tobacco)	X	X		
<i>Phaseolus</i> (beans)		X		
<i>Phaseolus vulgaris</i> (common bean)	X			
<i>Physalis</i> (groundcherry)	X			
<i>Raphanus sativus</i> (radish)	X			
<i>Ribes rubrum</i> (red currant)	X			
<i>Sinapis arvensis</i> (wild mustard)	X			
<i>Solanum jasminoides</i> (potato vine)				
<i>Solanum lycopersicum</i> (tomato)	X	XH		XH
<i>Solanum melongena</i> (aubergine)	X	XH		XH
<i>Solanum nigrum</i> (black nightshade)	X	XH		XH
<i>Solanum rostratum</i> (prickly nightshade)	X			
<i>Solanum triflorum</i> (cutleaf nightshade, USA)	X			
<i>Solanum trifolium</i> (weed)				
<i>Solanum tuberosum</i> (potato)	XH	XH	XH	XH
<i>Spinacia oleracea</i> (spinach)	X			
<i>Stellaria media</i> (common chickweed)	X			
<i>Taraxacum officinale</i> complex (dandelion)				
<i>Zea mays</i> (maize)		X		

Plant stage affected

The *Epitrix* potato flea beetles affect plants during growth and during tuber production.

Plant parts affected

Leaves, roots and tubers.

Symptoms/signs - description

The adult *Epitrix* potato flea beetles feed on foliage, producing numerous “shot-like” holes that are 1-1.5 mm in diameter.

Larvae burrow beneath the surface of tubers, leading to three main types of damage; holes, serpentine tracks and black splinter lesions (Boavida *et al.*, 2013; see Fig. 1 for serpentine tunnels).

Feeding damage by larvae increases the likelihood of infection from pathogenic bacteria and the development of soft rots. The larvae may also vector *Verticillium dahliae*, *Fusarium coeruleum* and *Thanatephorus cucumeris* (EPPO, 2005).

Morphology

Eggs:

Elliptical, off-white and approximately 0.5 mm long x 0.2 mm wide (Fig. 2 stage 3).

Larvae:

Worm-like, off-white body, with a brown head capsule. When mature, they measure about 5 mm in length (Fig. 2 stage 4).

Pupae:

About 2.5 mm in length and off-white in colour (Fig. 2 stage 5)

Adult:

Small (1.5 – 2.0 mm in length), oval, convex and brown or black. Species discrimination requires microscopic examination of genitalia (Fig. 5 and 6; also see EPPO, 2011 for details).

Similarities to other species/diseases/plant damages

Epitrix species are difficult to distinguish and identification often requires detailed microscopic examination (of genitalia). This has meant that identification to species level has not been regularly undertaken. As a consequence, reports of damage seen in the field and ascribed to particular species have to be viewed with some caution. Data on the distribution of individual species are therefore also not fully reliable. For example, *Epitrix papa*, a newly described species, was previously misidentified as *E. similaris* in Portugal and Spain (Orlova-Bienkowskaja, 2015). Molecular diagnostic tools may improve the situation in the coming years (Germain *et al.*, 2013).



Figure 3. Potato flea beetle adults. © EPPO



Figure 4. Potato leaves showing characteristic adult 'shot-hole' feeding damage. © Catherine Chatot, Germicopa SAS, France



Figure 5. *Epitrix cucumeris* adult. © Jean-François Germain. LNPV Montpellier



Figure 6. *Epitrix papa* adult. © Jean-François Germain. LNPV Montpellier



Figure 7. *Epitrix tuberosa* larvae. © Agriculture Canada, Ottawa, Bugwood.org

Detection and inspection methods

Leaves can be visually inspected for adult beetles and characteristic “shot-like” holes.

Potato tubers can be inspected for holes, serpentine tracks and black splinter lesions, which are indicators of *Epitrix* larvae.

Distribution

EPITRIX SIMILARIS

Table 2. Distribution of *E. similaris*.

(P) present, (W) widespread, (L) localized, (O) occasionally present, (D) reported in the past, no longer present, (E) eradicated, (I) absent, intercepted only		
COUNTRY/REGION	DISTRIBUTION (see codes above)	REFERENCES: please write (name, date) citation here and include full bibliographic details in reference list
ASIA	Absent	
AFRICA	Absent	
NORTH AMERICA	L	
USA	L	EPPO (2013)
California	P	EPPO (2013)
CENTRAL AMERICA & THE CARIBBEAN	Absent	
SOUTH AMERICA	Absent	
EUROPE	Absent	
OCEANIA	Absent	

EPITRIX TUBERIS

Table 3. Distribution of *E. tuberosa*.

(P) present, (W) widespread, (L) localized, (O) occasionally present, (D) reported in the past, no longer present, (E) eradicated, (I) absent, intercepted only		
COUNTRY/REGION	DISTRIBUTION (see codes above)	REFERENCES: please write (name, date) citation here and include full bibliographic details in reference list
ASIA	Absent	

AFRICA	Absent	
NORTH AMERICA	P	
CANADA	P	UK CAB International (1987); EPPO (2013)
Alberta	P	UK CAB International (1987); EPPO (2013)
British Columbia	P	Campbell <i>et al.</i> (1989); UK CAB International (1987), Bousquet (1991) EPPO (2013)
Manitoba	P	Campbell <i>et al.</i> (1989); Bousquet (1991)
Saskatchewan	P	UK CAB International (1987); Bousquet (1991); EPPO (2013)
USA	P	UK CAB International (1987); EPPO (2013)
Arizona	P	EPPO (2013)
California	P	UK CAB International (1987); Seeno and Andrews (1972); EPPO (2013)
Colorado	P	Wallis (1957); UK CAB International (1987); Seeno and Andrews (1972); EPPO (2013)
Idaho	P	EPPO (2013)
Nebraska	P	Wallis (1957); UK CAB International (1987); Seeno and Andrews (1972); Wilcox (1975); Arnett (1985); EPPO (2013)
New Mexico	P	UK CAB International (1987); EPPO (2013)
North Dakota	P	EPPO (2013)
Oregon	P	UK CAB International (1987); Seeno and Andrews (1972); EPPO (2013)
South Dakota	P	UK CAB International (1987); Kirk (1975); EPPO (2013)
Washington	P	Wallis (1957); Antonelli and Davidson (1991); UK CAB International (1987); Seeno and Andrews (1972); Wilcox (1975); Arnett (1985); EPPO (2013)
Wyoming	P	Wallis (1957); UK CAB International (1987); EPPO (2013)
CENTRAL AMERICA & THE CARIBBEAN	Absent	
SOUTH AMERICA	P	
ECUADOR	P	UK CAB International (1987); EPPO (2013)
EUROPE	Absent	

EPITRIX CUCUMERIS

Table 4. Distribution of *E. cucumeris*.

(P) present, (W) widespread, (L) localized, (O) occasionally present, (D) reported in the past, no longer present, (E) eradicated, (I) absent, intercepted only		
COUNTRY/REGION	DISTRIBUTION (see codes above)	REFERENCES: please write (name, date) citation here and include full bibliographic details in reference list
ASIA	Absent	
AFRICA	Absent	
NORTH AMERICA	P	
CANADA	W	EPPO (2013); CABI/EPPO (2013)
Alberta	P	EPPO (2013); CABI/EPPO (2013)
British Columbia	P	CABI/EPPO (2013)
Manitoba	P	EPPO (2013); CABI/EPPO (2013)
New Brunswick	P	EPPO (2013); CABI/EPPO (2013)
Newfoundland	P	EPPO (2013); CABI/EPPO (2013)
Northwest Territories	P	CABI/EPPO (2013)
Nova Scotia	P	EPPO (2013); CABI/EPPO (2013)
Nunavut	P	CABI/EPPO (2013)
Ontario	P	EPPO (2013); CABI/EPPO (2013)
Prince Edward Island	P	EPPO (2013); CABI/EPPO (2013)

Quebec	P	EPPO (2013); CABI/EPPO (2013)
Saskatchewan	P	EPPO (2013); CABI/EPPO (2013)
Yukon Territory	P	CABI/EPPO (2013)
MEXICO	P	EPPO (2013); CABI/EPPO (2013)
USA	W	EPPO (2013); CABI/EPPO (2013)
Arkansas	P	EPPO (2013); CABI/EPPO (2013)
California	P	EPPO (2013); CABI/EPPO (2013)
Colorado	P	EPPO (2013); CABI/EPPO (2013)
Connecticut	P	EPPO (2013); CABI/EPPO (2013)
Delaware	P	EPPO (2013); CABI/EPPO (2013)
Florida	P	EPPO (2013); CABI/EPPO (2013)
Illinois	P	EPPO (2013); CABI/EPPO (2013)
Indiana	P	EPPO (2013); CABI/EPPO (2013)
Iowa	P	EPPO (2013); CABI/EPPO (2013)
Kansas	P	EPPO (2013); CABI/EPPO (2013)
Kentucky	P	EPPO (2013); CABI/EPPO (2013)
Maine	P	EPPO (2013); CABI/EPPO (2013)
Maryland	P	EPPO (2013); CABI/EPPO (2013)
Massachusetts	P	EPPO (2013); CABI/EPPO (2013)
Michigan	P	EPPO (2013); CABI/EPPO (2013)
Minnesota	P	EPPO (2013); CABI/EPPO (2013)
Missouri	P	EPPO (2013); CABI/EPPO (2013)
Montana	P	EPPO (2013); CABI/EPPO (2013)
Nebraska	P	EPPO (2013); CABI/EPPO (2013)
New Hampshire	P	EPPO (2013); CABI/EPPO (2013)
New Jersey	P	EPPO (2013); CABI/EPPO (2013)
New York	P	EPPO (2013); CABI/EPPO (2013)
North Carolina	P	EPPO (2013); CABI/EPPO (2013)
North Dakota	P	EPPO (2013); CABI/EPPO (2013)
Ohio	P	EPPO (2013); CABI/EPPO (2013)
Oregon	P	CABI/EPPO (2013)
Pennsylvania	P	EPPO (2013); CABI/EPPO (2013)
Rhode Island	P	EPPO (2013); CABI/EPPO (2013)
South Carolina	P	EPPO (2013); CABI/EPPO (2013)
South Dakota	P	EPPO (2013); CABI/EPPO (2013)
Tennessee	P	EPPO (2013); CABI/EPPO (2013)
Vermont	P	EPPO (2013); CABI/EPPO (2013)
Virginia	P	EPPO (2013); CABI/EPPO (2013)
Washington	P	CABI/EPPO (2013)
West Virginia	P	EPPO (2013); CABI/EPPO (2013)
Wisconsin	P	EPPO (2013); CABI/EPPO (2013)
Wyoming	P	EPPO (2013); CABI/EPPO (2013)
CENTRAL AMERICA & THE CARIBBEAN	P	
COSTA RICA	P	EPPO (2013); Ministerio de Agricultura y Ganadería Servicio Fitosanitario del Estado
GAUDELLOUPE	W	EPPO (2013); CABI/EPPO (2013)
GUATEMALA	P	EPPO (2013)
JAMAICA	P	EPPO (2013); CABI/EPPO (2013)
NICARAGUA	P	EPPO (2013)
PUERTO RICO	P	EPPO (2013); CABI/EPPO (2013)
SOUTH AMERICA	P	
COLOMBIA	P	EPPO (2013); CABI/EPPO (2013)
ECUADOR	W	EPPO (2013); CABI/EPPO (2013)
VENEZUELA	P	EPPO (2013); CABI/EPPO (2013)
EUROPE	P	

AZORES	P	EPPO (2013); CABI/EPPO (2013)
MADEIRA	P	EPPO (2013); CABI/EPPO (2013)
PORTUGAL	P	CABI/EPPO (2013)
OCEANIA	Absent	

EPITRIX PAPA

Table 5. Distribution of *E. papa*.

(P) present, (W) widespread, (L) localized, (O) occasionally present, (D) reported in the past, no longer present, (E) eradicated, (I) absent, intercepted only		
COUNTRY/REGION	DISTRIBUTION (see codes above)	REFERENCES: please write (name, date) citation here and include full bibliographic details in reference list
ASIA	Absent	
AFRICA	Absent	
NORTH AMERICA	Absent	
CENTRAL AMERICA & THE CARIBBEAN	Absent	
SOUTH AMERICA	Absent	
EUROPE	P	
PORTUGAL	P	Orlova-Bienkowskaja (2015)
SPAIN	P	Orlova-Bienkowskaja (2015)
OCEANIA	Absent	



Figure 8. Locations and regions in which *E. cucumeris* and *E. papa* have been detected in Portugal and Spain.

History of introduction/spread

In 2004, potato tuber damage indicative of *Epitrix* was observed in north Portugal, near Porto. *Epitrix cucumeris* and a second *Epitrix* species were confirmed across Portugal in 2008. The second species was first identified as *E. similis*, but this has now been corrected, and was

confirmed as *E. papa* in 2015. *Epitrix papa* has also spread into Spain and has been recorded in Galicia (2010), Asturias (2014), and Andalucia (2015).

Interestingly, *Epitrix cucumeris* is also found in the Azores, where it has been since at least 1979, and Madeira, but no damage on potato tubers has been reported.

Phytosanitary status

Epitrix similaris is an A2 EPPO listed pest, but this may change following the recognition the description of *E. papa*.

Epitrix tuberis is on the EPPO A1 list, the East Africa A1 list, the Southern Africa A1 list, the Kazakhstan A1 list, the Russia A1 list, the Turkey A1 list, the Ukraine A1 list, and is a quarantine pest in Israel and Jordan.

Epitrix cucumeris is on the EPPO A2 list, the Kazakhstan A1 list, the Russia A1 list, the Turkey A1 list, the Ukraine A1 list, and is a quarantine pest in Jordan.

Means of movement and dispersal into the UK

Although adult beetles can fly, there is little evidence confirming long distance spread of these species through natural dispersal. Instead, the main pathway is likely to be via human transport, principally the movement of seed and ware potatoes with soil attached. Other, less likely, pathways include the movement of free soil, the movement of soil attached to other host and non-host plants, and the movement of soil attached to machinery, from infested areas.

Control

Chemical control

Once established, *Epitrix* is primarily controlled using a programme of foliar applied insecticide treatments. These control adults, but have no significant impact on the larvae or pupae in the soil. Although granular insecticides applied to the soil can also be used as a means of targeting larvae and pupae, these have so far provided inadequate protection and are expensive (Finlayson *et al.*, 1979). They are also not currently approved in the UK.

Foliar spray timing is critical, especially early on in the season when the first generation adults emerge. Early spraying ensures the adults are suppressed before they lay their eggs, reducing the number of second generation adults that emerge later in the season.

Of the insecticides used, synthetic pyrethroids are particularly effective as foliar sprays (Vernon and Mackenzie, 1991). An early season application of one of these insecticides can reduce tuber damage by > 70%. Later in the season, other insecticides that are currently sprayed against other insect pests, such as the Colorado beetle, provide control. Although they have the potential to overwinter in the centre of potato fields (Vernon and Thomson, 1991), *Epitrix* potato flea beetles tend to concentrate at the field perimeter. *Epitrix* potato flea beetles can therefore be controlled sufficiently by spraying the outer rows of the potato crop, as is the case for *E. tuberis* in Canada.

Reliance on insecticides means that control in organic crops will be very difficult. The development of resistance is also a concern. *Epitrix tuberis* has previously shown resistance to DDT (Kring, 1958) and organochlorines (Campbell and Finlayson, 1976). Additionally, there are far fewer insecticides available in the EU than there are in North America.

Field monitoring/economic threshold levels

In the USA and Canada, treatment thresholds have been developed to help decision making on when the early treatments should be applied. These are based on visual inspections of potato plants in the outer rows of the crop for adult beetles, usually 10 per row, over a period of 5-20 seconds per plant. If plants exceed 30 cm, sampling is usually done by sweep netting, in which 10 adjacent circular sweeps are carried out to give a sample of 100 plants. Economic thresholds vary depending on the *Epitrix* species, location and plant variety. For example, the economic threshold for *E. cucumeris* in Manitoba is 65 beetles per plant for the variety Norland and 190 per plant for Russet Burbank (Senanayake *et al.*, 1993). No thresholds have been developed for treatment in Portugal or Spain. Instead, growers inspect crops and usually apply sprays when adults and/or the first signs of foliar damage are found in potato crops.

Cultural controls and sanitary methods

Growing non-host crops (rotation) can help reduce the build-up of *Epitrix* beetle populations; Kabaluk and Vernon (2000) found that the cost of controlling *E. tuberis* was over £12 greater per hectare on fields that had potatoes planted for the last 3 years, as compared with a field that did not have potatoes in the previous year. Delaying the planting of potatoes until later in the season might also be effective. This forces *Epitrix* beetles to first find alternative hosts that are likely poorer in quality. Further controls include the removal of potential hosts (e.g. solanaceous weeds) over winter and during the season, and the careful disposal of reject potatoes.

Phytosanitary measures

Under Directive 2000/29/EC, potatoes originating on the American continent are not permitted to be introduced into the Union. Commission Decision 2003/61/EC of 27 January 2003, however, authorises certain Mediterranean Member States to import seed potatoes from Canada. Only Portugal has taken advantage of this exemption, since 1999.

Seed potatoes imported from Canada, and other third countries where one or more of *Epitrix similis*, *E. tuberis* and *E. cucumeris* is present, must be accompanied by a phytosanitary certificate, as outlined in paragraph 1 of article 13 of Directive 2000/29/EC.

The certificate should include the following: Either that a) potato tubers have been grown in an area deemed by the NPPO to be free of the aforementioned *Epitrix* species as per the relevant international standards for phytosanitary measures or b) potato tubers have been treated so that no more than 0.1% of soil remains or so that there is no risk of *Epitrix* spreading. In the case of point a), the pest free area should be specified.

Following this, the potato tubers should be inspected at the point of entry or destination as per Commission Directive 2004/103/EC to confirm they meet the conditions specified on the certificate.

Movement of potato tubers within the EU from demarcated to non-demarcated areas should be accompanied by a plant passport that is issued as per Commission Directive 92/105/EEC. The potato tubers should also meet the following conditions:

- a) That they have been grown in a registered place of production as per Commission Directive 92/90/EEC, or by a registered producer as per Commission Directive 93/50/EEC, or moved from a warehouse or dispatching centre registered as per Commission Directive 93/50/EEC.
- b) That they have been treated so that no more than 0.1% of soil remains or so that there is no risk of *Epitrix* spreading. National measures brought in for the UK also require that tubers are washed (and not just brushed) prior to import from non-demarcated areas of Spain.
- c) That they are packaged in material that is clean.

Potato tubers introduced from a third country known to harbour one of the aforementioned *Epitrix* species should also be accompanied by a plant passport if they are to be moved within the EU.

If a live *Epitrix* potato flea beetle is found to be associated with a consignment of potatoes, statutory action would be taken to destroy or re-export the consignment. A decision to destroy or re-export a consignment would also be taken if *Epitrix* feeding damage is identified on unwashed potatoes, even when a live *Epitrix* potato flea beetle is not found.

Impacts

Economic impact

In 1904, when *E. tuberis* was first recorded in North America, losses amounted to \$250,000 (Gentner, 1944). Yield losses of 22-25% and 43% have subsequently been reported on Prince Edward Island and Canada, respectively (Stewart and Thomson, 1989). The level of these losses represents a considerable danger to the EU, which produces 62 million tons of potatoes each year, with sales exceeding £2.5 billion per annum (Schwartzmann, 2010). In Portugal, the greatest losses occurred in the first few years before *Epitrix* potato flea beetles had been identified as the cause of the problem. Consignments of tubers showing damage were rejected by potato packers. In recent years, damage has been reduced in Portugal through the application of one or two insecticide sprays early in the season, in addition to those applied later for Colorado beetle control (Oliveira pers. comm. 2010). These treatments do not eliminate tuber damage, but reduce it to a level acceptable for the quality requirements of the country's internal market, which tend to be less stringent than those required in the UK and northern Europe.

Control of *Epitrix* potato flea beetles with insecticides requires precise timing, and it is likely that this will not always be met. Economic losses, beside those relating to chemical treatment, will therefore still occur. In the UK, *Epitrix* potato flea beetles could affect the marketability of ware and seed potatoes, particularly the latter, which represent a high risk pathway. Potato growers may therefore be very reluctant to buy seed if there is any perceived risk associated with it. Estimated losses following the establishment of *Epitrix* potato flea beetles could be as high as £10-41 million per year, despite the use of insecticides (Fera, <http://www.fera.defra.gov.uk/plants/plantHealth/pestsDiseases/documents/epitrixImpactAssessment.pdf>).

Environmental impact

Epitrix potato flea beetles primarily feed on plants within the Solanaceae family, and occasionally on plants from other families, such as cabbages and cucumbers. Although wild solanaceous species (and possibly other plant groups) may be targeted and may act as reservoirs for the beetle, it is unlikely that the environmental impact will be severe. The impact is therefore largely economic and derived from the direct effects of the beetles on crop yield and quality of potato. However, where *Epitrix* potato flea beetles are present, insecticides are used to control them, and this may have a potentially significant effect on non-target arthropods.

9. Appendix B

Statutory Action

- For findings highlighted in Green, a Europhyt notification will be made if live beetles/larvae are detected.
- For findings in yellow, no Europhyt notification will be made, except in cases where dead larvae are found, but an informal notification will be sent bilaterally to Spain or Portugal, as appropriate.

Table 6. Statutory action taken against potato tubers imported from Portugal and Spain.

Origin	Action – live larvae or beetles	Action – feeding damage/dead larvae on washed potatoes <0.1% soil	Action – feeding damage/dead larvae on brushed potatoes <0.1% soil	Action - feeding damage/dead larvae on unwashed/unbrushed potatoes (or washed/brushed with >0.1% soil)	Action – washed potatoes with <0.1% soil	Action – unwashed/brushed potatoes with >0.1% soil	Action – brushed potatoes with <0.1% soil	Action - non-notified consignments	Action - Incorrect or Absent PP
Spain mainland – other than Demarcated Areas	Destruction or Re-export	No action unless in exceptional circumstances (i.e. suspicion of pest presence) but may lead to increased inspection rates	Destruction or Re-export	Destruction or Re-export	No Action	Destruction or Re-export	Destruction or Re-export	Destruction or Re-export	N/A

Origin	Action – live larvae or beetles	Action – feeding damage/dead larvae on washed potatoes <0.1% soil	Action – feeding damage/dead larvae on brushed potatoes <0.1% soil	Action - feeding damage/dead larvae on unwashed/unbrushed potatoes (or washed/brushed with >0.1% soil)	Action – washed potatoes with <0.1% soil	Action – unwashed/brushed potatoes with >0.1% soil	Action – brushed potatoes with <0.1% soil	Action - non-notified consignments	Action - Incorrect or Absent PP
Portugal and Spain – Demarcated Areas	Destruction or Re-export	No action unless in exceptional circumstances (i.e. suspicion of pest presence) but may lead to increased inspection rates	No action unless in exceptional circumstances (i.e. suspicion of pest presence) but may lead to increased inspection rates	Destruction or Re-export	No Action	Destruction or Re-export	No Action	Destruction or Re-export	Destruction or Re-export
Portugal – other than Demarcated Areas, Spain – Balearic Islands, and other EU countries where the beetles are not present	Destruction or Re-export	No action unless in exceptional circumstances (i.e. suspicion of pest presence) but may lead to increased inspection rates	Destruction or Re-export	Destruction or Re-export	No Action	No Action	No Action	Destruction or Re-export	N/A

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