IMPORTANT PLANT PATHOGENS FOR MALTA AND SICILY

Alien Species of Malta and Sicily

Interreg
Italia - Malta
FAST

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Università di Catania
L-Università ta' Malta
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Authors
Naomi Bonini
Concita Blancato
Matilde Tessitori

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Introduction

This brochure contains twenty phytosanitary risk cards for protected areas, in which the risk of introduction and establishment of plant pathogens within the Sicilian and Maltese protected areas, are briefly analysed. This work is part of the Interreg Italia-Malta project Fight Alien Species Transborder (FAST) for the "Identification of plant pathogens threatening biodiversity in Sicily and Malta."

The brochure is divided into two main chapters: the first one provides phytosanitary risk cards of 13 plant pathogens occurring in Sicily and/or in Malta (Panel 1) and the second provides information on 7 alien plant pathogens, (Panel 2) which are not yet reported within the interested areas but are at risk of being introduced. Many of the plant pathogens treated in Panel 1 are reported exclusively in one of the two areas of interest, so they are considered as alien in the second one.

The first step in the execution of the present work was to compile the database of the ninety plant pathogens worldwide potentially harmful, based on EPPO A1 and A2 alert lists. The database consists of some basic information, such as: geographic distribution; host plant range, categorized into wild and cultivated species, and the type of transmission of the pathogens. A first hypothetical risk class assessment for their introduction/establishment into protected areas was performed according to the above information provided in the literature and finally, twenty plant pathogens, with special emphasis on those with tritrophic disease patterns, were chosen based on their assignment to a risk class.

The phytosanitary risk cards are planned to provide essential data for the rapid identification of plant pathogens detrimental to plant biodiversity, especially for autochthonous plant species, within protected areas. The first part of each card contains further detailed information about the identity of the pathogen, its geographical distribution and if applicable of the insect vector/s, the European legislative framework, the range of host-plants, biology, the life

cycle of the pathogen, and disease symptoms; while the second part identifies potential pathways of introduction and environmental suitability for the establishment and spread of the pathogen in the areas of interest. If possible, the complete list of host plants of the pathogen, underlining plant species and/or genera of interest for Mediterranean protected areas, is included in each card. The final assignment of low, medium, or high-risk class (both for the possible introductions and the established plant pathogens), was obtained considering all the information reported in the cards.

Phytosanitary risk card for protected areas

Panel 1

Risk card for protected areas

Erwinia amylovora

Identity of the pathogen

Scientific name	*Erwinia amylovora* (Burrill, 1882) Winslow et al., 1920
Taxonomic position	Bacteria, Proteobacteria, Gammaproteobacteria, Enterobacterales, Erwiniaceae
Related diseases	Fire blight

Current geographical distribution: Africa, America, Asia, Europe, Oceania (restricted).

Sicily (restricted areas*) YES ☑ NO ☐
Malta YES ☐ NO ☑

Current phytosanitary legislative framework:

Regulated quarantine pest ☐ Regulated non-quarantine pest ☑
Non regulated ☐

Note: Requirements for plant propagation materials in the area identified as 'protected' from the Implementing regulation (EU) 2019/2072 of 28 November 2019.

Range of plant hosts: 59 plant species, mainly Rosaceae (17 presents in Sicily)**.

For protected areas the most representative genera include ***Crataegus*** spp., ***Cotoneaster*** spp., ***Pyrus*** spp., ***Sorbus*** spp.

Biology and life cycle of the pathogen: *E. amylovora* can be considered a psychrotrophic bacterial species since it can grow at temperatures ranging from 4 °C to 37 °C, with an optimum of 28 °C. In winter it survives in **cankers** of infected host plants, which are the primary source of inoculum early in the growing season, in buds and apparently healthy wood tissue. In spring bacteria become active again, multiply and spread into adjacent healthy tissues. The bacterium mainly spreads from infected plants via **pollinating insects** during the flowering period, attracted from the sweet, sticky, bacteria-filled exudate. **Splashing rain** can be an important spread pathway from oozing cankers to flowers while dries ooze can spread by **wind**. Even **birds** and contaminated **pruning tools** have a role in the spread of *E. amylovora*. As most bacteria, penetration within the host tissue occurs throughout natural openings or lesions involving the presence of a water film.

Main symptoms: Infected flowers become **water soaked**, then shrivel and turn brownish black. Leaves develop brown-black blotches and then curl and shrivel. Twigs **wilt** from the tip downward and hooked, infected bark turns soft and darker than normal and when it is peeled away the inner tissues has **reddish streaks** (initial phase) or dark brown to black (advanced phase). Subsequently the bark shrinks and hardens, leaves turn black (**fire blight**) and on the branches develop cancers. If cancers grow and surround the branches, the part above the infection dies. Also infected immature fruits shrivel and turn black. During warm, wet weather a whitish mucoid **bacterial ooze** may exude from recently infected shoots, petioles, cankered bark and infected fruit and blossoms, this exudate is a specific manifestation of *E. amylovora* infection. Except for minor differences, the symptoms of fire blight are basically similar on all host plants.

Figure: Exudate and strands on *Cotoneaster* sp. A); milky ooze containing fire blight bacteria exuding from an infected apple fruit B); fire blight on Hawthorn (*Crataegus monogyna*), infected hedge C); flower infection on *Cotoneaster salicifolius* D) (source: https://www.cabi.org/).

Pathways of introduction

Transport of pathogen in potentially infected/contaminated:

SEEDS ☐ PLANTS FOR PLANTING ☑ FRESH FRUITS ☑
INSECT VECTORS ☑ BIRDS ☑ HONEYBEES AND BEEHIVES ☑

Environmental suitability for establishment and spread of the pathogen

Climatic and environmental conditions suitable for the spread of the pathogen:

YES ☑ NO ☐

Note: temperature **below 18°C** inhibit the develop of symptoms.

Speed of spread:

LOW ☐ MODERATE ☐ HIGH ☑

Note: The **flowering stage** is critical for the rate of pathogen's spread

RISK ASSESSMENT

*Distribution in interested area: *Erwinia amylovora* occurs in Cesarò (Messina); Maniace, Bronte, and Adrano (Catania); Centuripe, Regalbuto, and Troina (Enna). Except for these areas, Sicily is identified as a 'protected area' (Implementing regulation (EU) 2019/2072 of 28 November 2019). The occurrence of the pathogen in Sicily increases the potential risk of its introduction into protected areas. Since now in Malta there are no reports, however the presence of wetlands close to protected areas could increase the risk of introduction of the bacterium carried by migratory birds.

Risk of introduction: HIGH
Risk of establishment: HIGH

****Confirmed plant hosts of *Erwinia amylovora*, the highlighted species are occurring in areas of interest.**

Amelanchier alnifolia; Amelanchier canadensis; Amelanchier laevis; Aronia melanocarpa; Chaenomeles japonica; ***Cotoneaster nebrodensis;*** *Cotoneaster bullatus; Cotoneaster buxifolius; Cotoneaster dammeri; Cotoneaster horizontalis; Cotoneaster lacteus; Cotoneaster lucidus; Cotoneaster microphyllus; Cotoneaster moupinensis; Cotoneaster niger; Cotoneaster salicifolius; Cotoneaster x crispii; Cotoneaster x watereri;* ***Crataegus laevigata****;* ***Crataegus monogyna****; Crataegus x prunifolia;* ***Cydonia oblonga****; Eriobotrya japonica; Fragaria x ananassa; Malus baccata; Malus coronaria;* ***Malus domestica****; Malus floribunda;* ***Mespilus germanica****; Photinia davidiana;* ***Prunus armeniaca****; Prunus cerasifera;* ***Prunus domestica****; Prunus salicina; Pseudocydonia sinensis;* ***Pyracantha coccinea****; Pyracantha crenatoserrata; Pyrus betulifolia; Pyrus bourgaeana;* ***Pyrus communis****; Pyrus elaeagnifolia;* ***Pyrus pyraster****; Pyrus pyrifolia;* ***Pyrus spinosa****; Pyrus ussuriensis;* ***Rosa canina****; Rosa rugosa; Rubus fruticosus;* ***Rubus idaeus****;* ***Sorbus aria****;* ***Sorbus aucuparia****;* ***Sorbus torminalis****; Spiraea prunifolia.*

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Risk card for protected areas

'*Candidatus* Phytoplasma solani'

Identity of the pathogen:

Scientific name:	'*Candidatus* Phytoplasma solani' – 16SrXII (Quaglino *et al*. 2013)
Taxonomic position:	Bacteria, Tenericutes, Mollicutes, Acholeplasmatales, Acholeplasmataceae.
Others scientific name:	*Grapevine bois noir phytoplasma, Maize redness phytoplasma, Phytoplasma solani, Potato stolbur phytoplasma, Stolbur phytoplasma.*

Current geographical distribution: Europe, Asia, Africa, America.

Sicily YES ☑ NO ☐
Malta YES ☐ NO ☑

Current geographical distribution of the vectors:

Hyalesthes obsoletus	*Reptalus panzeri*	*Pentastiridius leporinus*	*Anaceratagallia ribauti*
Asia, Europe	Europe	America, Asia, Europe	Europe
Sicily YES ☑ NO ☐	**Sicily** YES ☑ NO ☐	**Sicily** YES ☑ NO ☐	**Sicily** YES ☑ NO ☐
Malta YES ☑ NO ☐	**Malta** YES ☑ NO ☐	**Malta** YES ☐ NO ☑	**Malta** YES ☐ NO ☑

Current phytosanitary legislative framework:

Regulated quarantine pest ☐ Regulated non-quarantine pest ☑
Non regulated ☐

Note: ANNEX V 'Production Standards, Voluntary National Qualification System for Plant Propagation Material', Legislative Decree No. 18 of February 2, 2021 on the production and marketing of propagating plant material, horticultural and fruits plants.

Range of plant hosts: 179 plant species, (119 present in Sicily)*.

The most representative genera for protected areas include ***Artemisia*** spp., ***Chenopodium*** spp., ***Cistus*** spp., ***Erigeron*** spp., ***Eucalyptus*** spp., ***Malva*** spp. and the species ***Convolvulus arvensis***, ***Urtica dioica***, ***Olea europea*** and ***Spartium junceum.***

Biology and life cycle of the pathogen: '*Ca*. P. solani' is a phloem-restricted non-cultivable bacteria. It can be transmitted by **grafting**, vegetative propagation of plant materials and phloem sap feeding **vectors**. Disease epidemiology is very complex and involves a wide range of host plants and different polyphagous insect vectors. The bacterium is introduced into new areas mainly by the movement of infected plant material, while local spread occurs through insect vectors transmission from infected to healthy plants. The main natural vectors are various species of Cixiidae, Cicadellidae and Psyllidae.

Figure: Sympthoms of '*Ca*. P. solani' infection *Vitis vinifera* A); *Solanum trilobatum* C); *Cynodon dactylon* D); *Solanum tuberosum* tuber E); and Maize plants F) (source: https://gd.eppo.int/).

Main symptoms: Different symptoms are associated with different host plants. Their develop depends not only on plant species, but also on environmental conditions. The most common symptoms include leaf **yellowing** or **reddening**, leaf **malformation**, leaf **rolling, dwarfism,** desiccation of inflorescences and **berry shrivel** on *Vitis* spp. plants.

Pathway of introduction

Transport of pathogen in potentially infected/contaminated:

SEEDS ☐ PLANTS FOR PLANTING ☑ FRESH FRUITS ☐ INSECT VECTORS ☑ CONTAINERS, TOOLS, EQUIPMENTS AND CONVEYANCE VEICLES ☐

Environmental suitability for establishment and spread of the pathogen

Climatic and environmental conditions suitable for the spread of pathogen:

YES ☑ NO ☐

Climatic and environmental conditions suitable for the spread of the insect vectors:

YES ☑ NO ☐

Note: this data refers to most of the vectors listed above.

Speed of transmission and spread:

LOW ☐ MODERATE ☐ HIGH ☑

RISK ASSESMENT

'Ca. P. solani' already occurs in Sicily. Its wide range of plant hosts is a risk factor for its introduction and into the interested areas, especially since many are wild hosts. In addition, many insect vectors of the bacterium are polyphagous and prefer wild weeds to cultivated plants.

Risk of introduction: HIGH
Risk of establishment: HIGH

***Confirmed plant hosts of '*Ca*. P. solani'.**

Achillea millefolium; Amaranthus retroflexus; Ammi majus; Artemisia scoparia; Artemisia vulgaris; Bellis perennis; Bromus inermis; Bupleurum tenuissimum; Calendula officinalis; Calystegia sepium; Capsella bursa-pastoris; Carum carvi; Centaurium erythraea; Cephalaria transsylvanica; Chenopodium album; Cirsium arvense; Cistus ladanifer; Convolvulus arvensis; Convolvulus tricolor; Coronilla varia; Crepis foetida; Crepis sp.; Cuscuta sp.; Cynodon dactylon; Datura stramonium; Digitalis purpurea; Echium vulgare; Epilobium sp.; Erigeron annuus; Erigeron bonariensis; Erigeron canadensis; Euphorbia falcata; Fallopia convolvulus; Geranium dissectum; Helminthotheca aculeata; Helminthotheca echioides; Lactuca saligna; Lactuca serriola; Lapsana communis; Linaria vulgaris; Macroptilium lathyroides; Malva sylvestris; Matricaria chamomilla; Medicago lupulina; Melilotus albus; Mercurialis annua; Monarda fistulosa; Oxalis sp.; Paeonia suffruticosa; Paeonia tenuifolia; Parietaria judaica; Parietaria officinalis; Persicaria maculosa; Picris hieracioides; Plantago lanceolata; Plantago major; Polygonum aviculare; Portulaca oleracea; Potentilla reptans; Prunella vulgaris; Rubia peregrina; Rumex acetosa; Sambucus nigra; Senecio vulgaris; Setaria viridis; Silene latifolia subsp. alba; Silene vulgaris; Solanum glaucophyllum; Solanum nigrum; Sonchus oleraceus; Sophora alopecuroides; Sorghum halepense; Spartium junceum; Styphnolobium japonicum; Taraxacum officinale; Trifolium medium; Trifolium pratense; Trifolium repens; Tussilago farfara; Urtica dioica; Urtica urens; Valeriana officinalis; Veronica persica; Viola odorata; Vitex agnus-castus.

Risk card for protected areas

Tomato spotted wilt virus (TSWV)

Identity of the pathogen

Scientific name	Tomato spotted wilt virus (TSWV)
Taxonomic position	Viruses and viroids, Riboviria, Orthornavirae, Negarnaviricota, Polyploviricotina, Ellioviricetes, Bunyavirales, Tospoviridae, Orthotospovirus.
Related diseases	Spotted wilt disease

Current geographical distribution: Africa, America, Asia, Europe, Oceania.

Sicily YES ☑ NO ☐
Malta YES ☑ NO ☐

Current phytosanitary legislative framework:

Regulated quarantine pest ☐ Regulated non-quarantine pest ☐
Non regulated ☑

Current geographical distribution of the main vectors:

Frankliniella occidentalis	***Frankliniella intonsa***	***Thrips tabaci***
Africa, America, Asia, Europe, Oceania	Europe, Asia, America, Oceania	America, Asia, Europe, Africa
Sicily YES ☑ NO ☐ **Malta** YES ☑ NO ☐	**Sicily** YES ☐ NO ☑ **Malta** YES ☐ NO ☑	**Sicily** YES ☑ NO ☐ **Malta** YES ☑ NO ☐

Note: TSWV is transmitted by several species of Thripidae, the three listed above are the species widely distributed in Europe.

Range of plant hosts: more than 1000 plant species, mainly Solanaceae and Asteraceae.

Biology and life cycle of the pathogen: TSWV exhibits high genetic diversity. Virus particles are transmitted and spread in natural conditions by several Thripidae included in the genera *Frankliniella* spp. and *Thrips* spp. in persistent, circulative, propagative manner. The virus is acquired only by the larvae and transmitted by late second instars and adults. Most thrips species are very polyphagous and has a high reproductive rate. In Europe *F. occidentalis* is the most common vector. TSWV can be also spread through the movement of infected plant tissue used for vegetative propagation.

Main symptoms: TSWV can induce a wide variety of symptoms that may vary on the same host species with cultivar, plant age, nutritional and environmental conditions. In general, infected plants are small and stunted, leaves may show bronzing, curling, chlorotic line patterns or mosaic with necrotic spots or brown patches. Necrotic streaks appear on stems extending to the terminal shoots. On ripe fruits, ringspots or necrotic streaks have been observed. Severe disease can result in plant death.

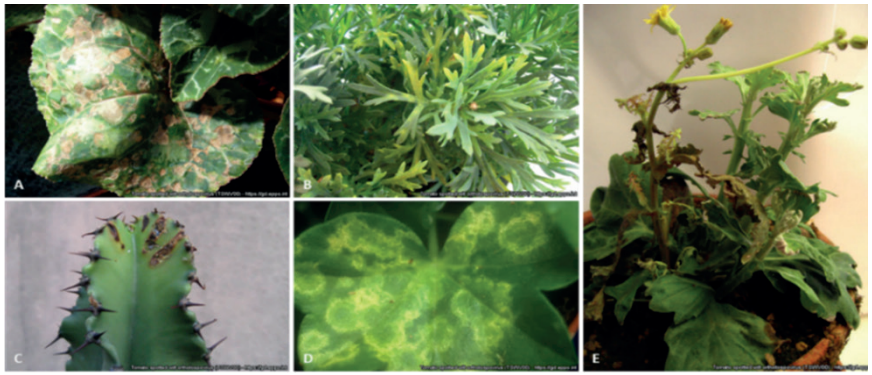

Figure: Symptoms of TSWV on cyclamen A); *Argyranthemum frutescens* (marguerite) B); *Euphorbia candelabrum* C); on pelargonium D); on *Sonchus* spp. and Chrysanthemum E) (source: https://gd.eppo.int/).

Pathways of introduction

Transport of pathogen in potentially infected/contaminated:

SEEDS ☐ PLANTS FOR PLANTING ☑ FRESH FRUITS ☐
INSECT VECTORS ☑ BIRDS ☐ HONEYBEES AND BEEHIVES ☐

Environmental suitability for establishment and spread of the pathogen

Climatic and environmental conditions suitable for the spread of the pathogen:

YES ☑ NO ☐

Climatic and environmental conditions suitable for the spread of the insect vectors:

YES ☑ NO ☐

Note: The main Thrips vectors are already widespread in the areas of interest.

Speed of spread:

LOW ☐ MODERATE ☐ HIGH ☑

Note: The recent introduction and widespread occurrence of the efficient polyphagous vector *Frankliniella occidentalis* has provided a means of rapid spread of the virus.

RISK ASSESSMENT

Because of the high polyphagy of Thrips, the wide range of plant hosts and the efficient transmission by all vegetative propagation techniques, it is likely that TSWV-infected plants are already present in protected areas.

Risk of introduction: HIGH
Risk of establishment: HIGH

***Due to the wide range of plant hosts of TSWV a full list is not shown here. The most representative genera for protected areas are listed below.**

Allium spp., *Amaranthus* spp., *Avena* spp., *Bidens* spp., *Brassica* spp., *Cirsium* spp., *Crepis* spp., *Cyperus* spp., *Datura* spp., *Erigeron* spp., *Euphorbia* spp., *Galium* spp., *Lepidium* spp., *Lionium* spp., *Malva* spp., *Medicago* spp., *Oenothera* spp., *Ox alis* spp., *Plantago* spp., *Ranunculus* spp., *Silene* spp., *Solanum* spp., *Trifolium* spp., *Vitis* spp., *Xanthium* spp.

Risk card for protected areas

Tomato chlorosis virus (ToCV)

Identity of the pathogen

Scientific name	Tomato chlorosis virus (ToCV)
Taxonomic position	Viruses, Closteroviridae, Crinivirus.
Related diseases	yellow leaf disorder of tomato

Current geographical distribution: Africa, America, Asia, Europe.

Sicily YES ☑ NO ☐

Malta YES ☐ NO ☑

Current geographical distribution of the vectors:

Bemisia tabaci	***Trialeurodes vaporariorum***	***Trialeurodes abutiloneus***
Africa, Asia, Europe, America, Oceania	Africa, Asia, Europe, America, Oceania	America
Sicily YES ☑ NO ☐ **Malta** YES ☑ NO ☐	**Sicily** YES ☐ NO ☑ **Malta** YES ☑ NO ☐	**Sicily** YES ☐ NO ☑ **Malta** YES ☐ NO ☑

Current phytosanitary legislative framework:

Regulated quarantine pest ☐ Regulated non-quarantine pest ☐
Non regulated ☑

Range of plant hosts: 84, mainly Solanaceae*.

For protected areas the most representative genera include ***Solanum*** spp.; ***Malva*** spp.; ***Nicotiana*** spp.; ***Chenopodium*** spp.; ***Amaranthus*** spp**.**

Biology and life cycle of the pathogen: ToCV is a phloem-limited virus transmitted locally by whiteflies of the genera *Bemisia and Trialeurodes*. The efficiency of transmission differs among whitefly species and is associated to differences in virus acquisition and accumulation rate. *T. vaporariorum and B. tabaci* are the two most important vectors for Europe. Both are common in glasshouses but are also found outdoors in the field during the summer months.

Main symptoms: Symptoms caused by ToCV infection are easily attributed to other causes, such as physiological or nutritional disorders and phytotoxicity of plants products. The most common symptoms are progressive yellowing of the whole plant branches and leaves chlorosis develops first on lower leaves and gradually advances toward the apical part of the plants. In advanced stages, yellow areas on leaves can also develop in red and brown necrotic flecks. This leads to a reduction in the photosynthesizing surface area of the leaf, which causes further symptoms including rolling and thickened crispy leaves.

Figure: Symptoms on tomato plants infected by Tomato chlorosis virus (source: https://gd.eppo.int/).

Pathways of introduction

Transport of pathogen in potentially infected/contaminated:

SEEDS ☐ PLANTS FOR PLANTING ☑ FRESH FRUITS ☐
INSECT VECTORS ☑ BIRDS ☐ HONEYBEES AND BEEHIVES ☐

Environmental suitability for establishment and spread of the pathogen

Climatic and environmental conditions suitable for the spread of the pathogen:

YES ☑ NO ☐

Climatic and environmental conditions suitable for the spread of the insect vectors:

YES ☑ NO ☐

Note: Data refers to the two widespread whiteflies *B. tabaci* and *T. vaporariorum*.

Speed of spread:

LOW ☐ MODERATE ☐ HIGH ☑

RISK ASSESSMENT

ToCV has a wide range of plant hosts, moreover whiteflies vectors are polyphagous species. The presence of the pathogens and its insect vectors in the area of interests increase the risk of spread of ToCV also into protected areas.

Risk of introduction: HIGH
Risk of establishment: HIGH

***Confirmed plant hosts of ToCV.**

Abelmoschus esculentus, Abutilon theophrasti, Alcea rosea, Alternanthera philoxeroides, Amaranthus graecizans subsp. sylvestris, Amaranthus retroflexus, Amaranthus viridis, Ammi majus, Anadendrum affine, Anagallis foemina, Aralia nudicaulis, Bauhinia variegata, Bidens bipinnata, Brassica oleracea var. capitata, Brassica, Calotropis procera, Capsicum annuum, Cardamine flexuosa, Cerastium glomeratum, Cestrum elegans, Cestrum nocturnum, Chenopodiastrum murale, Chenopodium album, Chenopodium opulifolium, Cirsium arvense, Codiaeum variegatum, Convolvulus arvensis, Conyza sp., Corchorus olitorius, Coriandrum sativum, Cucumis melo, Cucumis sativus, Cucurbita moschata, Cucurbita pepo, Datura stramonium, Eranthemum pulchellum, Erigeron annuus, Erigeron canadensis, Eruca vesicaria, Euphorbia heterophylla, Ficus benjamina, Ficus carica, Fumaria officinalis, Galium aparine, Glebionis coronaria, Glycine max, Gomphrena globosa, Gossypium barbadense, Gossypium hirsutum, Heliotropium lasiocarpum, Heptapleurum arboricola, Hibiscus cannabinus, Hibiscus rosa-sinensis, Ipomoea batatas, Ipomoea cholulensis, Ipomoea coccinea, Ipomoea hederacea, Jatropha integerrima, Lactuca saligna, Lactuca sativa, Lactuca serriola, Leucaena leucocephala, Luffa aegyptiaca, Malva parviflora, Malva sylvestris, Mazus pumilus, Metaplexis japonica, Momordica charantia, Morus alba, Nicandra physalodes, Nicotiana benthamiana, Nicotiana tabacum, Oxalis pes-caprae, Pelargonium auritum, Pentas lanceolata, Phaseolus vulgaris, Physalis angulata, Physalis ixocarpa, Physalis peruviana, Physalis pubescens, Phytolacca americana, Phytolacca icosandra, Plantago major, Portulaca oleracea, Raphanus raphanistrum,

Ricinus communis, Ruta chalepensis, Sisymbrium irio, Solanum aethiopicum, Solanum americanum, Solanum arcanum, Solanum chilense, Solanum chmielewskii, Solanum corneliomulleri, Solanum elaeagnifolium, Solanum galapagense, Solanum habrochaites, Solanum huaylasense, Solanum jamaicense, Solanum lycopersicum, Solanum mammosum, Solanum melongena, Solanum neorickii, Solanum nigrescens, Solanum nigrum, Solanum paniculatum, Solanum pennellii, Solanum peruvianum, Solanum pimpinellifolium, Solanum scuticum, Solanum sessiliflorum, Solanum sisymbriifolium, Solanum stramoniifolium, Solanum subinerme, Solanum tuberosum, Solanum velleum, Sonchus asper, Sonchus oleraceus, Stellaria media, Tectona grandis, Tribulus terrestris, Trigonotis peduncularis, Veronica hederifolia, Vicia faba, Vicia sativa subsp. nigra, Vicia tetrasperma, Vigna unguiculata, Withania somnifera, Youngia japonica, Zinnia.

Risk card for protected areas

Tomato brown rugose fruit virus (ToBRFV)

Identity of the pathogen

Scientific name	Tomato brown rugose fruit virus (ToBRFV)
Taxonomic position	Viruses and viroids, Riboviria, Orthornavirae, Kitrinoviricota, Alsuviricetes, Martellivirales, Virgaviridae, Tobamovirus.

Current geographical distribution: America, Asia, Europe.

Sicily YES ☑ NO ☐

Malta YES ☑ NO ☐

Current phytosanitary legislative framework:

Regulated quarantine pest ☑ Regulated non-quarantine pest ☐
Non regulated ☐

Note: Commission Implementing Regulation (EU) 2021/1809 of 13 October 2021 amending Implementing Regulation (EU) 2020/1191 on measures to prevent the introduction into and the spread within the Union of Tomato brown rugose fruit virus (ToBRFV).

Range of plant hosts: 26 species, mainly Solanaceae*.

For protected areas the most representative genera include wild species of ***Solanum*** spp. (for spread); ***Taraxacum*** spp.; ***Erigeron*** spp.; ***Malva*** spp.; ***Portulaca*** spp**.**

Biology and life cycle of the pathogen: ToBRFV is easily mechanically transmitted; the viral particles are extremely stable and can survive on inert, biological surfaces and soil for a long period without losing their virulence. Seeds coat, pollinating insects (especially Bumblebees for tomato plants) and equipment for cultural practice, are pathways for the spread of the pathogen. ToBRFV have no known natural vectors, but other tobamoviruses are known to be transmitted by birds.

Main symptoms: Symptoms on infected plants include mosaic with dark green blistering on leaves, deformation especially of young leaves with reduced interveinal surfaces, stem necrosis and sometimes flowers wilting. On tomato fruits the most common symptoms are yellow or green discoloration, deformation, brown rugose and calix necrosis. The severity of symptoms varies with cultivar, environmental conditions and time of infection. The most characterized plant hosts are *Solanum lycopersicum* and *Capsicum annuum,* no specific symptoms are reported for wild plants.

Figure: Symptoms of Tomato brown rugose fruit virus infection on tomato A), B), D) and pepper plants C) (source: https://gd.eppo.int/).

Pathways of introduction

Transport of pathogen in potentially infected/contaminated:

SEEDS ☐ PLANTS FOR PLANTING ☑ FRESH FRUITS ☑
INSECT VECTORS ☐ BIRDS ☐ BUMBLEBEES ☑
HANDS, TOOLS, CLOTHING AND MACHINERY ☑
CRATES AND PACKAGING MATERIALS ☑ DRAINAGE WATER ☑

Environmental suitability for establishment and spread of the pathogen

Climatic and environmental conditions suitable for the spread of the pathogen:

YES ☑ NO ☐

Speed of spread:

LOW ☐ MODERATE ☐ HIGH ☑

RISK ASSESSMENT

This new virus can be considered as an invasive species even though the range of host plants is not very wide lately it has also been reported in some wild plant species. Since now, it is only known to cause damage to tomato and pepper crops. The possible presence of symptomless infected plant hosts, especially wild plant, could be a risk for the spread of the pathogen also into the interested areas. The current geographical distribution and the high transmission rate could be a risk factor for the introduction of the pathogens into protected area.

Risk of introduction: HIGH
Risk of establishment: HIGH

***Confirmed plant hosts of ToBRFV.**

Capsicum spp.*; Capsicum annuum; Chenopodiastrum murale; Chenopodium giganteum; Chenopodium quinoa; Nicotiana benthamiana; Nicotiana clevelandii; Nicotiana glutinosa; Nicotiana tabacum; Petunia x hybrida; Solanum arcanum; Solanum cheesmaniae; Solanum chilense; Solanum chmielewskii; Solanum corneliomulleri; Solanum galapagense; Solanum habrochaites; Solanum huaylasense; Solanum juglandifolium; Solanum lycopersicum; Solanum lycopersicum var. cerasiforme; Solanum melongena; Solanum neorickii; Solanum nigrum; Solanum ochranthum; Solanum pennellii; Solanum peruvianum; Solanum pimpinellifolium; Solanum sitiens.*

Risk card for protected areas

Tomato leaf curl New Delhi virus (ToLCNDV)

Identity of the pathogen

Scientific name	Tomato leaf curl New Delhi virus (ToLCNDV)
Taxonomic position	Viruses and viroids, Monodnaviria, Shotokuvirae, Cressdnaviricota, Repensiviricetes, Geplafuvirales, Geminiviridae, Begomovirus.

Current geographical distribution of the pathogen: Africa, Asia, Europe.

Sicily YES ☑ NO ☐

Malta YES ☐ NO ☑

Current geographical distribution of the vector: Africa, Asia, America, Europe, Oceania.

Sicily YES ☑ NO ☐

Malta YES ☑ NO ☐

Known vector: *Bemisia tabaci*

Current phytosanitary legislative framework:

Regulated quarantine pest ☑ Regulated non-quarantine pest ☐
Non regulated ☐

Note: COMMISSION IMPLEMENTING REGULATION (EU) 2019/2072 of 28 November 2019 as regards protective measures against pest of plants, explaining special requirements for the movement within the Union territory of Solanaceae and Cucurbitaceae plant for planting originating from areas where ToLCNDV and its vector are known to occur.

Range of plant hosts: 62 species, mainly Solanaceae and Cucurbitaceae*.

For protected areas the most representative genera include ***Datura*** spp.; ***Convolvulus*** spp.; ***Chenopodium*** spp.; **Sonchus** spp.; and species in the family of **Malvaceae** and **Fabaceae**.

Biology and life cycle of the pathogen: ToLCNDV is a bipartite *Begomovirus* (family *Geminiviridae*) transmitted in a circulative persistent manner by the whitefly *B. tabaci* to a wide range of host plants. This vector is a very polyphagous species widespread in the European territory. The virus can rarely be transmitted mechanically through the germination of seeds from infected fruits (virus in seed coat) and by wounding, but with a very low efficiency. The spread is primarily due to vector transmission that reflects the geographical distribution of *B. tabaci*, influenced by climatic and environmental conditions.

Main symptoms: ToLCNDV infection causes leaf curl, distortion and blistering symptoms on tomato and a range of yellowing, spotting, chlorotic mottling, leaf deformation and stunting on other host plants. Symptoms are initially evident on youngest leaves, later they may extend to older leaves and to whole plant. Early infections can interfere with flowering and fruit development resulting in reduced flower setting and low numbers of fruits. Fruits remain small, sometimes discoloured, and blistered and can drop prematurely.

Figure: Symptoms of Tomato leaf curl New Delhi virus on Cucurbit plants (source: https://gd.eppo.int/).

Pathways of introduction

Transport of pathogen in potentially infected/contaminated:

SEEDS ☐ PLANTS FOR PLANTING ☑ FRESH FRUITS ☐
INSECT VECTORS ☑ BIRDS ☐ BUMBLEBEES ☐
VEHICLES, EQUIPMENT AND MACHINERY ☐

Note: mechanical transmission occurs with low efficiency, for this reason pathways of entry like vehicles, equipment and machinery or pollinating insects are not mentioned here.

Environmental suitability for establishment and spread of the pathogen

Climatic and environmental conditions suitable for the spread of the pathogen:

YES ☑ NO ☐

Speed of spread:

LOW ☐ MODERATE ☐ HIGH ☑

RISK ASSESSMENT

ToLCNDV is widespread in Sicily, as its insect vector perfectly adapted to Mediterranean climatic and environmental conditions. *B. tabaci* is a very efficient vector, one to few insects can cause an epidemy. The rate of disease spread directly depends on insect vector population. Moreover, because the polyphagous nature of this insect vector, the range of plant hosts of the virus may be larger than reported. The trade of potentially infected plants, host of the pathogen and/or of the vector, is regulated but considering the number of interceptions of *B. tabaci* there is uncertainty whether the measures in place are sufficient to prevent the entry and the spread of ToLCNDV into new areas. The pathogen could be already present into protected areas.

Risk of introduction: HIGH
Risk of establishment: HIGH

***Confirmed plant hosts of ToLCNDV.**

Abelmoschus esculentus, Acalypha indica, Benincasa fistulosa, Benincasa hispida, Calotropis procera, Capsicum annuum, Capsicum chinense, Capsicum frutescens, Carica papaya, Catharanthus roseus, Cestrum nocturnum, Chenopodium album, Chenopodium giganteum, Chrysanthemum indicum, Citrullus lanatus, Coccinia grandis, Commelina benghalensis, Convolvulus arvensis, Crossandra infundibuliformis, Cucumis melo var. flexuosus, Cucumis melo, Cucumis sativus, Cucurbita maxima, Cucurbita moschata, Cucurbita pepo var. giromontiina, Cucurbita pepo, Cyamopsis tetragonoloba, Dahlia pinnata, Datura stramonium, Daucus carota, Ecballium elaterium, Eclipta prostrata, Euphorbia hirta, Glycine max, Gossypium hirsutum, Hibiscus cannabinus, Jasminum multiflorum, Jatropha, Lagenaria siceraria, Lens culinaris, Luffa acutangula, Luffa aegyptiaca, Momordica charantia, Momordica dioica, Papaver somniferum, Parthenium hysterophorus, Phyllanthus niruri, Physalis minima, Ricinus communis, Rumex dentatus, Sauropus androgynus, Sechium edule, Solanum lycopersicum, Solanum melongena, Solanum nigrum, Solanum tuberosum, Sonchus oleraceus, Tagetes erecta, Trichosanthes cucumerina, Trifolium repens, Vigna radiata.

Risk card for protected areas

'*Candidatus* Phytoplasma phoenicium' (CaPphoe)

Identity of the pathogen

Preferred name	'*Candidatus* Phytoplasma phoenicium' - 16SrIX (Verdin et al.)
Taxonomic position	Bacteria, Tenericutes, Mollicutes, Acholeplasmatales, Acholeplasmataceae.
Related diseases	Almond witches' broom (AlmWB)

Current geographical distribution: America, Asia, Europe (sporadic)

Sicily YES ☑ NO ☐

Malta YES ☑ NO ☐

Note: The phytoplasma are currently reported only in Iran and Lebanon.

Current legislative framework:

Regulated quarantine pest ☑ Regulated non-quarantine pest ☐
Non regulated ☐

Note: '*Ca*. P. phoenicium' is regulated in Lebanon since 2011 and for all *Prunus* spp. propagation material in Israel. In Europe there are prohibitions on the movement of Prunus plants for planting from Iran (as non-Mediterranean).

Range of plant hosts: 18 plant species (13 presents in Sicily)*.

The most representative genera include ***Prunus*** spp.

Biology and life cycle of the pathogen: Phytoplasma cells live restricted to the **sieve tubes** of infected host plants and are transmitted by **grafting** and efficient phloem sap feeding vectors. The complex life cycle of 'Ca. P. phoenicium' involves different plant hosts, including weeds and uncultivated plant species and several leafhoppers. Information about modalities of transmission through insects are currently limited. Different species can acquire phytoplasma cells, but transmission has been proven only for three of them. The polyphagous ***Asymmetrasca decedens*** (Cicadelidae) in almond and peach trees, ***Tachycixius cypricus*** (Cixiidae) and ***Tachycixius viperinus*** (Cixiidae). The latter two may play a role in transmission on wild hosts. Furthermore, other potential vectors are suspected to have a role in the epidemiology of the disease.

Main symptoms: The initial symptoms on peach and nectarine trees are **early flowering** (15-20 days earlier than normal) and early development of all buds on infected branches. Leaves of infected plants may appear **slim**, **serrate**, **yellowish**, **light green** and **wilt.** The most characteristic symptom of '*Ca*. P. phoenicium' infection is **shoot proliferation** on the main trunk and crown, with the appearance of a witches'-broom that evolves at a later stage of the infection cycle.

Figure: Symptoms of '*Ca*. P. phoenicium infection on almond trees A), B) and on nectarine tree C) (source: https://gd.eppo.int/).

Pathways of introduction

Transport of pathogen in potentially infected/contaminated:

SEEDS ☐ PLANTS FOR PLANTING ☑ FRESH FRUITS ☐
INSECT VECTORS ☑ BIRDS ☐ HONEYBEES AND BEEHIVES ☐

Environmental suitability for establishment and spread of the pathogen

Climatic and environmental conditions suitable for the spread of the pathogen:

YES ☑ NO ☐

Note: Warm temperate climate with dry summer is preferred.

Climatic and environmental conditions suitable for the spread of the insect vectors:

YES ☑ NO ☐

Speed of spread:

LOW ☐ MODERATE ☑ HIGH ☐

ASSESSMENT

Current prohibitions on plant for planting would prevent the entry of some commodities into the interested areas. However, prohibitions in force do not cover all of Europe and the mentioned plants do not cover the whole host range of the pathogen. Some infected plants can remain symptomless, it is likely that some host plants are still unknown and that the host list is incomplete. Even considering potential alternative vectors, '*Ca.* P. phoenicium' has a high likelihood of establishing, spreading and causing impacts.

Risk of introduction: MEDIUM
Risk of establishment: HIGH

***Confirmed plant hosts of AlmWB, the highlighted species are occurring in areas of interest.**

Cultivated: *Allium cepa; Allium sativum; Catharanthus roseus;* ***Citrus sinensis****; Dendranthema x grandiflorum;* ***Prunus armeniaca****;* ***Prunus dulcis****; Prunus orientalis;* ***Prunus persica****;* ***Prunus persica var. nucipersica****; Prunus x amygdalo-persica;* ***Punica granatum****;* ***Vitis vinifera****.*

Spontaneous: ***Anthemis****; Juniperus occidentalis;* ***Pistacia vera****; Prunus scoparia;* ***Smilax aspera****.*

Risk card for protected areas

Ralstonia solanacearum

Identity of the pathogen

Scientific name	*Ralstonia solanacearum* (Smith 1896) Yabuuchi et al., 1996 emend. Safni et al., 2014.
Taxonomic position	Bacteria, Proteobacteria, Betaproteobacteria, Burkholderiales, Burkholderiaceae.
Related diseases	Bacterial wilt

Current geographical distribution: America, Africa, Asia, Europe, Oceania.

Sicily YES ☑ NO ☐

Malta YES ☑ NO ☐

Current phytosanitary legislative framework:

Regulated quarantine pest ☑ Regulated non-quarantine pest ☐
Non regulated ☐

Note: COMMISSION IMPLEMENTING REGULATION (EU) 2022/1193 of 11 July 2022 establishing measures to eradicate and prevent the spread of *Ralstonia solanacearum* (Smith 1896) Yabuuchi et al. 1996 emend. Safni et al. 2014.

Range of plant hosts: 74 plant species, mainly Solanaceae (34 presents in Sicily)*.

For protected areas the most representative genera include ***Eucaliptus*** spp., ***Oxalis*** spp.; wild species of ***Solanum*** spp., especially *Solanum dulcamara;* the species ***Canna indica.***

Biology and life cycle of the pathogen: *R. solanacearum* is a species complex (RSSC) of cosmopolitan group of bacterial plant pathogens (*R. solanacearum*, *R. pseudosolanacearum* and two subspecies of *R. syzygii*) of the family Burkholderiaceae. Entry into plants is usually through stomata or root lesions from where the bacteria move by colonization of the xylem, process that is accelerated at higher temperatures. Blocking of the vessels by bacterial biofilm is considered the major cause of wilting. *R. solanacearum* is a soilborne pathogens, but survival is short at low temperature in bare soil. Disease is usually most severe at temperatures of 24-35°C, high soil moisture, wet weather or rainy seasons.

Main symptoms: The first visible symptom of *R. solanacearum* is a **wilting** of the leaves at the ends of the branches during the heat of the day with recovery at night, premature **yellowing** of leaves and **stunted** plants. **Vascular browning** with bacterial **slime oozing** is common from the cut. As the disease develops, a streaky brown discoloration of the stem may be observed along with epinasty of the petioles, bronzing on leaves and **brow rot**. In tomatoes large numbers of adventitious roots are produced on the stem. Under less favourable environmental conditions the disease develops slowly, while under favourable conditions infected plants can die.

Figure: Symptoms of *R. solanacearum* infection on geranium A); eggplant B); tomato C) and in a field crop of chili in India D) (source: https://gd.eppo.int/).

Pathways of introduction

Transport of pathogen in potentially infected/contaminated:

SEEDS ☑ PLANTS/TUBERS FOR PLANTING ☑
FRESH FRUITS ☑ INSECT VECTORS ☐ BIRDS ☐
HONEYBEES AND BEEHIVES ☐ VEHICLES, EQUIPMENT AND MACHINERY ☑ WATER ☑

Environmental suitability for establishment and spread of the pathogen

Climatic and environmental conditions suitable for the spread of the pathogen:

YES ☑ NO ☐

Note: The disease is rarely found where the mean temperature in winter falls below 10°C. The lower limit of the air temperature is -10°C and the upper limit +40°C. The optimal temperature for pathogen replication is between 24 and 35°C.

Speed of spread:

LOW ☐ MODERATE ☐ HIGH ☑

RISK ASSESSMENT

Establishment of *R. solanacearum* in riparian weed hosts along rivers, for example bittersweet (*Solanum dulcamara*), is a risk factor for bacterium spread via water into nature (also in protected area), where it is impossible to control these weeds. This may pose a problem also for growers when they use surface water for irrigation near the interested areas.

Risk of introduction: MEDIUM
Risk of establishment: HIGH

***Confirmed plant hosts of *R. solanacearum*, the highlighted species are occurring in areas of interest.**

Ageratum conyzoides; Amaranthus cruentus; Amomum subulatum; Annona cherimola; Anthurium spp.; *Arachis hypogaea; Artemisia* spp.; *Beta vulgaris; Beta vulgaris var. cicla; Bougainvillea glabra; Capsicum* spp.; *Capsicum annuum; Capsicum frutescens; Casuarina cunninghamiana; Casuarina equisetifolia; Casuarina glauca; Cereus peruvianus; Cestrum nocturnum; Chenopodium* spp.*; Citrullus lanatus; Citrus* spp.; *Coffea arabica; Coleus* spp.; *Coleus forskohlii; Colocasia esculenta; Commelina forskaolii; Conyza bonariensis; Corchorus olitorius; Cosmos bipinnatus; Cucumis melo; Cucumis sativus; Cucurbita maxima; Cucurbita moschata; Cucurbita pepo; Curcuma alismatifolia; Curcuma longa; Cynara cardunculus; Cynara cardunculus var. scolymus; Cyphomandra betacea; Datura stramonium; Drymaria cordata; Emilia coccinea; Emilia sonchifolia;* ***Eucalyptus*** *spp.; Eupatorium cannabinum; Ficus carica; Galinsoga parviflora; Galinsoga quadriradiata; Gossypium; Helianthus annuus; Heliconia; Heliconia caribaea; Hevea brasiliensis; Hydrangea; Hydrocotyle ranunculoides; Ipomoea batatas; Justicia adhatoda; Lagenaria siceraria; Maranta arundinacea; Medicago trunculata; Momordica charantia; Monochoria vaginalis; Musa; Musa balbisiana; Musa paradisiaca; Musa x paradisiaca; Nicotiana rustica; Nicotiana tabacum;* ***Olea Europeea****; Olea Europeea subsp. Europeea; Oryza sativa; Oxalis latifolia; Paspalum; Pelargonium; Pelargonium hortorum; Pelargonium zonale hybrids; Phyllanthus niruri; Physalis; Physalis angulate; Platostoma chinensis; Plectranthus barbatus; Pogostemon cablin; Polygonum capitatum; Portulaca oleracea; Ricinus communis; Rosa; Salpiglossis sinuate; Salvia reflexa; Sesamum indicum; Setaria parviflora; Siraitia grosvenorii; Solanum americanum; Solanum capsicastrum; Solanum carolinense; Solanum cinereum;* ***Solanum dulcamara****; Solanum luteum; Solanum lycopersicum; Solanum macrocarpon; Solanum melongena;* ***Solanum nigrum****; Solanum phureja; Solanum pimpinellifolium; Solanum sisymbriifolium; Solanum tuberosum; Soliva anthemifolia;* ***Sonchus oleraceus****; Strelitzia reginae; Tagetes; Tagetes erecta; Talinum fruticosum; Tectona grandis;* ***Urtica dioica****; Vaccinium corymbosum; Verbena brasiliensis; Washingtonia filifera; Zingiber officinale.*

Interreg Italia-Malta FAST

Risk card for protected areas

Pepino mosaic virus (PepMV)

Identity of the pathogen

Scientific name	Pepino mosaic virus (PepMV)
Taxonomic position	Viruses and viroids, Riboviria, Orthornavirae, Kitrinoviricota, Alsuviricetes, Tymovirales, Alphaflexiviridae, Potexvirus.
Related diseases	Pepino mosaic disease

Current geographical distribution: Africa, America, Asia (restricted), Europe, Oceania.

Sicily YES ☑ NO ☐

Malta YES ☐ NO ☑

Current phytosanitary legislative framework:

Regulated quarantine pest ☐ Regulated non-quarantine pest ☑
Non regulated ☐

Note: In Europe the movement of tomato seeds is regulated based on emergency decision 2004/200/EC as regards measures to prevent the introduction into and the spread within the Community of Pepino mosaic virus.

Range of plant hosts: 81 plant species, mainly Solanaceae*.

For protected areas the most representative genera include ***Malva*** spp., ***Nicotiana*** spp., wild species of ***Solanum*** spp.

Biology and life cycle of the pathogen: PepMV is transmitted mainly mechanically, and virus particles are quite stable at room temperature. The virus can survive and remain infectious for several weeks in plant debris, on the outside of the seeds and on contaminated surfaces (wood containers, tools, clothing, machinery). Roots of infected plants show significant concentrations of virus and when are damaged or die, virus particles can be released in the and in drainage water. Bumblebees play a role in virus mechanical transmission.

Main symptoms: Symptoms of PepMV can be extremely variable, ranging from latent to very severe infections. On tomato plants initial symptoms are small **yellow spots** on leaves, that can evolve in **blistering**/bubbling, chlorosis, **mosaic** and **necrosis**. A characteristic but rare symptom are **bright yellow flecks** on tomato leaves. Older leaves may show **mottling**, slight **curling** on the top and stem can show necrosis. The most typical symptoms on fruits are discolorations, such as **marbling** or **flaming**, and occasionally cracking and **malformation** of fruits. Develop of symptoms is influenced by climatic and environmental conditions.

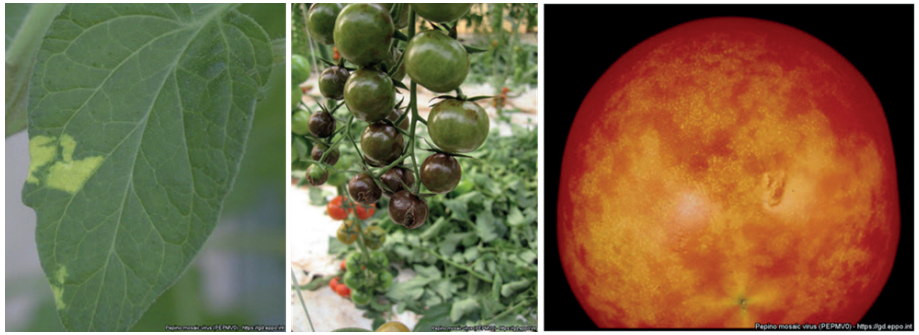

Figure: Symptoms of PepMV infection on tomato plants (source: https://gd.eppo.int/).

Pathways of introduction

Transport of pathogen in potentially infected/contaminated:

SEEDS ☐ PLANTS FOR PLANTING ☑ FRESH FRUITS ☑
INSECT VECTORS ☐ BIRDS ☐ HONEYBEES AND BUMBLEBEES ☑
HANDS, TOOLS, CLOTHING AND MACHINERY ☑
CRATES AND PACKAGING MATERIALS ☑ DRAINAGE WATER ☑

Environmental suitability for establishment and spread of the pathogen

Climatic and environmental conditions suitable for the spread of the pathogen:

YES ☑ NO ☐

Speed of spread:

LOW ☐ MODERATE ☐ HIGH ☑

RISK ASSESSMENT

PepMV is easily mechanically transmissible. Since symptoms are not always readily recognized, it can rapidly unnoticed spread by normal cultural practices in a cultivated environment or by movement of people, vehicles, items or pollinated insect in natural one.

Risk of introduction: MEDIUM
Risk of establishment: HIGH

***Confirmed plant hosts of PepMV.**

Allium sativum; Amaranthus graecizans; Amaranthus retroflexus; Amaranthus sp.; Amaranthus viridis; Bassia scoparia; Calendula arvensis; Calystegia sepium; Capsicum annuum; Chenopodiastrum murale; Convolvulus althaeoides; Convolvulus arvensis; Convolvulus humilis; Cucumis sativus; Datura innoxia; Datura metel; Datura stramonium; Diplotaxis erucoides; Echium creticum; Echium humile; Erigeron sumatrensis; Glebionis segetum; Heliotropium Europeeum; Lepidium sp.; Malva neglecta; Malva nicaeensis; Malva parviflora; Malva sylvestris; Moricandia arvensis; Nicandra physalodes; Nicotiana benthamiana; Nicotiana clevelandii; Nicotiana debneyi; Nicotiana glauca; Nicotiana glutinosa; Nicotiana occidentalis; Nicotiana quadrivalvis; Nicotiana rustica; Nicotiana tabacum; Ocimum basilicum; Oloptum miliaceum; Onopordum cyprium; Onopordum sp.; Physalis floridana; Physalis peruviana; Plantago afra; Plantago lagopus; Plantago major; Rumex sp.; Sisymbrium irio; Solanum americanum; Solanum boliviense; Solanum cardiophyllum; Solanum chilense; Solanum chmielewskii; Solanum curtilobum; Solanum demissum; Solanum dulcamara; Solanum lycopersicum; Solanum melongena; Solanum microdontum; Solanum mochiquense; Solanum muricatum; Solanum nigrum; Solanum oxycarpum; Solanum palustre; Solanum peruvianum; Solanum pimpinellifolium; Solanum raphanifolium; Solanum sarrachoides; Solanum stenotomum; Solanum stoloniferum; Solanum tuberosum; Sonchus asper; Sonchus oleraceus; Sonchus tenerrimus; Taraxacum officinale; Tetragonia tetragonioides; Vicia faba; Vigna unguiculata.

Interreg Italia-Malta FAST

Risk card for protected areas

Impatiens necrotic spot virus (INSV)

Identity of the pathogen

Scientific name	Impatiens necrotic spot virus (INSV)
Taxonomic position	Viruses and viroids, Riboviria, Orthornavirae, Negarnaviricota, Polyploviricotina, Ellioviricetes, Bunyavirales, Tospoviridae, Orthotospovirus.
Related diseases	Necrotic spot of Impatiens

Current geographical distribution: Africa, America, Asia, Europe, Oceania.

Sicily YES ☑ NO ☐

Malta YES ☐ NO ☑

Current phytosanitary legislative framework:

Regulated quarantine pest ☐ Regulated non-quarantine pest ☑
Non regulated ☐

Note: The thresholds for the presence of INSV on the plants for planting of Begonia x hiemalis and Impatiens New Guinea Hybrids is regulated in the COMMISSION IMPLEMENTING DIRECTIVE (EU) 2020/177 of 11 February 2020 as regards pests of plants on seeds and other plant reproductive material.

Current geographical distribution of the vectors:

Frankliniella fusca	*Frankliniella occidentalis*	*Frankliniella intonsa*
America	Africa, America, Asia, Europe, Oceania	Europe, Asia
Sicily ☐ Malta ☐	Sicily ☑ Malta ☑	Sicily ☐ Malta ☐

Range of plant hosts: 266 species, mainly ornamental*.

For protected areas the most representative species are ***Stellaria media*** and ***Cerastium glomeratum.***

Biology and life cycle of the pathogen: INSV is an Orthotospovirus transmitted by three different species of Thrips (family Thripidae). *F. occidentalis* and *F. intonsa* occurs in Europe and the first is widespread, while *F. fusca* has a limited geographical distribution. Thrips are very polyphagous; they acquire the virus from different infected plants and after a latent period transmit it to new hosts in a persistent manner. The insect vector remains infectious for life. INSV is also transmitted through plant propagating material and for current data not by seed.

Main symptoms: Symptoms of INSV infection can vary according to the host plant affected (species, variety, age, developmental stage, etc.), nutritional and environmental conditions of the plants. The same host species can show mild, severe or no symptoms in different conditions. The most common observed symptoms include stunting, wilting, chlorosis, necrosis of leaves and stem, ringspot or spot on leaves and fruits, mottles (blotches) or mosaic, zig-zag patterns or streaks on leaves and leaf distortion.

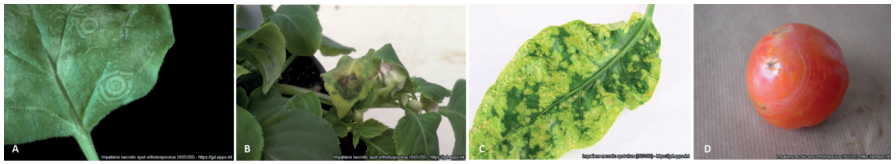

Figure: Symptoms of Impatiens necrotic spot virus on *Nicotiana benthamiana* A), *Impatiens* spp. B), *Anthurium* spp. C) and *Solanum lycopersicum* (source: https://gd.eppo.int/).

Pathways of introduction

Transport of pathogen in potentially infected/contaminated:

SEEDS ☐ PLANTS FOR PLANTING ☑ FRESH FRUITS ☐
INSECT VECTORS ☑ BIRDS ☐ HONEYBEES AND BEEHIVES ☐

Environmental suitability for establishment and spread of the pathogen

Climatic and environmental conditions suitable for the spread of the pathogen:

YES ☑ NO ☐

Climatic and environmental conditions suitable for the spread of the insect vectors:

YES ☑ NO ☐

Speed of spread:

LOW ☐ MODERATE ☐ HIGH ☑

RISK ASSESSMENT

INSV already occurs in Sicily, moreover the two Thrips vector are very polyphagous species widely distributed in the interested areas. For this reason, the risk of introduction of the virus into protected area could be high, while the establishment medium. This is because the wide range of host plants consists mainly of ornamental plants, a few vegetable crops, and some weeds.

Risk of introduction: HIGH
Risk of establishment: MEDIUM

***Confirmed plant hosts of INSV.**

Abelia x grandiflora, Acanthospermum hispidum, Aconitum sp., Adenium obesum, Aeschynanthus sp., Ageratum houstonianum, Agrostemma githago, Allium cepa, Allium cernuum, Allium cristophii, Allium lusitanicum, Allium moly, Allium oleraceum, Allium oreophilum, Allium porrum, Allium rotundum, Allium sativum, Allium scorodoprasum, Allium sphaerocephalon, Allium tuberosum, Allium zebdanense, Alstroemeria aurea, Alstroemeria sp., Althaea sp., Amaryllis sp., Anemone coronaria, Anemone sp., Anthemis sp., Anthriscus cerefolium, Anthurium andraeanum, Anthurium scherzerianum, Anthurium sp., Antirrhinum majus, Antirrhinum sp., Aphelandra sp., Arabidopsis sp., Arachis hypogaea, Ardisia sp., Asparagus densiflorus, Asplenium nidus, Begonia cucullata, Begonia leathermaniae, Begonia peltata, Begonia semperflorens hybrids, Begonia sp., Begonia tuberhybrida hybrids, Begonia x hiemalis, Bougainvillea sp., Bougainvillea spectabilis, Bouvardia sp., Browallia sp., Browallia speciosa, Calceolaria herbeohybrida hybrids, Calceolaria sp., Calendula sp., Callistephus sp., Calycanthus floridus, Canna x generalis, Capsicum annuum, Cardamine hirsuta, Cardamine scutata, Cerastium glomeratum, Chenopodium album, Chrysanthemum sp., Chrysanthemum x morifolium, Cichorium intybus, Cineraria sp., Cissus sp., Clarkia amoena subsp. lindleyi,

Clivia sp., Codiaeum variegatum, Coleus scutellarioides, Columnea sp., Cordyline fruticosa, Cucumis sativus, Curcuma longa, Curcuma sp., Cycas sp., Cyclamen persicum, Cyclamen sp., Cyperus esculentus, Cyperus rotundus, Cyrtomium falcatum, Dahlia sp., Datura innoxia, Datura stramonium, Delphinium sp., Dendrobium sp., Desmodium tortuosum, Dianthus caryophyllus, Dianthus chinensis, Dianthus sp., Diascia rigescens, Diascia sp., Dieffenbachia seguine, Digitalis sp., Dischidia sp., Dracaena fragrans, Dracaena sp., Echeveria sp., Epipremnum pinnatum, Episcia cupreata, Erica sp., Erigeron canadensis, Eruca vesicaria subsp. sativa, Erysimum cheiri, Eupatorium capillifolium, Euphorbia seguieriana, Eustoma russellianum, Eustoma sp., Exacum affine, Fatsia sp., Ficaria verna, Ficus benjamina, Ficus elastica, Franklinia alatamaha, Freesia refracta, Freesia sp., Gardenia jasminoides, Gazania sp., Gentiana macrophylla, Gentiana sp., Geranium carolinianum, Geranium sp., Gerbera jamesonii, Gerbera sp., Gladiolus sp., Gladiolus x gandavensis, Gnaphalium sp., Gomphrena globosa, Halesia carolina, Hedera helix, Helianthus annuus, Helichrysum sp., Hibiscus rosa-sinensis, Hippeastrum hybrids, Hippeastrum sp., Hosta sp., Hoya carnosa, Hoya sp., Hoya wayetii, Hydrangea quercifolia, Hydrangea sp., Hymenocallis littoralis, Ilex glabra, Impatiens New Guinea hybrids, Impatiens hawkeri, Impatiens sp., Impatiens walleriana, Ipomoea tricolor, Iris pumila, Iris x hollandica, Isotoma axillaris, Jacquemontia tamnifolia, Kalanchoe blossfeldiana, Kalanchoe farinacea, Kalanchoe sp., Kalanchoe thyrsiflora, Kohleria sp., Lactuca sativa, Lavandula sp., Leucanthemum sp., Limonium sinuatum, Limonium sp., Lobelia erinus, Lobelia sp., Lysimachia congestiflora, Maranta leuconeura, Matricaria chamomilla, Mollugo verticillata, Monarda didyma, Nemesia strumosa, Nepenthes x coccinea, Nicotiana benthamiana, Nicotiana tabacum, Ocimum basilicum, Oncidium sp., Opuntia microdasys, Osteospermum sp., Oxydendrum arboreum, Pelargonium peltatum, Pelargonium radens, Pelargonium sp., Pelargonium x hortorum, Penstemon sp., Peperomia obtusifolia, Peperomia rotundifolia, Pericallis cruenta, Pericallis x hybrida, Petunia sp., Petunia x hybrida, Phalaenopsis amabilis, Phalaenopsis hybrids, Philodendron sp., Phlox sp., Photinia x fraseri, Physalis ixocarpa, Pilea cadierei, Pittosporum sp., Plantago asiatica, Platycodon grandiflorus, Portulaca grandiflora, Portulaca oleracea, Primula obconica, Primula sp., Ranunculus asiaticus, Ranunculus sp., Raphanus raphanistrum,

Rhaphiolepis indica, Richardia scabra, Rosa sp., Rubus sp., Rubus, Ruscus sp., Salvia sp., Salvia splendens, Saxifraga stolonifera, Schefflera actinophylla, Schefflera sp., Schizanthus sp., Schizanthus x wisetonensis, Scindapsus sp., Sinningia sp., Sinningia speciosa, Solanum brevicaule, Solanum lycopersicum, Solanum mochiquense, Solanum muricatum, Solanum tuberosum, Sonchus oleraceus, Spathiphyllum sp., Spinacia oleracea, Stachys floridana, Stellaria media, Stephanotis sp., Streptocarpus ionanthus, Streptocarpus sp., Syngonium podophyllum, Torenia fournieri, Trachelium sp., Tradescantia albiflora, Tripleurospermum maritimum, Tulipa sp., Verbena hybrids, Verbena rigida, Verbena sp., Viola sp., Wahlenbergia marginata, Zantedeschia aethiopica, Zantedeschia albomaculata, Zantedeschia odorata, Zantedeschia sp., Zingiber sp., Zinnia elegans, Zinnia sp.

Interreg Italia-Malta FAST

Risk card for protected areas

'*Candidatus* Liberibacter solanacearum' (Lso)

Identity of the pathogen

Scientific name	'*Candidatus* Liberibacter solanacearum' (Liefting, Perez-Egusquiza & Clover).
Taxonomic position	Bacteria, Proteobacteria, Alphaproteobacteria, Rhizobiales, Phyllobacteriaceae.
Lso haplotype	Lso A-B-C-D-E-F-G-H
Related diseases	Zebra chip (potatoes), psyllid yellows (tomatoes) yellows decline (carrots) vegetative disorder (carrots and celery).

Current geographical distribution: America, Asia, Oceania, Europe.

Sicily (restricted distribution) YES ☑ NO ☐

Malta YES ☐ NO ☑

Current phytosanitary legislative framework:

Regulated quarantine pest ☐ Regulated non-quarantine pest ☑
Non regulated ☐

Note: The import of seed potatoes from third countries (other than Switzerland) is prohibited as laid down in Council Directive 2000/29/EC, Annex III Part A. Import of ware potatoes is also prohibited, except from a limited number of Mediterranean and European countries where Lso A, B and F are not present.

Current geographical distribution of the vectors:

Bactericera cockerelli	*Trioza apicalis*	*Bactericera trigonica*	*Trioza urticae*
America, Oceania	Asia, Europe	Africa, Asia, Europe	Asia, Europe
Sicily YES ☐ NO ☑ **Malta** YES ☐ NO ☑	**Sicily** YES ☐ NO ☑ **Malta** YES ☐ NO ☑	**Sicily** YES ☑ NO ☐ **Malta** YES ☑ NO ☐	**Sicily** YES ☐ NO ☑ **Malta** YES ☐ NO ☑

Range of plant hosts: 38, mainly Solanaceae and Apiaceae*

For protected areas the most representative host plants include wild species of ***Solanum*** spp., ***Chenopodium album***, ***Convolvolus arvenis***, ***Urtica dioica***.

Biology and life cycle of the pathogen: '*Ca.* L. solanacearum' is a Gram-negative, unculturable alphaproteobacterium restricted to the **phloem** of its host plants and **psyllid** vector's hemolymph, within which it alternates its life cycle. Different species of phloem feeder psyllids transmit different **haplotypes** of Lso in various **geographical areas** and host plants. Seed transmission could not be confirmed.

Main symptoms: Symptoms and disease severity vary between different plant hosts of the bacterium. The most common are **stunting**, erectness of new foliage, upward **rolling**, **chlorosis** and **purpling** of leaves, shortened and thickened of terminal internodes, enlarged nodes, develop of **axillary branches** or aerial tubers, leaf **scorching**. Fruits are also altered, infected plants develop numerous small and **misshapen fruits**, compromising their quality. Low bacterial concentration can result in symptomless infected plants.

Figure: Symptoms of '*Ca*. L. solanacearum' infection on potato A); carrot B); gooseberry C) and tamarillo D) plants (source: https://gd.eppo.int/).

Pathways of introduction
Transport of pathogen in potentially infected/contaminated:

SEEDS ☐ PLANTS FOR PLANTING ☑ FRESH FRUITS ☐
INSECT VECTORS ☑ BIRDS ☐ HONEYBEES AND BEEHIVES ☐

Note: Lso can be transported by infected vegetative propagation material, but transmission occurs only if the insect vector is present.

Environmental suitability for establishment and spread of the pathogen

Climatic and environmental conditions suitable for the spread of the pathogen:

YES ☑ NO ☐

Climatic and environmental conditions suitable for the spread of the insect vectors:

YES ☑ NO ☐

Note: this is valid for most insect vectors of the pathogen.

Speed of spread:

LOW ☐ MODERATE ☐ HIGH ☑

RISK ASSESSMENT

Lso is already established in Sicily as well as the insect vector *Bactericera trigonica,* the occurrence of infected plants in protected areas is also likely. Climate change and globalisation may provide preferential pathways for the spread of this emerging pests.

Risk of introduction: MEDIUM

Risk of establishment: MEDIUM

***Confirmed plant hosts of Lso, the highlighted species are occurring in areas of interest.**

Cultivated: *Apium graveolens; Apium graveolens var. rapaceum; Capsicum annuum; Capsicum frutescens; Daucus carota; Ipomoea batatas; Petroselinum crispum; Solanum lycopersicum; Solanum melongena.*

Spontaneous: *Aegopodium podagraria; Anthriscus cerefolium; Anthriscus sylvestris;* ***Chenopodium album****;* ***Convolvulus arvensis****;* ***Datura stramonium****;* ***Daucus aureus****;* ***Fallopia convolvulus****;* ***Foeniculum vulgare****;* ***Galium*** *sp.;* ***Heracleum sphondylium****;* ***Hyoscyamus niger****; Lycium barbarum; Nicotiana attenuata;* ***Nicotiana tabacum; Pastinaca sativa****;* ***Persicaria lapathifolia****; Physalis longifolia;* ***Physalis peruviana;*** *Physalis philadelphica;* ***Solanum americanum;*** *Solanum betaceum;* ***Solanum dulcamara; Solanum elaeagnifolium****; Solanum rostratum; Solanum tuberosum; Solanum umbelliferum;* ***Urtica dioica****.*

Risk card for protected areas

Xanthomonas vesicatoria

Identity of the pathogen

Scientific name	*Xanthomonas vesicatoria* Vauterin et al. (1995)
Taxonomic position	Bacteria, Gracilicutes.
Related diseases	Bacterial spot of tomato and pepper

Current geographical distribution: Africa, America, Europe, Asia, Oceania

Sicily YES ☑ NO ☐

Malta YES ☐ NO ☑

Current phytosanitary legislative framework:

Regulated quarantine pest ☐ Regulated non-quarantine pest ☑
Non regulated ☐

Note: regulated non-quarantine pests (“RNQPs”) concerning vegetable propagating and planting material (*Capsicum annum* and *Solanum lycopersicum*) by the COMMISSION IMPLEMENTING DIRECTIVE (EU) 2020/177 of 11 February 2020.

Range of plant hosts: 9 plant species, mainly Solanaceae*.

For protected areas the most representative plants include weed of **Solanaceae**, ***Hyoscyamus niger*** and species include in the genera ***Datura*** spp.

Biology and life cycle of the pathogen: *X. vesicatoria* enters the plant hosts through natural openings (stomata) or wounds and can survive in seeds for several years and in infected debris. Long-distance dissemination occurs mainly through the trade of infected seeds, while spread is primarily by rain-splash, overhead irrigation and maybe by aerial dispersal. The disease is affected by climate conditions, especially by humidity and temperature: the spread of the bacterium is favoured by heavy rainfall and its multiplication occurs preferably between 30 - 35°C.

Main symptoms: Characteristic symptom of *X. vesicatoria* infection are necrotic lesions on leaves, stems, and fruits. These starts as water-soaked spots that gradually turn into necrotic lesions that in leaves are surrounded by yellow haloes. Necrotic spots can become dry in the center and fall out leading to "shot-hole" symptoms and when numerous can cause leaf abscission. In some cases, cancers may develop on the stems of infected plants.

Figure: Leaves and fruits symptoms on tomato plants infected by *Xanthomonas vesicatoria* (source: https://gd.eppo.int/).

Pathways of introduction

Transport of pathogen in potentially infected/contaminated:

SEEDS ☑ PLANTS FOR PLANTING ☑ FRESH FRUITS ☑
INSECT VECTORS ☐ BIRDS ☐ HONEYBEES AND BEEHIVES ☐

Environmental suitability for establishment and spread of the pathogen

Climatic and environmental conditions suitable for the spread of the pathogen:

YES ☑ NO ☐

Note: temperature **above 35°C** is unfavourable for the bacterium.

Speed of spread:

LOW ☐ MODERATE ☑ HIGH ☐

Note: Heavy rainfall have an important role in pathogen's spread rate.

RISK ASSESSMENT

X. vesicatoria occurs in Sicily on cultivated plants, mainly pepper and tomato. The risk of introduction into protected areas could be defined as medium due to the type of transmission by seed and rainwater; however, considering the limited range of host plants, the risk of establishment into the interested area is low.

Risk of introduction: MEDIUM
Risk of establishment: LOW

***Confirmed plant hosts of *X. vesicatoria*, the highlighted species are regarded in the areas of interest.**

Cultivated: *Capsicum annuum; Lycium barbarum; Solanum lycopersicum; Solanum tuberosum.*

Spontaneous: Datura spp.*;* ***Hyoscyamus niger****; Nicotiana rustica; Physalis* spp.*;* wild ***Solanum*** spp.

Interreg Italia-Malta FAST

Risk card for protected areas

Clavibacter michiganensis subsp. *michiganensis*

Identity of the pathogen

Scientific name	*Clavibacter michiganensis* subsp. *michiganensis* (Smith, 1910; Davis et al., 1984)
Taxonomic position	Bacteria, Actinobacteria, Actinobacteria, Actinobacteridae, Actinomycetales, Micrococcineae, Microbacteriaceae
Related diseases	Bacteria canker disease

Current geographical distribution: Africa, America, Asia, Europe, Oceania.

Sicily YES ☑ NO ☐

Malta YES ☐ NO ☑

Current phytosanitary legislative framework:

Regulated quarantine pest ☐ Regulated non-quarantine pest ☐ Non regulated ☑

Range of plant hosts: 46 plant species, mainly Solanaceae, many experimental hosts*.

For protected areas the most representative hosts include wild species of ***Solanum*** spp.

Biology and life cycle of the pathogen: *C. michiganensis* subsp. *michiganensis* is an anaerobic Gram-negative bacterium that cause important disease in tomato plants. It enters plants through natural

opening, mainly hydathodes or through tissue lesions, colonize the xylem vessels and can also reach the seed. The bacterium mainly spread over long distance by infected seeds and plant for planting (high efficiency of transmission), while the primary source for local spread are water and cultural practices. It can cause local or more frequently systemic infection and can survive in seeds and dried plant material for years; the first one occurs mainly when the bacterium enters broken trichomes or natural openings on leaves, while germination of seedling by infected seeds or transmission by wounds generally results in systemic infection.

Main symptoms: Different symptoms are observed for local and systemic infection. For local infections, the most common symptoms are blistering, curling and marginal necrosis on leaves that progressively widening until shrivelling of entire stems. In some conditions, cankers may also develop on stem. Xylem colonization allows the bacterium to spread rapidly through the plant and lead to systemic infection. In advanced stage, brown streak appears on stem and petioles (vascular discolouration) and when cutting a viscous granular bacterial mass is evident, lead to wilting of the entire plant. Brown streaks on stem can split open and cause cankers. Fruits of infected tomato plants may remain small and fall prematurely or ripen unevenly and can often show external marbling and internal bleaching of vascular and surrounding tissue.

Figure: Symptoms of *C. michiganensis* subsp. *michiganensis* infection on tomato plants (source: https://gd.eppo.int/).

Pathways of introduction

Transport of pathogen in potentially infected/contaminated:

SEEDS ☑ PLANTS FOR PLANTING ☑ FRESH FRUITS ☑
INSECT VECTORS ☐ VEHICLES, EQUIPMENT AND MACHINERY ☑
WATER ☑

Environmental suitability for establishment and spread of the pathogen

Climatic and environmental conditions suitable for the spread of the pathogen:

YES ☑ NO ☐

Note: The optimum temperature for growth of the bacterium is 24-28°C.

Speed of spread:

LOW ☐ MODERATE ☑ HIGH ☐

RISK ASSESSMENT

Spread via infected seeds or plant for planting are the main pathways of introduction of *C. michiganensis* subsp. *michiganensis* into new geographical areas. Since now, the bacterium results absent in Malta and present in Sicily. The small range of wild host plants reduce the risk of both introduction and establishment of the pathogen in the interested areas.

Risk of introduction: MEDIUM
Risk of establishment: LOW

***Confirmed plant hosts of *C. michiganensis* subsp. *michiganensis*.**

Avena sativa; Browallia speciosa; Brugmansia x candida; Brunfelsia lactea; Capsicum annuum; Capsicum frutescens; Cestrum elegans; Citrullus lanatus; Cucumis sativus; Datura innoxia; Datura metel; Datura sp.; Datura stramonium; Helianthus annuus; Hordeum vulgare; Hyoscyamus niger; Nicotiana quadrivalvis; Nierembergia frutescens; Nierembergia sp.; Physalis heterophylla; Physalis longifolia; Salpiglossis sp.; Schizanthus sp.; Secale cereale; Solanum aethiopicum; Solanum americanum; Solanum atropurpureum; Solanum aviculare; Solanum capsicoides; Solanum carolinense; Solanum douglasii; Solanum dulcamara; Solanum lycopersicum; Solanum melongena; Solanum myriacanthum; Solanum nigrum; Solanum pectinatum; Solanum pseudocapsicum; Solanum quitoense; Solanum scabrum; Solanum triflorum; Solanum tuberosum; Solanum violaceum; Streptosolen jamesonii; Triticum aestivum; Zea mays.

Phytosanitary risk card for protected areas

Panel 2

Risk card for protected areas

Xylella fastidiosa

Identity of the pathogen

Scientific name	*Xylella fastidiosa* (Well e Raju)
Taxonomic position	Bacteria, Proteobacteria, Gammaproteobacteria, Lysobacterales, Lysobacteraceae.
Subspecies name	*X.fastidiosa* subsp. *fastidiosa, X.fastidiosa* subsp. *multiplex*, *X.fastidiosa* subsp. *pauca*, *X.fastidiosa* subsp. *sandyi*, *X. fastidiosa* subsp. *tashke*, *X. fastidiosa* subsp. *morus*
Related diseases	Pierce's disease of grapevine (PD), olive quick decline syndrome (OQDS/CoDiRO), bacterial leaf scorch of shade trees (BLS), phony peach disease (PPD), citrus variegated chlorosis (CVC), almond leaf scorch (ALS).

Current geographical distribution: Europe, America, Asia, Africa.

Sicily YES ☐ NO ☑
Malta YES ☐ NO ☑

Current geographical distribution of the vectors:

Philaenus spumarius	***Neophilaenus campestris***	***Philaenus italosignus***
Africa, Europe, America, Asia, Oceania	Europe, North Africa	Europe
Sicily YES ☑ NO ☐ **Malta** YES ☑ NO ☐	**Sicily** YES ☑ NO ☐ **Malta** YES ☐ NO ☑	**Sicily** (endemic) YES ☑NO ☐ **Malta** YES ☐ NO ☑

Note: All Auchenorrhyncha that feed on xylem sap are considered potential vectors of *X. fastidiosa.* *P. spumarius* is the major vector in Europe, *N. campestris* and *P. italosignus* were found infected in nature but their ability to transmit the bacterium is proven only in experimental conditions. Other confirmed vectors of *X. fastidiosa* are not discussed here for their geographical distribution (*Homalodisca vitripennis, Xyphon fulgidum, Draeculacephala minerva, Graphocephala atropunctata*, *Acrogonia terminalis, Dilobopterus costalimai, Oncometopia facialis…*).

Current phytosanitary legislative framework:

Regulated quarantine pest ☑ Regulated non-quarantine pest ☐
Non regulated ☐

Note: *X. fastidiosa* is an A2 Quarantine pest in Europe.

Commission Implementing Regulation (EU) 2020/1201 of 14 August 2020 as regards measures to prevent the introduction into and the spread within the Union of *X. fastidiosa*.

Range of plant hosts: 664 plant species*, 412 confirmed with at least two detection methods.

For protected areas the most representative genera include ***Acacia*** spp., ***Euphorbia*** spp., ***Erigeron*** spp. and the species ***Medicago arborea***, ***Spartium junceum*** but also **Olea europea.**

Biology and life cycle of the pathogen: *X. fastidiosa* **is a xylem-limited** fastidious bacterium transmitted by several xylem-fluid feeding insects in a persistent manner. It is a **polyphagous** bacterium that can infect the xylem of a wide range of cultivated and wild host plants. According to host plant species, bacterial cells may remain **localized** at the inoculation site or become **systemic**.

Main symptoms: Symptoms of *X. fastidiosa* infection are variable and depends on several factors including plant host species, its phenological stage, but also environmental and climatic conditions. The appearance of symptoms could vary from few months to several years and sometimes infected plants can remain **symptomless**. Bacterial cells accumulation results in xylem vessels occlusion and may leads to symptoms similar to those cause from water stress. The main common symptoms are leaf **scorching**, **wilting**, premature **defoliation**, **chlorosis** or **bronzing** along the leaf margin, **stunting** and **dieback** of shoots and twigs, until rapid plant **death**.

Figure: Symphtoms of *Xylella fastidiosa* infection on *Spartium junceum A); Olea europea B); Acacia saligna C); Polygala myrtifolia D); Nerium oleander E)* (source: https://gd.eppo.int/).

Pathway of introduction
Transport of pathogen in potentially infected:

SEEDS ☐ PLANTS FOR PLANTING ☑ FRESH FRUITS ☐
INSECT VECTORS ☑ CONTAINERS, TOOLS, EQUIPMENTS AND CONVEYANCE VEICLES ☐

Environmental suitability for establishment and spread of the pathogen

Climatic and environmental conditions suitable for the spread of pathogen:

YES ☑ NO ☐

Note: The bacterium is sensible to freezing temperatures and prefers mild winter. This is an important factor for their survival between seasons through the year.

Climatic and environmental conditions suitable for the spread of the insect vectors:

YES ☑ NO ☐

Note: Climatic conditions can affect life cycle of insects impacting vector control strategies.

Speed spread:

LOW ☐ MODERATE ☐ HIGH ☑

RISK ASSESSMENT

The main pathways of introduction and spread of the bacterium into new areas are the movement and trade of plant for planting or plant parts containing both the bacterium and /or the vector insects. The broad host range, that include many spontaneous further than cultivated plants, increases the risk of pathogen spread into the interested areas. If *X. fastidiosa* were introduced in Sicily or Malta, the role of potential vectors (also present in our territories) in its transmission and spread is currently unknown. In conclusion, the pathogen's complexity is an important factor to be considered in monitoring, prevention measures, risk assessment and disease management.

Risk of introduction: HIGH
Risk of establishment: HIGH

***Due to the wide range of plant hosts of *X. fastisiosa* (included in more than 75 botanical families) a full list is not show, but species or genus of main interest in the intereste areas are listed below (the highlighted plant species are individuated as IAS):**

Acacia saligna; *Amaranthis retroflexus; Artemisia arborescens; Asparagus acutifolius; Bidens pilosa; Calicotome* spp.; *Cercis siliquastrum; Chenopodium albus; Cistus* spp.; *Citrus* spp.; *Convolvulus cneorum; Coronilla* spp.; *Cytisus* spp.; *Erigeron* spp.; *Erysimum* spp.; *Ficus carica; Fraxinus* spp.; *Heliotropium* spp.; *Hibiscus* spp.; *Juglans regia; Laurus nobilis; Lavandula* spp.; *Lolium multiflorum; Medicago* spp.; *Morus* spp.; *Myoporum insulare; Myrtus communis; Nerium oleander; Olea europea; Phagnalon saxatile; Phillyrea latifolia; Phlomis fruticosa; Pistacia vera; Plantago major; Polygala myrtifolia; Prunus* spp.; *Raphanus sativus; Rhamnus alaternus; Robinia pseudoacacia; Rumex* spp.; *Sorghum halepense; Spartium junceum; Teucrium capitatum; Veronica* spp.; *Vitis* spp.

Risk card for protected areas

Ralstonia pseudosolanacearum

Identity of the pathogen

Scientific name	*Ralstonia pseudosolanacearum* (Safni et al., 2014)
Taxonomic position	Bacteria, Proteobacteria, Betaproteobacteria, Burkholderiales, Burkholderiaceae.
Related diseases	Bacterial wilt

Current geographical distribution: America, Africa, Europe (few occurrences or transient), Oceania.

Sicily YES ☐ NO ☑

Malta YES ☐ NO ☑

Current phytosanitary legislative framework:

Regulated quarantine pest ☑ Regulated non-quarantine pest ☐
Non regulated ☐

Note: COMMISSION IMPLEMENTING REGULATION (EU) 2021/2285 of 14 December 2021 amending Implementing Regulation (EU) 2019/2072 as regards the listing of pests, prohibitions and requirements for the introduction into, and movement within, the Union of plants, plant products and other objects, and repealing Decisions 98/109/EC and 2002/757/EC and Implementing Regulations (EU) 2020/885 and (EU) 2020/1292.

Range of plant hosts: 117 plant species, mainly Solanaceae and Cucurbitaceae*.

For protected areas the most representative genera include ***Amaranthus*** spp., ***Artemisia*** spp., ***Brassica*** spp., ***Limonium*** spp. and wild species of ***Solanum*** spp.

Biology and life cycle of the pathogen: *R. pseudosolanacearum* is a soilborne bacteria included into the *R. solanacearum* species complex (RSSC), a cosmopolitan group of bacterial plant pathogens (that also include the species *R. solanacearum* and two subspecies of *Ralstonia syzygii*) of the family Burkholderiaceae. The reclassification into three different species was performed recently, so the biology should be reviewed. Survival of the bacterium in soil and disease severity are strong influenced by environmental and climatic conditions. Disease severity usually increase with high soil moisture, wet weather or rainy seasons and temperatures between 24-35°C. Entry into plants is usually through root lesions and movement of bacterial cells occurs trough the xylem.

Main symptoms: The most characteristic symptom on different host plants of *R. pseudosolanacearum* is **wilting**. This symptom may appear sectorial, first on youngest leaves, and gets worse in warmest time of day. If environmental conditions are suitable for bacterial cells multiplication, it can rapidly lead to plant collapse and death. Other symptoms of infection are bronzed and chlorotic leaves, epinasty, develops of adventitious roots, browning of vascular tissues and bacterial slime oozing from cut infected stems.

Figure: Symptoms of *R. pseudosolanacearum* infection on the whole tomato plant a), on leaves b) and on stem c) (source: https://gd.eppo.int/).

Pathways of introduction

Transport of pathogen in potentially infected/contaminated:

SEEDS ☑ PLANTS/TUBERS FOR PLANTING ☑ FRESH FRUITS ☑
INSECT VECTORS ☐ BIRDS ☐ HONEYBEES AND BEEHIVES ☐
VEHICLES, EQUIPMENT AND MACHINERY ☑ WATER ☑

Environmental suitability for establishment and spread of the pathogen

Climatic and environmental conditions suitable for the spread of the pathogen:

YES ☑ NO ☐

Note: Temperature optima for the pathogen within 24-35°C.

Speed of spread:

LOW ☐ MODERATE ☐ HIGH ☑

RISK ASSESSMENT

Spread via infected seeds or plant for planting are the main pathways of introduction of *R. solanacearum* into new geographical areas. Since now, the bacterium results absent in Malta and transient in Italy. The wide range of plant hosts could be a risk factor both for the introduction and the establishment of the pathogen. Moreover, some of these hosts are wild plants found in the areas of interest.

Risk of introduction: MEDIUM
Risk of establishment: MEDIUM

***Confirmed plant hosts of *R. pseudosolanacearum*.**

Ageratum conyzoides, Amaranthus sp., Amomum subulatum, Angelica keiskei, Annona squamosa, Anthurium andraeanum, Anthurium sp., Arachis hypogaea, Aralia cordata, Artemisia sp., Begonia hybrids, Begonia sp., Beta vulgaris subsp. vulgaris var. cicla, Bidens pilosa, Boehmeria nivea, Bougainvillea sp., Brassica oleracea, Campanula sp., Capsicum annuum, Capsicum frutescens, Casuarina equisetifolia, Cestrum nocturnum, Chaenostoma cordatum, Chrysanthemum sp., Cicer arietinum, Coleus sp., Corchorus olitorius, Cosmos caudatus, Croton hirtus, Cucumis sativus, Cucurbita maxima, Cucurbita moschata, Cucurbita pepo, Curcuma alismatifolia, Curcuma aromatica, Curcuma longa, Curcuma zedoaria, Cyamopsis tetragonoloba, Cyphostemma mappia, Dahlia sp., Delphinium sp., Dimorphotheca ecklonis, Ensete ventricosum, Eruca vesicaria subsp. sativa, Eucalyptus urophylla, Eucalyptus, Eustoma russellianum, Fagopyrum esculentum, Ficus carica, Fragaria x ananassa, Grevillea striata, Hedychium coronarium, Helianthus sp., Hibiscus sabdariffa, Hibiscus sp., Impatiens sp., Ipomoea aquatica, Ipomoea batatas, Justicia adhatoda, Kaempferia galanga, Kalanchoe sp., Lagenaria siceraria, Limonium sp., Ludwigia octovalvis, Luffa aegyptiaca, Mandevilla sp., Manihot esculenta, Maranta arundinacea, Momordica charantia, Morus alba, Nicotiana tabacum, Olea Europeea, Pelargonium x hortorum, Pelargonium, Perilla frutescens, Petroselinum crispum, Phaseolus vulgaris,

Physalis angulata, Piper hispidum, Platostoma palustre, Plukenetia volubilis, Pogostemon cablin, Portulaca oleracea, Raphanus sativus, Rosa, Salix gracilistyla, Sesamum indicum, Sesbania herbacea, Solanum aethiopicum, Solanum americanum, Solanum campylacanthum, Solanum capsicoides, Solanum incanum, Solanum lycopersicum, Solanum macrocarpon, Solanum melongena, Solanum muricatum, Solanum myriacanthum, Solanum nigrum, Solanum scabrum, Solanum sisymbriifolium, Solanum tuberosum, Spigelia anthelmia, Strelitzia reginae, Symphytum officinale, Syzygium aromaticum, Syzygium samarangense, Tagetes sp., Vaccinium corymbosum, Vaccinium membranaceum, Vicia faba, Vinca major, Zingiber mioga, Zingiber montanum, Zingiber officinale, Zingiber sp., Zinnia sp.

Risk card for protected areas

Grapevine flavescence dorée phytoplasma

Identity of the pathogen

Scientific name	Grapevine flavescence dorée phytoplasma
Taxonomic position	Bacteria, Tenericutes, Mollicutes, Phytoplasmas.
Related diseases	Flavescence dorée of grapevine

Current geographical distribution: Europe.

Sicily YES ☐ NO ☑

Malta YES ☐ NO ☑

Current phytosanitary legislative framework:

Regulated quarantine pest ☑ Regulated non-quarantine pest ☐ Non regulated ☐

Note: Flavescence dorée phytoplasma is listed under Commission Implementing Regulation 2019/2072 in Annex II, Part B, as a Union quarantine pest known to occur in the EU. Moreover, Annex VI prohibits the introduction of Vitis plants from third countries other than Switzerland, and Annex VIII details its internal movement requirements.

Current geographical distribution of the vectors: America, Europe (restricted distribution)

Sicily YES ☐ NO ☑

Malta YES ☐ NO ☑

Main vector: *Scaphoideus titanus.*

Range of plant hosts: 21, mainly Vitaceae*.

For protected areas the most representative genera include ***Salix*** spp., ***Vitis*** spp., and the species ***Ailanthus altissima, Clematis vitalba*** and ***Vicia faba.***

Biology and life cycle of the pathogen: Like all phytoplasmas, flavescence dorée **phytoplasma** is localized in the **phloem** of infected plant hosts. It is transmitted by **dodder grafts** and insect vectors in a persistent-propagative manner. Infected vectors remain inoculative for the rest of their life and can infect a healthy plant on each feeding or probing event. The whole biological cycle of the pathogen is mostly completed in **grapevine**, in which cause a severe economic important disease, and in the ampelophagous cicadellid ***Scaphoideus titanus***.

Main symptoms: Phytoplasmas induce symptoms indicating that host nutrient circulation and hormonal balance are affected. The main symptoms are color aberrations like **yellowing** discoloration on leaves, **rolling** down of laminae, flower-withering, reduced fruit settings and **berry-shrivelling**. The shoots of early infected susceptible grapevine fail to lignify and during winter blacken and die. At the end of summer longitudinal fissures may appear in the bark at the base of badly diseased branches.

Figure: Flavescence dorée symptoms on grapevine (source: https://gd.eppo.int/).

Pathways of introduction

Transport of pathogen in potentially infected/contaminated:

SEEDS ☐ PLANTS FOR PLANTING ☑ FRESH FRUITS ☑
INSECT VECTORS ☑ BIRDS ☐ HONEYBEES AND BEEHIVES ☐

Environmental suitability for establishment and spread of the pathogen

Climatic and environmental conditions suitable for the spread of the pathogen:

YES ☑ NO ☐

Climatic and environmental conditions suitable for the spread of the insect vectors:

YES ☐ NO ☑

Note: *Scaphoideus titanus* is a neartic leafhopper. It adapts badly to local climatic conditions, even more in view of climate change.

Speed of spread:

LOW ☐ MODERATE ☐ HIGH ☑

Note: It is an epidemic disease characterized by rapid spread within vineyards due to vine-to-vine transmission.

RISK ASSESSMENT

Grapevine flavescence dorée phytoplasma has a closed disease cycle. An 'host jump' is a risk factor for the introduction of the pathogen in new areas. Therefore, the establishment of the pathogen would occur if an efficient insect vector were present in the interested area. Is not excluded the possible roles of alternative and secondary FDp plant hosts and vectors.

Risk of introduction: MEDIUM
Risk of establishment: LOW

***Confirmed plant hosts of Grapevine flavescence dorée phytoplasma, the highlighted species are occurring in areas of interest.**

Cultivated*: *Corylus avellana; *Vitis acerifolia; Vitis hybrids;* ***Vitis vinifera***; *Vitis x doaniana; Vitis x champinii; Vitis riparia; Vitis rupestris; Vitis amurensis;* ***Vitis berlandieri***; *Vitis coignetiae;* ***Vitis labrusca***; *Vitis pentagona.*

Spontaneous*: *Alnus glutinosa; ***Clematis vitalba***; ***Salix*** *sp.; Trifolium repens; Vicia faba;* ***Ailanthus altissima***; *Vitis vinifera subsp. sylvestris;* ***Glebionis carinatum***.

Interreg Italia-Malta FAST

Risk card for protected areas

'*Candidatus* Liberibacter asiaticus'

Identity of the pathogen

Scientific name	'*Candidatus* Liberibacter asiaticus' (Jagoueix, Bové & Garnier)
Taxonomic position:	Bacteria, Proteobacteria, Alphaproteobacteria, Rhizobiales, Phyllobacteriaceae.
Related disease (common)	Huanglongbing, greening of citrus.

Current geographical distribution: Asia, Africa, America, Oceania.

Sicily YES ☐ NO ☑

Malta YES ☐ NO ☑

Current geographical distribution of the vectors:

Diaphorina citri	***Trioza erytreae***
Africa, Asia, America, Oceania	Africa, Europe.
Sicily YES ☐ NO ☑	**Sicily** YES ☐ NO ☑
Malta YES ☐ NO ☑	**Malta** YES ☐ NO ☑

Current phytosanitary legislative framework:

Regulated quarantine pest ☐ Regulated non-quarantine pest ☑
Non regulated ☐

Note: a list of plants, plant products and other objects, originating from third countries and the corresponding special requirements for their introduction into the Union territory are listed in the COMMISSION IMPLEMENTING REGULATION (EU) 2019/2072 of 28 November 2019.

Range of plant hosts: 43 plant species, mainly Rutaceae.

Biology and life cycle of the pathogen: '*Ca*. L. asiaticus' is one of the three exigent bacteria associated with huanglongbing, an important disease of *Citrus* spp. plants. It is the most widespread in the world of the three and results absent only in the European continent. Bacterial cells live confined in the sieve tubes and in the endolymph of insect vectors that feed on phloem of infected plants. Exist complex molecular interactions between bacterial cells, plant hosts, and insect vectors. Known vectors of the bacterium are the two psyllids *D. citri* and *T. eryreae* that transmit it in a persistent manner, thus the insect retains the infection for its entire life once it acquires the bacterium.

Main symptoms: The pathogen cause both microscopic and macroscopic alterations in infected plants. Symptoms appear after a variable latency period (time from inoculation to develop of symptoms) and are generally the same for the three species of '*Ca*. Liberibacter', although 'Ca. L. asiaticus' seems to be the most severe form of the disease. Overall, the most common symptoms observed on citrus plants are stunting, twig dieback, sparse yellow foliage, asymmetric chlorotic patterns on leaves, smaller fruits, inversion in colouration when maturing and severe fruit drop. Often symptoms develop sectoral and in severe cases lead plants to death.

Figure: Symphtoms of Huanglongbing on *Citrus* spp. plants (source: https://gd.eppo.int/).

Pathway of introduction
Transport of pathogen in potentially infected:

SEEDS ☐ PLANTS FOR PLANTING ☑ FRESH FRUITS ☑
INSECT VECTORS ☐ CONTAINERS, TOOLS, EQUIPMENTS AND CONVEYANCE VEICLES ☐

Environmental suitability for establishment and spread of the pathogen

Climatic and environmental conditions suitable for the spread of pathogen:

YES ☑ NO ☐

Note: '*Ca*. Liberibacter asiaticus' is heat-tolerant and withstands high temperatures, its optimum ranging from 24 to 32°C

Climatic and environmental conditions suitable for the spread of the insect vectors:

YES ☑ NO ☐

Note: *D. citri* is a tropical and subtropical psyllid, its optimal developmental temperature ranges is 25-28°C; *T. eryteae* is very sensitive to temperature above 32°C.

Speed of spread:

LOW ☐ MODERATE ☑ HIGH ☐

The wide geographic distribution of 'Ca. L. asiaticus' and its tolerance to environmental temperatures similar to those of Mediterranean areas, do not exclude the possibility that the bacterium could be introduced in Europe. However, the current absence of main vectors in the areas of interest and the low number of wild plant hosts of the bacterium, decrease the risk of establishment. In any case, most of the studies on huanglongbing concern Citrus, since it is the major economic important host. For this reason, assessing the impact that the pathogen would have on wild plants is currently difficult.

Risk of introduction: MEDIUM
Risk of establishment: LOW

***Confirmed plant hosts of '*Ca.* L. asiaticus'.**

Atalantia buxifolia, Balsamocitrus dawei, Citroncirus webberi, Citroncirus, Citrus amblycarpa, Citrus aurantiifolia, Citrus aurantium, Citrus depressa, Citrus hystrix, Citrus jambhiri, Citrus junos, Citrus limettioides, Citrus limon, Citrus limonimedica, Citrus macroptera, Citrus maxima, Citrus medica, Citrus paradisi, Citrus reticulata, Citrus sinensis, Citrus trifoliata, Citrus volkameriana, Citrus x limonia, Citrus x nobilis, Citrus x tangelo, Citrus, Clausena indica, Clausena lansium, Cleome rutidosperma, Fortunella margarita, Fortunella, Limonia acidissima, Murraya paniculata, Pisonia aculeata, Rutaceae, Swinglea glutinosa, Toddalia, Trichostigma octandrum, x Citrofortunella macrocarpa.

Risk card for protected areas

Tobacco ringspot virus (TRSV)

Identity of the pathogen

Scientific name	Tobacco ringspot virus (TRSV)
Taxonomic position	Viruses and viroids, Riboviria, Orthornavirae, Pisuviricota, Pisoniviricetes, Picornavirales, Secoviridae, Nepovirus.
Related diseases	Bud blight (soybean)

Current geographical distribution: Africa, America, Asia, Europe, Oceania.

Sicily YES ☐ NO ☑

Malta YES ☐ NO ☑

Current phytosanitary legislative framework:

Regulated quarantine pest ☐ Regulated non-quarantine pest ☐
Non regulated ☑

Range of plant hosts: about 140 species*.

For protected areas the most representative genera include ***Trifolium*** spp. (for spread); ***Rubus*** spp.; ***Erigeron*** spp.; ***Chenopodium*** spp.; ***Amaranthus*** spp**.**

Biology and life cycle of the pathogen: TRSV is local spread mainly by its nematode vectors of the species complex *Xiphimena americanum,* while seed infection is the more important means of dispersal of the virus. The spread over long distance can also occur by grafting of woody hosts and vegetative propagation of herbaceous one. Since

the virus can survive in soil in its vector as well as in seeds of plant hosts, TRSV can be transferred to newly plant hosts after a longer period in the absence of these. Transmission has been reported by pollen and arthropods, but data are limited and their relevance unclear. In addition, the virus seems to systemically spread and propagate within European honeybees and throughout weed hosts by an unknown vector.

Main symptoms: Infected plants often can remain symptomless. Symptoms of TRSV infection are sherper's crooking and death of terminal bud, chlorotic and necrotic spots, streaks and ringspots on leaves, stunting, wilting, delayed maturity and altered bud and leaf proliferation. In advanced stage pods abort and dead areas become brittle. Reduction in seed production may occur.

Figure: Symptoms of shepherd's crooked A), F); bud blight B); pit discoloration C); delayed maturity D) and general field symptoms E) on plants infected by Tobacco ringspot virus (source: https://cropprotectionnetwork.org/).

Pathways of introduction

Transport of pathogen in potentially infected/contaminated:

SEEDS ☑ PLANTS FOR PLANTING ☑ FRESH FRUITS ☐
INSECT VECTORS ☐ BIRDS ☐ HONEYBEES ☑
NEMATODE VECTORS ☑

Environmental suitability for establishment and spread of the pathogen

Climatic and environmental conditions suitable for the spread of the pathogen:

YES ☑ NO ☐

Speed of spread:

LOW ☐ MODERATE ☐ HIGH ☑

RISK ASSESSMENT

The presence of symptomless infected plant hosts, especially wild plant, could be a risk for the spread of the pathogen also into the interested areas. The current geographical distribution does not appear to be a risk factor for the introduction of the pathogens into protected area, since TRSV is present in Italy in few occurrences and absent in Malta. While the pathogen could become established if it were introduced into the areas of interest.

Risk of introduction: LOW-MEDIUM
Risk of establishment: MEDIUM

***Confirmed plant hosts of TRSV.**

Abutilon theophrasti, Achillea millefolium, Aeonium sp., Ajuga reptans, Althaea sp., Amaranthus cruentus, Amaranthus hybridus, Amaranthus palmeri, Amaranthus retroflexus, Ambrosia artemisiifolia, Anemone coronaria, Apocynum cannabinum, Arctium lappa, Argyranthemum frutescens, Armoracia rusticana, Arum orientale, Astilbe rubra, Bacopa, Begonia semperflorens hybrids, Boerhavia coccinea, Boerhavia erecta, Brassica sp., Capsicum annuum, Carica papaya, Celosia, Chenopodiastrum murale, Chenopodium album, Chenopodium giganteum, Chrysanthemum x morifolium, Cichorium intybus, Citrullus lanatus, Clerodendrum thomsoniae, Colchicum sp., Cornus florida, Cornus racemosa, Cornus sericea, Crataegus sp., Crepis tectorum, Crocus sp., Crotalaria spectabilis, Cucumis melo, Cucumis sativus, Cucurbita pepo, Dahlia sp., Daphne odora, Datura metel, Datura stramonium, Daucus carota, Echinacea purpurea, Echinochloa crus-galli, Elymus repens, Equisetum arvense, Erigeron annuus, Erigeron canadensis, Erodium cicutarium, Eupatorium capillifolium, Eupatorium purpureum, Forsythia ovata, Fraxinus americana, Galinsoga parviflora, Galinsoga quadriradiata, Gerbera sp., Gladiolus grandiflorus, Glycine max, Gomphrena globosa, Helenium amarum, Helianthus annuus, Hemerocallis sp., Hibiscus cannabinus, Hyacinthus sp., Hydrangea macrophylla, Hydrangea paniculata, Impatiens walleriana, Iris ensata, Iris sibirica, Iris x germanica, Iris x hollandica, Jaltomata procumbens, Lactuca serriola, Lamprocapnos spectabilis, Lepidium densiflorum, Lepidium didymum, Lilium sp., Lolium pratense, Lotus corniculatus, Lupinus polyphyllus, Lysimachia nummularia, Malus domestica, Malvastrum coromandelianum, Melilotus albus, Mentha x gentilis, Narcissus sp., Nicotiana tabacum, Osmunda cinnamomea, Pelargonium x hortorum, Persicaria lapathifolia, Petunia grandiflora hybrids, Phaseolus vulgaris, Phlox subulata, Physalis floridana, Plantago lanceolata, Polygonum aviculare, Populus tremuloides, Portulaca oleracea, Portulaca, Potentilla sp., Prunus armeniaca, Prunus avium, Pueraria montana, Rosa sp., Rubus allegheniensis, Rubus argutus, Rubus flagellaris, Rubus fruticosus, Rubus occidentalis, Rubus sp., Rumex crispus, Rumex obtusifolius, Salix nigra, Sambucus sp., Schefflera sp., Senecio vulgaris, Sinapis arvensis, Solanum diphyllum, Solanum elaeagnifolium, Solanum lycopersicum, Solanum melongena, Solanum nigrum, Sonchus arvensis, Sonchus oleraceus, Sophora microphylla, Stellaria sp., Tagetes patula, Tanacetum vulgare, Taraxacum officinale, Trifolium pratense, Tulipa sp., Ulmus americana, Vaccinium corymbosum, Vicia sp., Vigna radiata, Vigna unguiculata subsp. unguiculata, Vitis aestivalis, Vitis vinifera, Xanthium strumarium, Zamia furfuracea.

Risk card for protected areas

Cucurbit yellow stunting disorder virus (CYSDV)

Identity of the pathogen

Scientific name	Cucurbit yellow stunting disorder virus (CYSDV)
Taxonomic position:	Viruses, Closteroviridae, Crinivirus

Current geographical distribution: Africa, America, Asia, Europe.

Sicily YES ☐ NO ☑

Malta YES ☐ NO ☑

Current geographical distribution of the vectors: Africa, America, Asia, Europe, Oceania.

Sicily YES ☑ NO ☐

Malta YES ☑ NO ☐

Known vector: *Bemisia tabaci*

Current phytosanitary legislative framework:

Regulated quarantine pest ☐ Regulated non-quarantine pest ☐
Non regulated ☑

Range of plant hosts: 19 plant species, mainly Cucurbits.

For protected areas the most representative genera include ***Chenopodium*** spp., ***Malva*** spp., ***Sonchus*** spp. and the species ***Solanum elaeagnifolium*.**

Biology and life cycle of the pathogen: CYSDV is a widely distributed crinivirus that is non-circulative, semi-persistently transmitted by the whitefly *B. tabaci*. The life cycle and the short-distance spread of the virus is strongly dependent on its polyphagous insect vector; while the long-distance spread is mainly due to the trading and movement of vegetative propagation materials, as plant for planting. Adults of *B. tabaci* do not fly very efficiently but, once airborne, can be transported long distances in air currents. There are different biotypes of the insect that transmit the virus with different transmission rate in different geographical areas in fields or in glasshouse crops. This virus is not known to be seed-borne.

Main symptoms: Symptoms of CYSDV infection are mainly characterized on cucumbers and melons. The first symptom is an interveinal mottle on the older leaves, then leaves became chlorotic and the plant grow stunted.

Figure: Symphtoms of Cucurbit yellow stunting disorder virus infection on melon plants (source: https://www.cabi.org/).

Pathway of introduction

Transport of pathogen in potentially infected:

SEEDS ☐ PLANTS FOR PLANTING ☑ FRESH FRUITS ☐
CUT FLOWERS OR BRANCHES ☐ VECTORS ☑
CONTAINERS, TOOLS, EQUIPMENTS AND CONVEYANCE VEICLES ☐

Environmental suitability for establishment and spread of the pathogen

Climatic and environmental conditions suitable for the spread of pathogen:

YES ☑ NO ☐

Climatic and environmental conditions suitable for the spread of the insect vectors:

YES ☑ NO ☐

Note: the insect vector *B. tabaci* is already widespread in the interested area

Speed of spread:

LOW ☐ MODERATE ☑ HIGH ☐

RISK ASSESSMENT

The known host range of CYSDV is not so wide, however transmission by the widespread and polyphagous whitefly B. tabaci increase the risk of spread of the pathogen. This vector moves readily from one host species to the next and is estimated to have a host range of around 600 species. CYSDV is considered an 'emerging virus' and is increasingly recorded from several European, American and Asiatic countries.

Risk of introduction: LOW
Risk of establishment: MEDIUM

***Confirmed plant hosts of CYSDV.**

Amaranthus retroflexus; Bassia hyssopifolia; Chenopodium album; Citrullus lanatus; Cucumis melo; Cucumis sativus; Cucurbita maxima; Cucurbita pepo; Cucurbitaceae; Lactuca sativa; Malva neglecta; Malva parviflora; Malvella leprosa; Medicago sativa; Phaseolus vulgaris; Physalis acutifolia; Sisymbrium irio; Solanum elaeagnifolium; Sonchus sp.

Risk card for protected areas

Curtobacterium flaccumfaciens pv. *flaccumfaciens*

Identity of the pathogen

Scientific name	*Curtobacterium flaccumfaciens pv. flaccumfaciens* (Hedges) Collins & Jones
Taxonomic position	Bacteria, Actinobacteria, Micrococcales, Microbacteriaceae.
Related diseases	Bacterial wilt disease of *Phaseolus* spp.

Current geographical distribution: Africa, America, Europe, Asia (restricted), Oceania.

Sicily YES ☐ NO ☑

Malta YES ☐ NO ☑

Current phytosanitary legislative framework:

Regulated quarantine pest ☐ Regulated non-quarantine pest ☐
Non regulated ☑

Range of plant hosts: 43 plant species, mainly Fabaceae*.

For protected areas species of interest could be ***Amaranthus retroflexus***, **Amaranthus viridis**, ***Chenopodium album, Vicia villosa***.

Biology and life cycle of the pathogen: *C. flaccumfaciens* pv. *flaccumpaciens* is a seed-borne systemic vascular bacterium very resistant to drying. It may enter roots or above-groung plant parts through lesions or rarely by stomata and move mainly by colonization of the xylem. Blocking of the vessels by bacterial biofilm interferes with the movement of water from roots to the foliage and may be the cause of wilting and symptoms development. This one is accelerated at higher temperatures and moisture; winds and hailstorm weather may enhance survival and dispersion of the pathogen that can also survive in plant debris and in non-hosts weeds. Spread over short and long distance is mainly due to the movement of infected seeds.

Main symptoms: The first symptom is an interveinal **chlorosis** of leaves that become later **necrotic**, **wilt** and fall prematurely. Overall plant wilting can lead to plant death; in general, wilting is more severe during daily heat and decrease with temperature drop. Seeds of infected plants may be **shrivelled**, discoloured and **flowers blighted**. Disease severity depends also on environmental conditions (mainly moisture stress) and on time of inoculation: plats infected by seeds or during the seedlings stage remain chlorotic, stunted and death prematurely.

Figure: Symptoms of *Curtobacterium flaccumfaciens* pv. *flaccumfaciens* infection on *Phaseolus* spp. (source: https://gd.eppo.int/).

Pathways of introduction

Transport of pathogen in potentially infected/contaminated:

SEEDS ☑ PLANTS FOR PLANTING ☑ FRUITS ☑
INSECT VECTORS ☐ BIRDS ☐ HONEYBEES AND BEEHIVES ☐
VEHICLES, EQUIPMENT AND MACHINERY ☐

Environmental suitability for establishment and spread of the pathogen

Climatic and environmental conditions suitable for the spread of the pathogen:

YES ☑ NO ☐

Note: Environmental temperatures above 30 °C improve growth of the pathogen in vascular tissues.

Speed of spread:

LOW ☐ MODERATE ☑ HIGH ☐

RISK ASSESSMENT

Curtobacterium flaccumfaciens pv. *flaccumfaciens* is not present in Italy and Malta, the main pathway of introduction into new areas is the trade of infected seeds. Some studies reported the presence of the bacterium in symptomless economic important vegetables and some weeds. This is an important factor, but its role in the disease spread is uncertain.

Risk of introduction: LOW
Risk of establishment: MEDIUM

***Confirmed plant hosts of *C. flaccumfaciens* pv. *flaccumfaciens*.**

Amaranthus retroflexus, Amaranthus viridis, Avena sativa, Avena strigosa, Brassica napus, Chenopodium album, Cicer arietinum, Commelina benghalensis, Cyperus rotundus, Digitaria insularis, Emilia fosbergii, Erigeron bonariensis, Galinsoga parviflora, Gamochaeta purpurea, Glycine max, Helianthus annuus, Hordeum vulgare, Ipomoea lonchophylla, Ipomoea triloba, Lablab purpureus, Lens culinaris, Lepidium virginicum, Lolium, Lupinus polyphyllus, Medicago sativa, Nicandra physalodes, Phaseolus coccineus, Phaseolus lunatus, Phaseolus vulgaris, Pisum sativum, Raphanus sativus, Senna obtusifolia, Solanum americanum, Triticum aestivum, Vicia faba, Vicia villosa, Vigna angularis, Vigna mungo, Vigna radiata, Vigna unguiculata subsp. sesquipedalis, Vigna unguiculata, Zea mays, Zornia glabra.