PRA template 3 (accidental introduction of potentially invasive species)

Pest Risk Analysis (PRA) for

Name of organism: *Tuta absoluta* (tomato leafminer)

Territory: Anguilla Assessment Number: 001/2020

Date: 20/01/2020 Version: 1

PRA type: accidental introduction

All sections should be completed. If not applicable indicate it

Part 1: Initiation

1.1 Summary of assessment results (max. 500 words)

Give a brief summary of the risks of introduction, establishment, spread, impact and overall risk. Fill this part only in after you have completed all the PRA template.

Tuta absoluta, a severe pest on tomato and other Solanaceae crops such as eggplant and potato, is currently spreading rapidly around the globe.

The likelihood of entry into Anguilla is moderately likely, because although it is a severe pest globally it is generally either well controlled or not yet present in the main source countries of tomato, pepper and aubergine imports into Anguilla. It is likely that the pathway with the highest risk of accidentally introducing *T. absoluta* is trade with the Dominican Republic (DR), where *T. absoluta* has recently been reported from. Further information is required on the import of ornamental species, which could be also hosts of the pest (any ornamental Solanaceae). If prevention measures fail, establishment on Anguilla is highly likely, due to very suitable environmental conditions combined with a fast potential spread (owing to the small size of the territory and a high self-dispersal capacity of the pest).

The main anticipated impact of *T. absoluta* invasion on Anquilla is on agriculture, with a predicted loss of tomato production and, to some degree, of other solanaceous crops, which would reduce the profitability of farming. However, as production of these crops is relatively low on Anguilla no job losses are expected and, overall, the socioeconomic impacts are considered only medium risk. Public and animal health may also be affected, to a small or medium degree, due to the possible side effects of predicted pesticide use increase (in order to control *T. absoluta*). This could result in an increased direct exposure to pesticides, or the contamination of water supplies. However, there is limited information about the likelihood of drinking water contamination and whether such an impact might only become noticeable over time.

As no endemic or rare native Solanaceae occur on Anguilla, the impact on the environment is predicted to be small, apart from a potential loss of agrobiodiversity in the area with predicted increased pesticide usage.

Biosecurity measures currently in place are likely to be insufficient to prevent the entry of *T. absoluta*. Pre-border restrictions (e.g. reliable phytosanitary measures and certificates regarding any imports from DR, where *T. absoluta* is already present) need to be reviewed and put in place. In addition, import permits need to be evaluated continuously based on current risk per country and pest alerts. Further and more detailed inspections at entry points should be encouraged, including the effective destruction of infected material (incineration). If the pest does become established on Anguilla, further control measures should be put in place, including a suitable Integrated Pest Management (IPM) strategy to limit the required increased use of pesticides.

1.2 Assessor details

Institution/Department:

Name and Job Title:
Address:
Phone (office and/or mobile): Email:

Part 2: Background

2.1 Aim of assessment

This section is intended to put the new organism(s) in perspective of the wider activitie(s) having led to conducting this PRA (e.g. previous horizon scanning, recent alerts or interceptions); all technical/scientific words must be explained

Tuta absoluta is a severe pest on tomato and other Solanaceae crops such as eggplant and potato, and is currently spreading rapidly around the globe. The species has not arrived on Anguilla as yet, but is regularly flagged up during Horizon Scanning exercises as a priority species for assessment of the risks of it becoming established on the island. This PRA looks at the likelihood of arrival, establishment and spread, and how significant any negative impacts of its introduction could become. The PRA aims to give advice on how the risks of introduction can be minimised and which mitigation measures should be put in place if the species becomes established.

2.2 Identity

Identify the organism as fully as possible

Scientific name (incl. taxonomic authority, date): *Tuta absoluta* (Meyrick, 1917)

What is it? (max. 2 sentence description): A small lepidopteran leaf miner

English name(s): tomato leafminer

Family: Gelechiidae

Synonyms: *Gnorimoschema absoluta* (Meyrick, 1917) Clarke, 1962; *Phthorimaea absoluta* (Meyrick, 1917); *Scrobipalpula absoluta* (Meyrick, 1917) Povolny, 1964; *Scrobipalpuloides absoluta* (Meyrick, 1917) Povolny, 1987

Other taxonomic remarks: *Tuta absoluta* was originally described as *Phthorimaea absoluta* (Meyrick 1917) from a single male which was collected in Huancayo, Peru. This specimen is deposited in the Natural History Museum, London, UK. *Tuta absoluta* is the ecological equivalent of *Keiferia lycopersicella* (tomato pinworm) of the same family that is a pest of tomato in the USA. This species is also found in Mexico and southern states in the USA, as well as on the islands of Cuba, Haiti, the Bahamas and Hawaii.

2.3 Images of the species if available

If available, please provide pictures of different stages and habitats

Figure 1: caterpillar of Tuta absoluta*. Source: https://www.cabi.org/isc/datasheet/49260 ©Marja van der Straten/NVWA Plant Protection Service/Bugwood - CC BY-NC 3.0 US*

Figure 2: Adult moth of Tuta absoluta*. Source: https://www.cabi.org/isc/datasheet/49260 ©Marja van der Straten/NVWA Plant Protection Service/Bugwood - CC BY-NC 3.0 US*

2.4 Existence of PRAs for this species

Please indicate if already PRAs for this species exist and which target areas and climatic conditions these cover (for suggestions of websites to check see guidance notes (e.g. DoA Australia))

Existing PRAs for *T. absoluta* mainly cover countries belonging to the EU, including a particularly detailed study focussed on the Netherlands and the UK (https://secure.fera.defra.gov.uk/phiw/riskRegister/viewPestRisks.cfm?cslref=19105; Potting *et al*., 2013). Another rapid PRA covers member states of the EU in general (https://pflanzengesundheit.julius-kuehn.de/dokumente/upload/6cbac_tuta-absoluta-express-pra-en.pdf). For large parts of Europe, survival and spread of *T. absoluta* outdoors is only expected during the summer months, but for southern European states with a Mediterranean climate, the permanent establishment of *T. absoluta* outdoors is anticipated. In all countries, rapid spread indoors (glasshouses, polytunnels) is widely predicted within tomato growing facilities.
A PRA has been conducted for the accidental introduction of this species to the island of St Helena (2019), upon which this document is largely based.

2.4 Biology/Ecology

Please provide background information relevant to your application covering the bullet points in box below whenever applicable; see also guidance notes

- **growth form and size:**

Egg: The eggs are elliptical, and their colour varies from oyster-white to bright yellow, darkening in the embryonic phase and becoming almost black near eclosion (Imenes *et al*., 1990).

Larva: The first-instar larvae are whitish soon after eclosion, becoming greenish or light pink in the second to fourth instars according to food (leaflet or ripe fruit, respectively). There are usually four instars (Imenes *et al*., 1990).

Pre-pupa: The pre-pupae are lighter than the feeding larvae (first to fourth instars) and develop a distinguishing pink colouration on the dorsal surface. They exit the mines and build silk cocoons on the leaflets or in the soil, according to habitat. When pupation occurs inside mines or fruit, the pre-pupae do not build cocoons.

Pupa: Pupae are obtecta with greenish coloration at first, turning chestnut brown and dark brown near adult emergence (Imenes *et al*., 1990).

Adult: Adult moths are about 10 mm long, with silverish-grey scales, filiform antennae, alternating light or dark segments and recurved labial palps which are well developed (Imenes *et al*., 1990).

- **habitat:** The habitat within its natural range in South America is not known. Generally, the species is highly associated with the occurrence of its host plants, in particular tomato plants. It cannot survive colder winters but spreads rapidly within subtropical or tropical climates.
- **lifecycle (e.g. reproduction and dispersal):** The female of *T. absoluta* lays about 260 eggs during its life time. The peak of oviposition occurs in the first and second day after adult mating, when around 92% of the total eggs are laid. The female, 1 or 2 days after emergence, releases a potent sex pheromone that lures males to exhibit mating behaviour and copulation. The female average number of matings in the laboratory was about 10.4 (Imenes *et al*., 1990; Uchoa-Fernandes *et al*., 1995a). The sex pheromone of *T. absoluta* has been isolated and identified. The main compounds are tetradecatrienyl acetate and tetradecadienyl acetate in the proportions of 91:9, respectively. The first component has been used for monitoring this pest in Brazil (Uchoa-Fernandes *et al*., 1995a; Attygalle *et al*., 1995, 1996). Eclosion of eggs (at 26-30°C and 60-75 % RH) occurs at about 5-7 days. The larvae under these conditions pass through four instars which are completed in around 20 days. After this period the larva eliminates all material of the gut and builds a cocoon for pupation. *T. absoluta* has a differentiated behaviour of pupating when occurring in processing tomato or fresh market tomato plants. In the first it pupates on the soil (1-2 cm deep) and in the last the larva builds a cocoon and pupates on the leaf surface or inside mines (Uchoa-Fernandes *et al*., 1995b). Pupation lasts about 10-11 days for females and 11-13 days for males. Taking pupae of the same age, female emergence always occurs first. Under laboratory conditions, the adults will live for 30-40 days. With 4-5 generations per annum (maximal 10 to 12) the reproduction potential of *T. absoluta* is very high. https://pflanzengesundheit.julius-kuehn.de/dokumente/upload/6cbac_tuta-absoluta-express-pra-en.pdf. Duration of development ranges from 24 (27 °C) to 76 days (14 °C). Oviposition mostly occurs on the underside of leaves. The larvae mine in the leaves, but also in the stem and inside tomato fruits. Pupation takes place in the soil, but also partly in the leaf axils, crinkled leaves or even in the mines. *T. absoluta* overwinters as eggs, pupae and adults, and adult moths are active during the night while hiding between leaves by day (https://pflanzengesundheit.julius-kuehn.de/dokumente/upload/6cbac_tuta-absoluta-express-pra-en.pdf).
- **hosts:** The most important host for *T. absoluta* is tomato (*Solanum lycopersicum*) but it also develops on other commercially grown Solanaceae such as the potato (*Solanum tuberosum*; above ground parts only), egg plant (*Solanum melongena*), and Pepino (*Solanum muricatum*), as well as ornamentals such as *Petunia*, *Brugmansia* spp. and *Datura suaveolens* (Galarza, 1984; http://www.lepiforum.de/lepiwiki.pl?Tuta_Absoluta). There are references to other hosts in the family Solanaceae (*Lycopersicon hirsutum, Solanum lyratum, S. nigrum, S. muricatum, S. elaeagnifolium, Lycopersicon puberulum, Datura stramonium, D. ferox, Nicotiana glauca*) (Clarke, 1962; Vargas, 1970; Garcia and Espul, 1982; Coelho and França, 1987; http://www.lepiforum.de/lepiwiki.pl?Tuta_Absoluta).
- **host specificity:** There are some records from outside the Solanaceae from beans (*Phaseolus vulgaris*) and *Malva* spp. (http://www.lepiforum.de/lepiwiki.pl?Tuta_Absoluta). However, these still require confirmation.
- **associated pathogens, pests or parasites:** see below under biological control

- **other:**

2.5 What is the current distribution of the species

Consider: native range, history of introduction and invasion outside native range

The moth has been described from Peru and is widespread in all South American countries, but no information is available on whether its spread throughout the continent occurred naturally or was human-assisted through the farming of Solanaceae. There are specimens of *T. absoluta* from Distrito Federal, Goias, Brazil in the collection of the Natural History Museum (London, UK) (https://www.cabi.org/ISC/datasheet/49260#08D6DBBE-369F-41A9-8E0A-7AF44AB41C41).

T. absoluta has been confirmed as present in a wide range of countries on a global scale in recent years. The only exceptions are North America and Australia, as well as some parts of Southeast Asia, which are currently still uninvaded. In contrast, the species has become very widespread and abundant throughout most of Europe and Africa (see https://gd.eppo.int/taxon/GNORAB/distribution).

Within the Central American and Caribbean region *T. absoluta* has been so far recorded from Costa Rica, Panama and Haiti (https://www.cabi.org/ISC/datasheet/49260#08D6DBBE-369F-41A9-8E0A-7AF44AB41C41). **Any publication available regarding its occurrence in the DR?**

Part 3: Risk of accidental introduction, establishment and spread

3.1 Probability of entry introduction

3.1.1 Has the species been introduced into other countries and/or have multiple introductions been reported Please check existing interception data in the territory

The species has been introduced to many countries within a short span of time. So far, no positive interceptions have occurred on Anguilla.

3.1.2 What are the likely pathways for the accidental introduction of the species?

Consider whether the species or some of its life-stages can easily be overlooked?

The introduction of this species can occur through the import of infested tomato fruits, plants for planting of tomato and eggplants, as well as ornamental plants for planting of the family Solanaceae. All stages of development may occur on fruits as well as on plants. In the glasshouse, all stages of development can be found throughout the whole year. https://pflanzengesundheit.julius-kuehn.de/dokumente/upload/6cbac_tuta-absoluta-express-pra-en.pdf

Pathways in detail, according to Potting *et al*. (2013):

Tomato fruits from infested areas:

Relatively large quantities of fruits are moved between countries. Vine tomatoes in particular may contain all stages of the organism. There is a low to medium risk of transfer from sorting and packing companies to tomato production in glasshouses, in cases where companies are separate. There is a medium to high chance of transfer in companies that sort, pack and produce tomatoes in one building or on the same site.

Containers and packaging equipment (e.g. crates) and transportation vehicles:

Transport equipment associated with tomato fruits from infested areas has been reported as a pathway, with of outbreaks in both the Netherlands and the UK being linked to the movement of infested crates/containers.

Plants for planting of tomato or aubergine:

This has been dismissed as a significant pathway for the Netherlands and the UK as, at the time, there was no significant trade in propagation material of tomato and aubergine from infested areas. Similarly, Anguilla does currently not import tomato or aubergine seedlings.

Plants for planting of ornamental Solanaceae:
Equally, this has been dismissed as a significant pathway for the Netherlands as only relatively small quantities of these ornamentals are imported to the Netherlands from infested areas. The relevance of any possible ornamental species belonging to the Solanaceae family being imported into Anguilla is not clear at this point. Although further research is needed, this potential pathway is expected to be of low risk.

Passenger luggage:
Infested fruits and ornamental Solanaceae plants may be introduced by travellers from infested countries. There are no data available for *T. absoluta*, but USA data for *Helicoverpa armigera* show that this pathway can be important (Lammers & MacLeod, 2007). Although risks associated with this pathway may be low in temperate climates (the probability that *T. absoluta* will enter a commercial glasshouse from fruits or plants imported by private persons is estimated to be very low) a transfer to open grown tomatoes in subtropical climates are significantly higher. Currently, Anguilla does not allow visitors to carry fresh plant products in passenger luggage. However, there is a considerable risk that some passengers might try to smuggle small quantities of fruits and vegetables in.

3.1.3 What is the probability of the pest being associated with the pathway(s) at origin?

Please give any information available about: prevalence of pest in the source area; occurrence of life stage able to associate with consignment; volume and frequency of movement along the pathway; seasonal timing; pest management procedures applied at place of origin; for definition of probability see guidance notes 3.1.

The probability varies largely between countries. The chances of infestation of commercially grown indoor tomatoes coming from the UK, the Netherlands or the USA, where *T. absoluta* is currently not fully established, is very low. This may differ from tomatoes grown outdoors, particularly when coming from areas with large infestations such as Spain, Italy or African countries. It needs to be pointed out that *T. absoluta* does not develop on potato tubers, and is therefore not associated with the import of potatoes.
Anguilla imports a significant amount of tomatoes (http://www.factfish.com/statistic-country/anguilla/tomatoes,+fresh+or+chilled,+import+weight) On Anguilla most food products are imported through Miami, USA and DR https://apps.fas.usda.gov/posts/cbato/cfm_summary.htm

3.1.4 What is the probability of the pest surviving during transport?

Consider: speed and conditions of transport; duration and vulnerability of life cycle; previous interceptions of the pest; prevalence of pest; commercial procedures during transport (e.g. refrigeration)

The fact that this species was first found at 3500 m in Peru (Potting *et al*., 2013) indicates that it can tolerate relatively low temperatures. However, development stops between 6° and 9°C (Barrientos *et al*. 1998; Bentacourt *et al*., 1996).

3.1.5 What is the probability of the pest evading existing biosecurity procedures? **Consider:**

inspection methods and quality control; certification schemes; chemical treatment

The existing inspection procedures on Anguilla (inspection at delivery sites by agricultural officers and trained hotel/shop staff) don't currently include any thorough inspections of tomatoes and eggplants for the occurrence of *T. absoluta*. The probability of the pest evading current biosecurity procedures can therefore be considered medium (though high in cases where tomatoes come from countries with established populations of *T. absoluta*). Although there is no need to inspect potatoes for this species, a more thorough inspection of tomatoes is suggested.
There may be a small risk that some ornamental plant imports are not checked for *T. absoluta*, in cases where it is unnoticed that these plants belong to the Solanaceae family.

3.1.6 What is the probability of transfer from entry point to a suitable host or habitat?

Consider: dispersal mechanisms, including vectors; number of destinations; proximity to suitable hosts; seasonality

In the case of Anguilla this is considered high for escaping adult moths. This is due to the widespread presence of agricultural areas and gardens close to the potential entry points. The suitable climatic conditions would allow adult moths to be active all year round.

Summary probability of accidental introduction

Probability of introduction in next 10 years	Very unlikely ☐	Unlikely ☐	Moderately likely ☒	Likely ☐	Very likely ☐
Confidence	High confidence ☒	Medium confidence ☐	Low confidence ☐		

3.2 Probability of establishment

3.2.1 Does the territory provide suitable climatic and habitat conditions for the species to **survive** and **reproduce** under natural conditions unassisted or without human interference (e.g. cultivation, gardens)? **Consider:** climate similarity between the species global range and the PRA area, availability of the habitat conditions required by the species based on its behaviour elsewhere; identify/name specifically the climate/habitat it might survive? Which land-cover? Justify why and provide landmarks as examples; for definition of human interference see guidance notes 3.2.1

- **Survival:** *T. absoluta* is likely to survive in most parts of Anguilla all year round
- **Reproduction (self-sustaining population):** The organism may multiply both outdoors and indoors in all parts of Anguilla all year round. Recently, *T. absoluta* has spread globally over a wide geographical area in a very short time period, indicating a high ability to reproduce under a relatively wide range of climatic conditions.

3.2.2 How likely can the species survive and reproduce indoors or similar habitats (e.g. polytunnels, gardens, urban area)? **Consider:** availability of the habitat conditions required by the species based on its behaviour elsewhere; identify/name specifically the conditions it might survive?

- **Survival:** *T. absoluta* is likely to survive and establish in greenhouses with continuous tomato production. Several sub-tropical Lepidoptera have established in greenhouses with vegetable production, such as *Chrysodeixis chalcites* and *Duponchelia fovealis* (Malais & Ravensberger, 2002; Potting *et al*., 2013). During cropless periods, *T. absoluta* may survive as adult, egg, larva or pupa. At many commercial tomato production sites, the period between two successive tomato crops is less than 10 days (Potting *et al*., 2013). The organism is small (<1 cm) and adults, larvae or pupae may survive in crevices or remaining plant material. There is no information about the diapausing abilities of the organism (Potting *et al*., 2013).
- **Reproduction (self-sustaining population):** The mean duration of the life cycle is 40 days at 20°C. In a greenhouse with a year-round tomato crop, *T. absoluta* could have approximately 9 generations (Potting *et al*., 2013).

3.2.3 (**only for pests and diseases**) If hosts or vectors are required, are these available in the PRA area? **Consider:** abundance of hosts and alternate hosts or vectors and how these are distributed in the PRA area; geographic proximity of hosts to pathway destinations; presence of other suitable species that could be new hosts; compare the known distribution of the pest with ecoclimatic zones in the PRA area; soil factors for soilborne pests; survival strategies; survival in protected cultivation

Any naturalised or cultivated tomatoes or other Solanaceae on Anguilla provide widely available hosts, which could facilitate the rapid establishment of *T. absoluta* on Anguilla.

Summary probability of establishment

Probability of establishment in the wild	Very unlikely ☐	Unlikely ☐	Moderately likely ☐	Likely ☐	Very likely ☒

Confidence	High confidence ☒	Medium confidence ☐	Low confidence ☐		

3.3 Probability of spread

3.3.1 What is the potential spread in the territory? **Consider:** rate and distance of spread elsewhere; natural barriers in PRA area, the occurrence of a dispersal vector or commodity; see also guidance notes 3.3.1

- **self-dispersal:** The organism is likely to disperse within tomato crops or other suitable Solanaceous crops, both indoors and outdoors. Dispersal from infested greenhouses to uninfested greenhouses is possible, and moths from infested glasshouses may spread to field crops. In turn, field populations may enter greenhouses (Potting *et al*., 2013). Moths are attracted to light, which may enhance their movement into uninfested illuminated greenhouses at night (Matta & Rippa, 1981). In Spain, natural spread is seen as the main cause of establishment of the organism in unaffected areas and islands (SEWG, 2008; Potting *et al*., 2013).
- **direct transport by humans:** Without changing clothes, the pest may spread by people visiting different glasshouses within a few days. However, growers often take precautions to avoid spread by using overcoats (Potting *et al*., 2013). Transport of infested plants from young plant nurseries could be a means of spread. Bulk transport of tomato fruits from infested plantations (indoors or outdoors) to shops and markets may further spread. Consumers will eat the tomato fruits, or put them in wastebaskets if they are not suitable for consumption. Therefore, it is unlikely that the pest will spread by movement of infested fruits by consumers (Potting *et al*., 2013). Considering the size of Anguilla, it is unlikely that human associated spread would reach the same scale as the predicted natural spread.
- **transport via vehicles (e.g. boat, cars, including tyres):** Although it is unlikely, micromoths might be attracted to the light inside cars, and be carried to different part of the island accidentally.
- **wind drift or via driftwood:** likely (wind drift)
- **water:** very unlikely
- **transport via animals (e.g. berries digested by birds, seeds stuck to wool, etc.):** unlikely
- **transport with vectors:** not applicable
- **other:** none at this stage
- **how rapidly would the organism spread by natural means?**

Summary probability of spread

How quickly can the species spread (excluding deliberately assisted by humans)	Less than 10 m/year. Can't occupy suitable habitats within next 100 years Very slowly ☐	Between 10 and 100 m per year. Suitable habitats are likely to be occupied between 50 and 100 years Slowly ☐	Between 100 and 500 m per year. Suitable habitats are likely to be occupied between 50 and 100 years Moderate pace ☐	> 500 m per year Can occupy suitable habits throughout the territory within 5 to 20 years Quickly ☐	Can occupy suitable habits throughout the territory within 5 years Very quickly ☒
Confidence	High confidence ☒	Medium confidence ☐	Low confidence ☐		

Part 4: Economic and environmental risks

It is important to look at the potential magnitude of the consequences, and to look at distribution effects (who bears risks). Consider potential maximum impact.

Please, **complete this section referencing supporting material**. Please, cite the material in the text and provide a description of where the information in the application has been sourced in the list of references (e.g. from in-house research, independent research, technical literature, community or other consultation, and provide that information with this application). If the information available is scarce, include information about related species (e.g. same genus or family) clearly indicating that it does not correspond to the organism being assessed.

4.1 Risks recorded from outside the territory, which are applicable to the territory

4.1.1 Is the species listed in the following Plant Protection organizations and Invasive lists and if so, what is its status?

America
COSAVE: ~~yes~~/no
NAPPO: yes/~~no~~ *T. absoluta* has been highlighted in several NAPPO-PAS Pest Alerts
OIRSA yes/~~no~~ Management of *T. absoluta* is covered in several documents
https://www.oirsa.org/busqueda.aspx?q=Tuta
Europe
EPPO: yes/~~no~~ Included on EPPO A2 List of pests recommended for regulation as quarantine pests;
EC Plant Health Directive (Council Directive 2000/29/EC): ~~yes~~/no
Africa
ARC: yes/no (page currently not running)
Others:
CABI CPC yes/~~no~~ Full datasheet
CABI ISC yes/~~no~~ Full datasheet
GISD ~~yes~~/no
Other information relevant for the territory (e.g. regional, national…)
USA: Tomato fruits from infested areas are regulated in relation to *T. absoluta* (APHIS, 2007)
Egypt: Emergency measures (WTO-SPS, G/SPS/N/EGY/37)

4.1.2 Is there any negative impact of the species on the economy, environment or public health recorded from any parts of its current distribution? Please provide a summary of the available information

Following its introduction into Europe, Africa and the Middle East, *T. absoluta* has already caused extensive economic damage in these areas. The impact of the pest includes severe yield losses reaching 100% in some cases, increasing tomato prices, bans on the trade of tomato including seedlings, an increase in synthetic insecticide applications, disruption of integrated management programmes of other tomato pests, and an increase in the cost of crop protection. In addition, the outbreak of this pest led to a significant augmentation of risks for growers, consumers and the environment associated with the blind use of chemicals (USDA-APHIS, 2012; Zappalà *et al*., 2012; Zlof and Suffert, 2012). Considering its high biotic potential, its ability to adapt to various climatic conditions, and the speed with which it has colonized Europe and Africa, *T. absoluta* will probably impact heavily on the livelihood of local tomato growers and tomato agribusinesses in these regions (https://www.cabi.org/ISC/datasheet/49260).

T. absoluta is also the most important pest on tomato in the area of origin in South America, both in the open field as well as in protected cultivation (under plastic or in glasshouse). The yield, as well as fruit quality, can be reduced significantly by direct feeding damage as well as through secondary infection with pathogens. High yield losses may be particularly noticeable during periods of low rainfall. In Peru, *T. absoluta* is regarded as a significant pest on potato leaves growing in warm regions below 1000 m above sea level (https://pflanzengesundheit.julius-kuehn.de/dokumente/upload/6cbac_tuta-absoluta-express-pra-en.pdf).

4.2 Economic and socioeconomic effects

4.2.1 Could the species have any negative effect on economic activities in the territory? Please include any information about specific assessments from areas outside the PRA area including experiences with closely related species with relevance for the area of interest **(consider:** reduction in crop yield or quality; reduction in prices or demand, including export markets; increase in production costs (including costs of control); vectoring of other pests of economic importance; extent of phytosanitary regulations imposed by importing countries)

- agriculture: Severe crop failures would be expected to occur on tomatoes and egg plants on Anguilla if *T. absoluta* became established. At this stage it is unclear whether management practices on Anguilla are suitable to keep yield losses relatively low. This will depend to what degree integrated crop management

- as currently practised - would be suitable to encourage natural enemies to help control *T. absoluta*. In Spain the integrated crop management practice against *T. absoluta* comprises a range of methods, which may, in part, be applicable on Anguilla. These are: biological control with the mirid bugs *Nesidiocoris tenuis* and *Macrolophus caliginosus* (would not be possible to be used on Anguilla as not host specific enough); mass trapping with sex pheromone; cultural practices like net screens to prevent the moth access to the plants, and insecticidal control where necessary. Because the presence of the organism in a greenhouse may lead to unacceptable levels of cosmetic fruit damage, it seems likely that the first reactions will be intensive insecticidal control. In a worst-case scenario, it is estimated that up to 18 extra insecticide treatments are necessary to fully control *T. absoluta* in greenhouses (Potting *et al*. 2013). It is not clear how much would be needed in the open field, but extra costs are likely to be significant. It can also be expected that insecticidal control of *T. absoluta* will disrupt IPM practice, because the insecticides that are probably needed to control the pest (e.g. Indoxacarb or Spinosad) would negatively affect biological control agents and pollinating bees. As a consequence, growers will have to control other pests using insecticides instead of biological control agents. If the presence of *T. absoluta* made it impossible to use IPM strategies, the use of chemical pesticides would increase and thereby the probability that pests will develop resistance to these insecticides would also increase. It is expected that *T. absoluta* cannot be completely controlled, especially because of the mining behaviour (Potting *et al.* 2013). It should be noted that on Anguilla there are only a small number of part-time commercial growers, although many people grow their own tomatoes.

- livestock: n/a.
- fisheries: n/a.
- aquaculture: n/a
- forestry: n/a.
- tourism: n/a.
- recreational potential: n/a.
- infrastructure: n/a.
- employment rates: There is a risk that commercial tomato growers on Anguilla may have to stop growing this crop altogether. However, most farmers have other sources of income via tourism, so the impact might be reduced.
- other: The introduction of *T. absoluta* is expected to lead to an increased use of chemical pesticides, which is unwanted by many consumers. On the other hand, most consumers on the island currently buy conventionally grown tomatoes rather than organically grown tomatoes. It is therefore expected that the social impact of the pest will be limited (Potting *et al*. 2013).

4.2.2 Are there any risks of impacts on cultural valuable species, habitats, landscapes, practices or other values? Please include any information about specific assessments from areas outside the PRA area including experiences with closely related species with relevance for the area of interest

- competition with or impact on cultural valuable species: none.
- impact on historically valuable practices: none.
- change of landscape: none.
- value of landscape for recreation: none.
- other: are there any valuable ornamental Solanaceae on Anguilla?

Summary economic and socioeconomic impacts

Make sure the summary score is well linked with the information reported above so the scoring is fully justified (for more information risk levels see guidance notes)

Risk of socioeconomic impact	Very small ☐	Small ☐	Medium ☒	Large ☐	Very large ☐
Confidence	High confidence ☐	Medium confidence ☒	Low confidence ☐		

4.3 Impact on public health

4.3.1 Could there be any impact on public health? **Consider:** Can the species be disease-causing or be a parasite, or be a vector or reservoir for human diseases?

There would be a low risk of increased exposure to harmful chemicals if the use of pesticides to control *T. absoluta* increased. This usage could be problematic for farmers if practices to minimise exposure are not adequate. Increased spraying might also generate problems for consumers if the time between treatment and harvest is not correct (too short). Finally, there is the potential for problems of pesticide contamination of water sources (aquifers). Very little is known about these potential impacts, but it could be an impact observed over time (small-medium impact).

Summary public health impact

Risk of impact on public health	Very small ☐	Small ☐	Medium ☒	Large ☐	Very large ☐
Confidence	High confidence ☐	Medium confidence ☐	Low confidence ☒		

4.4 Impact on animal health

Could there be any impact on animal health? **Consider:** Can the species be disease-causing or be a parasite, or be a vector or reservoir for animals?

There is a small chance of pigs consuming tomatoes with harmful levels of pesticides on them, which might cause some issues over time. However, we have very little information about this potential impact.

Summary animal health impact

Risk of impact on animal health	Very small ☐	Small ☒	Medium ☐	Large ☐	Very large ☐
Confidence	High confidence ☐	Medium confidence ☐	Low confidence ☒		

4.5. Environmental and ecosystem effects

4.5.1 Are there any threats to native or endemic species? Indicate direct effects on native species; note any aspects related to pollination of native species should be covered in the following question (**consider**: threat to endangered species; impact on keystone species; changed community structure; hybridization with native species)

There is a significant risk that *T. absoluta* would attack native plants belonging to the Solanaceae family. However, of this family, only four regionally widespread species (*Lycium americanum, Datura stramonium, Physalis angulata, Solanum racemosum*) have been recoded from the territory, and no endemic Solanaceae species exist (Howard and Kellogg 1987). The potential increased use of insecticides in open fields may impact negatively on agrobiodiversity on Anguilla.

4.5.2 What is the level of potential negative impact on ecosystem services in the PRA area? (**consider**: provisioning services (freshwater, wood and fibre, fuel); regulating services (soil formation, natural hazards, water and air quality); cultural services (aesthetic, educational, recreational, spiritual); supporting services (nutrient cycling, habitat stability; pollination) see also guidance notes 4.5.2

Increased use of insecticides in open fields may impact negatively on soil biodiversity, water quality and pollination on Anguilla over time.

Summary environmental impact

Risk of environmental impact	Very small ☐	Small ☒	Medium ☐	Large ☐	Very large ☐
Confidence	High confidence ☐	Medium confidence ☒	Low confidence ☐		

Part 5: Pest risk management

5.1 Prevention

5.1.1 Which measures **already** in place are suitable to minimise the risk of introduction and establishment **Consider**: inspection of commodities; trapping, disrupting specific pathways, etc.

- **pre-border:** Tomatoes are commonly imported as fruits or seeds. However, there is no specific regulation in place regarding potted plants. All consignments of tomato and aubergine fruits must be accompanied by a phytosanitary certificate certifying that the plant material has been inspected in the exporting country in accordance with appropriate official procedures and found to be free of *T. absoluta*, and conform to Anguilla's current import requirements.
  If satisfied that the specified pre-shipment pesticide treatments have been undertaken, the exporting country National Plant Protection Organisation must confirm this by recording the treatments applied in the 'Disinfestation and/or Disinfection Treatment' section of the phytosanitary certificate.
  The fruits must be packed and shipped in a manner to prevent contamination by regulated pests. The package(s) should not be opened in transit. However, where a consignment is either stored, split up or has its packaging changed whilst in another country en route to Anguilla, a 'Re-export Phytosanitary Certificate' is required.
- **at the border:** There are two main pathways for introduction; plants for planting and fruits of tomato and aubergine. It does not attack potato tubers and is therefore not likely to enter with consignments of potato. Overall, *T. absoluta* is reported as being easily detected https://gd.eppo.int/taxon/GNORAB/documents. Although it is recommended to prohibit the import of tomato plants altogether, *T. absoluta* is relatively easily found on plants because it prefers the apical buds, flowers and new fruits, where black frass is visible. When there is a severe attack it colonizes the leaves on the other parts of the plant. Mines are evident on attacked leaves (Imenes *et al*., 1990). Fruits in trade should have no signs of insect damage. In cases where fruits originate from infested areas, measures are needed to disinfest fruits and to prevent moths escaping from the pathway during movement or at the time of unloading; this could be achieved, for instance, by using closed packaging conditions, refrigeration or screening. Another pathway is the introduction with carriage equipment and transportation units. Movement of carriage equipment associated with tomato fruits from infested areas has been identified as an important pathway. It is important to clean or dispose of all packaging which has contained infested fruit, as well as any vehicles/containersthat have been used to transport such fruit, in order to limit the possibility of spread. Inspections of tomato cargo are very limited, and they are carried out at the destination point on the island (not on entry), which could facilitate the entry of the pest. There is also very limited inspection of personal luggage.
- **post-border:** none currently in place

5.1.2 Which measures **not yet** in place are suitable to minimise the risk of introduction and establishment **Consider**: inspection of commodities; trapping, disrupting specific pathways, etc.

- **pre-border:** Tomato for commercial growing should only be imported into Anguilla as seeds, not as potted plants. In cases of new outbreaks in exporting countries, imports should immediately be stopped until adequate phytosanitary measures are put in place at the production sites. One option for trade with the DR would be to establish quarantine zones around the crops/plants produced in the DR. This would need to include potatoes; even though the import of the potatoes themselves is safe, there would still be a risk that *T. absoluta* is hidden within packaging material.
- **at the border:** Biosecurity staff and staff involved in inspections (e.g. staff at hotels, restaurants etc.) should be trained to specifically look out for *T. absoluta*. In addition to training, the distribution of awareness raising leaflets and ID-guides would be useful. The percentage of sample inspections should be increased, if possible, and be carried out at the point of entry where possible. Not only tomatoes and aubergines but also potatoes from the DR will require a particularly thorough inspection, as *T. absoluta* may hide not only inside infected tomato and aubergine fruits but also in packaging, which has been near potato crops, coming from this country where the pest is already established. Inspection for adults on other plant imports from DR (in cases where these were produced in the vicinity of tomato fields) should also be increased.

- **post-border:** There are effective pheromone traps available for *T. absoluta*. Some of these should be positioned in proximity to the fruit storage in the harbour area, at hotels and restaurants, and possibly within the few commercial tomato fields present on Anguilla. Traps need to be controlled and replaced at regular intervals.

Summary efficacy of current prevention measures from 5.1.1

Probability of prevention measures being effective	Very unlikely ☐	Unlikely ☒	Moderately likely ☐	Likely ☐	Very likely ☐
Confidence	High confidence ☐	Medium confidence ☒	Low confidence ☐		

Summary efficacy of proposed prevention measures from 5.1.2

Probability of suitable future prevention measures being effective	Very unlikely ☐	Unlikely ☐	Moderately likely ☐	Likely ☒	Very likely ☐
Confidence	High confidence ☐	Medium confidence ☒	Low confidence ☐		

5.2 Control

5.2.1 What existing control measures available in the territory for the control of other pests can provide adequate control to mitigate the risks described above? **Consider:** cultural practices e.g. irrigation, planting, harvesting methods etc.; pest control programmes; natural enemies; please link to effectiveness, practicality, costs, negative consequences and acceptability

- eradication: Although not comprehensive, some measures to destroy infected material at the point of border control are in place. However, there are currently no incineration facilities available on Anguilla.
- containment to prevent further spread: No specific measure in place.
- mechanical/chemical control: In case of establishment, control methods in place on Anguilla for other pests can also be used for the control of *T. absoluta*. This is, however, unlikely to prevent a certain degree of fruit damage, in particular because the larvae in the leaf and fruit-mines cannot be controlled sufficiently with contact insecticides. Currently, the following agents are indicated as effective: Indoxacarb and Spinosad, as well as *Bacillus thuringiensis* (availability on Anguilla?). Furthermore, cultivation measures such as crop rotation with non-Solanaceae, or adapted fertilisers and irrigation are recommended. Infested plant material and plant debris after harvest should be burnt.
- biological control: not available on Anguilla at present.

5.2.2 What additional control measures currently not available in the territory can provide adequate control to mitigate the risks described above? **Consider:** cultural practices e.g. irrigation, planting, harvesting methods etc.; pest control programmes; natural enemies; please link to effectiveness, practicality, costs, negative consequences and acceptability

- eradication: No effective methods are currently available to eradicate the pest once it becomes established.
- containment to prevent further spread: No effective methods are currently available to contain the pest once it becomes established.
- mechanical/chemical control: IPM strategies are being developed in South America to control *T. absoluta*. Studies are being carried out on the use of synthetic sex pheromones to monitor population levels and trigger applications of chemicals (Salas, 2004). Various active substances are effective and can be used in combination with biological control agents. Concerning chemical control, several treatments are required per growing season and it must be noted that a decrease in the efficacy of products used

against *T. absoluta* has been observed since the 1980s in tomato crops. Resistance to some insecticides has been reported in several countries, for example to abamectin, cartap and permethrin in Brazil (Siqueira *et al*., 2000). Other control methods include cultural practices (rotation with non-solanaceous crops, ploughing, adequate fertilization, irrigation, destruction of infested plants and of post-harvest plant debris, etc.). Finally, the susceptibility of tomato cultivars to *T. absoluta* varies and plant resistance is being investigated. https://gd.eppo.int/taxon/GNORAB/documents. Recent information and details on available management strategies are provided by Balzan and A.-C. Moonen (2018).

- biological control: Parasitoids (e.g. *Trichogramma pretiosum*) or predators (e.g. *Podisus nigrispinus*) can be used for the control of *T. absoluta,* but the introduction of non-host specific predators to Anguilla should be avoided , and research is being done on biological control (Villas Boas & Franca, 1996; Torres *et al*., 2002). The following parasitoids have been recorded from *T. absoluta*: *Trichogramma pretiosum*, 22 brackish wasp species (Braconidae) and 13 chalcid wasp species (Chalcididae).

Summary efficacy of current control measures from 5.2.1

Probability of control measures being effective	Very unlikely ☐	Unlikely ☐	Moderately likely ☒	Likely ☐	Very likely ☐
Confidence	High confidence ☐	Medium confidence ☒	Low confidence ☐		

Summary efficacy of proposed control measures from 5.2.2

Probability of suitable future control measures being effective	Very unlikely ☐	Unlikely ☐	Moderately likely ☐	Likely ☒	Very likely ☐
Confidence	High confidence ☐	Medium confidence ☒	Low confidence ☐		

Other information

Add here any further information you wish to include in this application including if there are any ethical considerations that you are aware of in relation to your application

The large amount of literature and information available for this PRA has allowed an informed assessment to be made, at relatively high confidence levels throughout most of the PRA process. However, two areas should be investigated in more detail:

- How realistic is a threat to water supplies, if the impact of *T. absoluta* led to an increased usage of pesticides?
- How well are the potential risks of accidentally introducing *T. absoluta* from the DR covered through biosecurity measures already in place, or proposed in this PRA, and what role do fake import permits from DR play in this?

Is there a need for a more detailed PRA or for more detailed analysis of particular sections of the PRA? (For completion by the Biosecurity group only!)

No ☒ Yes ☐

If yes, please forward to FERA or NNSS or others

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Appendices and referenced material (if any) and glossary (if required)

In case this is an application made for the deliberate introduction of a species/commodity it is recommended that you contact a member of the biosecurity group as early in the application process as possible. Biosecurity can assist you with any questions you have during the preparation of your application including providing advice on any consultation requirements.

Unless otherwise indicated, all sections of this form must be completed for the application to be formally received and assessed. If a section is not relevant to your application, please provide a comprehensive explanation why this does not apply.

Commercially sensitive information must be included in an appendix to this form and be identified as confidential. If you consider any information to be commercially sensitive, please show this in the relevant section of this form and cross reference to where that information is located in the confidential appendix.

Any information you supply to biosecurity prior to formal lodgement of your application will not be publicly released. Following formal lodgement of your application any information in the body of this application form and any non-confidential appendices will become publicly available.

Information resources

This list of online resources may help the applicant to gather information about the organism being assessed. In bold are key databases with relevant information about invasive species. The other resources provide information about the description, distribution, and habitat the species. It is recommended to check additional resources about the species from within its native range (e.g. local floras).

Global

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