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Characterisation of palms and ornamentals in the EU: a tool for crop-based survey of Union quarantine pests

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Abstract

This technical report was prepared in the context of EFSA's mandate on plant pest surveillance (M-2020-0114), at the request of the European Commission. Its purpose is to support the Member States in the planning and preparation of crop-based surveys of regulated pests in line with Commission Implementing Regulation (EU) 2019/2072. In particular, the report includes the list of palms and ornamental species reported as hosts of regulated pests within the scope of grant GP/EFSA/PLANTS/2022/10 'Development of crop-based survey tools for plant pests of fruit trees, conifers, and palms and ornamentals in the EU'. A list of pests associated with palms and ornamentals is provided. In addition, the occurrence, phenology, main uses, management, distribution and climate suitability of palms and ornamentals in the EU is elaborated. Finally, the regulatory requirements and data on trade and import for palms and ornamentals are reported. In total, 111 palm tree species are reported as hosts of at least one of the regulated pests. Among them, only three are native to the EU, four are non-native but locally abundant in the EU, while 104 palm species are considered to be very rare or absent in the EU. With the exception of the date palm, all palm species present in the EU are used for ornamental purposes. The ornamental crop group comprises 36 plant species, of which three are native to the EU, 14 are non-native but locally abundant in the EU, and 19 are considered to be absent or very rare in the EU. Ornamentals are often cultivated in production systems ranging from low shelters or tunnels to high-technology greenhouses or glasshouses. The most common ornamental plants in the EU that are grown as potted plants, seedlings, bulbs, corms or cut flowers include chrysanthemums, carnations, dahlias, pelargonium, gerbera and violas. Ornamentals are cultivated in all Member States; the Netherlands being by far the biggest producer.

Keywords: crop-based surveillance, crop characterisation, pest detection, plant pest, Union quarantine pest

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1 Introduction

The scope of this report is to characterise the palm trees and ornamental plant species reported as hosts of Union quarantine [1] pests (Table 1) that are the subject of grant GP/EFSA/PLANTS/2022/10, 'Development of crop-based survey tools for plants – LOT 4: pests of palms and ornamentals'. In particular, the report includes a list of palm and ornamental plant species, regulated pests associated with the respective species, and an overview of their occurrence in the EU. Furthermore, for each plant species, information on the main phenological stages, their main use in EU countries and the regulatory phytosanitary requirements have been provided. Trade patterns are also discussed. This information is presented in the following seven chapters: (2) plant species; (3) phenology; (4) main uses; (5) management; (6) climatic suitability and distribution; (7) regulation; and (8) trade and import.

Table 1: List of the EU quarantine pests that are the subject of grant GP/EFSA/PLANTS/2022/10 'Development of crop-based survey tools for plants – LOT 4: pests of palms and ornamentals'

#	Scientific name of the pest	Taxonomical category	EPPO code
1	*Fusarium oxysporum* f. sp. *albedinis* (Kill & Maire)	Fungus	[FUSAAL]
2	*Myndus crudus* van Duzee	Insect	[MYNDCR]
3	*Paysandisia archon* (Burmeister)	Insect	[PAYSAR]
4	*Rhynchophorus ferrugineus* (Oliver)	Insect	[RHYCFE]
5	*Rhynchophorus palmarum* (L.)	Insect	[RHYCPA]
6	Palm lethal yellowing phytoplasmas: 1. *Candidatus* Phytoplasma cocostanzania – subgroup16SrIV-C 2. *Candidatus* Phytoplasma palmae – subgroups 16SrIV-A, 16SrIV-B, 16SrIV-E, 16SrIV-F 3. *Candidatus* Phytoplasma palmicola – 16SrXXII-A 4. *Candidatus* Phytoplasma palmicola-related strain 16SrXXII-B 5. New *Candidatus* Phytoplasma causing palm lethal yellowing from 16SrIV group – 'Bogia coconut syndrome'	Phytoplasmas	[PHYP56]
7	*Nemorimyza maculosa* (Malloch)	Insect	[AMAZMA]
8	*Ripersiella hibisci* Kawai and Takagi	Insect	[RHIOHI]
9	Chrysanthemum stem necrosis virus	Virus	[CSNV00]

2 Plant species

In total, 111 palm tree species and 36 ornamental and wild plants considered as occurring in the EU are reported as being hosts of at least one of the targeted pest species (Table 2).

However, the vast majority of palm tree hosts are not native to the EU, and can be regarded as occurring very or extremely rarely. Therefore, the palm crop group can be essentially narrowed to 24 species (Table 7). Among them, only date palm (*Phoenix dactylifera*) is cultivated as a crop. Native palm species in the EU are *Phoenix canariensis*, *Phoenix theophrasti* and *Chamaerops humilis*. Other palms can be considered as non-native. Certain species are more

[1] Commission Implementing Regulation (EU) 2019/2072 of 28 November 2019 establishing uniform conditions for the implementation of Regulation (EU) 2016/2031 of the European Parliament and the Council, as regards protective measures against pests of plants, and repealing Commission Regulation (EC) No 690/2008 and amending Commission Implementing Regulation (EU) 2018/2019. OJ L 319, 10.12.2019, p. 1–279.

common, such as *Trachycarpus fortunei* or *Washingtonia* spp., while others can be considered as rare. All palms in the EU, including the date palm, are planted as ornamental trees. They are prominent landscape amenities in many Mediterranean cities and communities. Single specimens or scarce groups can be found in central and even northern Europe, in private gardens, parks, botanical gardens or public green areas. Twenty-four palm species in this report were shortlisted based on the combination of their climate suitability (i.e. palm species of considerable 'cold hardiness'; see Section 6.1), distribution data (CABI, online; POWO, online; GBIF, online; PlantNET, online; see Section 6.2) and an extensive literature review (Orsino and Olivari, 1987; Merlo et al., 1993; Vamvoukakis et al., 1988; García-Castaño et al., 2014; Rivera et al., 2015; Shabani et al., 2015; Fehr and Burga, 2016; Caudullo et al., 2017; Rochat et al., 2017; Obón et al., 2018; Spennemann, 2018; Ferry et al., 2019; Essl, 2019; Wazen et al., 2020; Tonellotto et al., 2022; EFSA et al., 2023a).

The palm species listed in Table 2 were assigned to three different categories based on their occurrence in the EU: 'native', 'non-native locally abundant' and 'virtually absent'. The category 'native' refers to palm tree species native to the EU. The category 'non-native locally abundant' refers to species which are non-native, but which can occur and can be relatively common in specific parts of the EU, most notably in the Mediterranean region. The category 'virtually absent' refers to species which are non-native and can be considered as rare, very rare or extremely rare. This group comprises specimens that are grown only in greenhouses or glasshouses, in private collections or in botanical gardens. Wide distribution in the EU can be used only tentatively when describing *P. canariensis* in the Mediterranean parts of the EU and its prevalence as an ornamental in coastal cities. The information used to assign a certain palm tree species to a particular category was retrieved from CABI (online), GBIF (online), POWO (online) and the available scientific literature.

Other plant species that are hosts of the targeted pests (Table 1) can be classified as 'wild plants', 'not cultivated in horticulture' and 'ornamental plants'. A total of 36 species can be regarded as occurring in the EU (Table 3). They are assigned to the three different categories based on their occurrence in the EU: 'native', 'non-native locally abundant' and 'virtually absent'. It should be taken into account that many ornamental plant species do not occur naturally in the EU and originate from other parts of the world. Five species out of the 36 occurring in the EU are not considered to be ornamental species, cultivated in horticulture. These are American burnweed (*Erechtites hieraciifolius*), horseweed (*Erigeron canadensis*), Pennsylvania cudweed (*Gamochaeta pensylvanica*), curlycup gumweed (*Grindella squarrosa*) and silk leaf (*Lagascea mollis*). Crimson bottlebrush (*Melaleuca citrina*) has been included under *Callistemon* spp., a common ornamental species, as *M. citrina* has been formerly named *Callistemon citrinus* (Curtis) Skeels. With these amendments, the list of ornamental plants has been reduced from 36 to 30 plant species. These 30 species are considered to be relevant hosts of the Union quarantine pests presented in Table 1, and are further characterised in this report (Table 8). The information for inclusion of a certain ornamental host species in a particular category was collected from CABI (online), GBIF (online), INBO (online), POWO (online), PlantNET (online) and the available scientific literature (Mayer et al., 2017; Haeuser et al., 2018).

Table 2: List of palm tree species, their assigned occurrence in the EU and targeted pests (Table 1) known to use them as hosts (NAT: native; NNL: non-native locally abundant; VA: virtually absent)

Plant species	Occurrence	Pests
Chamaerops humilis	NAT	*Paysandisia archon* *Rhynchophorus ferrugineus* *Ripersiella hibisci*
*Phoenix canariensis**	NAT*	*Myndus crudus* Palm lethal yellowing phytoplasmas *Paysandisia archon* *Rhynchophorus ferrugineus* *Rhynchophorus palmarum* *Ripersiella hibisci*
Phoenix theophrasti	NAT	Palm lethal yellowing phytoplasmas *Paysandisia archon* *Rhynchophorus ferrugineus*
Phoenix dactylifera	NNL	*Fusarium oxysporum* f. sp. *albedinis* *Myndus crudus* Palm lethal yellowing phytoplasmas *Paysandisia archon* *Rhynchophorus ferrugineus* *Rhynchophorus palmarum* *Ripersiella hibisci*
Trachycarpus fortunei	NNL	*Myndus crudus* Palm lethal yellowing phytoplasmas *Paysandisia archon* *Rhynchophorus ferrugineus* *Ripersiella hibisci*
Washingtonia filifera	NNL	*Myndus crudus* *Paysandisia archon* *Rhynchophorus ferrugineus*
Washingtonia robusta	NNL	*Myndus crudus* Palm lethal yellowing phytoplasmas *Paysandisia archon* *Rhynchophorus ferrugineus* *Rhynchophorus palmarum*
Acoelorrhaphe wrightii	VA	*Myndus crudus*
Acrocomia aculeata	VA	*Myndus crudus* *Rhynchophorus palmarum*
Acromonia mexicana	VA	*Myndus crudus* Palm lethal yellowing phytoplasmas
Adonidia merrillii	VA	*Myndus crudus* Palm lethal yellowing phytoplasmas
Aiphanes horrida	VA	Palm lethal yellowing phytoplasmas
Aiphanes lindeniana	VA	Palm lethal yellowing phytoplasmas
Aiphanes minima	VA	Palm lethal yellowing phytoplasmas
Allagoptera arenaria	VA	Palm lethal yellowing phytoplasmas
Areca catechu	VA	*Rhynchophorus ferrugineus* Palm lethal yellowing phytoplasmas

Plant species	Occurrence	Pests
Arenga engleri	VA	*Myndus crudus* Palm lethal yellowing phytoplasmas
Arenga pinnata	VA	*Rhynchophorus ferrugineus* Palm lethal yellowing phytoplasmas
Arenga saccharifera	VA	*Rhynchophorus ferrugineus*
Attalea cohune	VA	*Rhynchophorus palmarum*
Attalea maripa	VA	*Rhynchophorus palmarum*
Bactris gasipaes	VA	*Rhynchophorus palmarum*
Bactris major	VA	*Rhynchophorus palmarum*
Bismarckia nobilis	VA	*Rhynchophorus ferrugineus*
Borassus flabellifer	VA	*Myndus crudus* *Rhynchophorus ferrugineus* Palm lethal yellowing phytoplasmas
Brahea armata	VA	*Paysandisia archon* *Rhynchophorus ferrugineus* *Rhynchophorus palmarum*
Brahea brandegeei	VA	Palm lethal yellowing phytoplasmas
Brahea edulis	VA	*Paysandisia archon* *Rhynchophorus ferrugineus* *Rhynchophorus palmarum*
Butia capitata	VA	*Paysandisia archon* *Rhynchophorus ferrugineus*
Butia yatay	VA	*Paysandisia archon* *Rhynchophorus ferrugineus*
Calamus merrillii	VA	*Rhynchophorus ferrugineus*
Carludovica palmata	VA	Palm lethal yellowing phytoplasmas
Caryota cumingii	VA	*Rhynchophorus ferrugineus*
Caryota maxima	VA	*Rhynchophorus ferrugineus*
Caryota mitis	VA	*Myndus crudus* *Ripersiella hibisci* Palm lethal yellowing phytoplasmas
Caryota rumphiana	VA	Palm lethal yellowing phytoplasmas
Caryota urens	VA	Palm lethal yellowing phytoplasmas
Chamaedorea elegans	VA	*Rhynchophorus ferrugineus* *Rhynchophorus palmarum*

Plant species	Occurrence	Pests
Chamaedorea seifrizii	VA	*Ripersiella hibisci*
Chelyocarpus chuco	VA	Palm lethal yellowing phytoplasmas
Coccothrinax miraguama	VA	*Myndus crudus*
Cocos nucifera	VA	*Myndus crudus* Palm lethal yellowing phytoplasmas *Rhynchophorus ferrugineus* *Rhynchophorus palmarum*
Copernicia alba	VA	Palm lethal yellowing phytoplasmas
Corypha taliera	VA	Palm lethal yellowing phytoplasmas
Corypha umbraculifera	VA	*Rhynchophorus ferrugineus* Palm lethal yellowing phytoplasmas
Corypha utan	VA	*Myndus crudus* *Rhynchophorus ferrugineus* Palm lethal yellowing phytoplasmas
Cryosophila warscewiczii	VA	Palm lethal yellowing phytoplasmas
Cyphophoenix nucele	VA	Palm lethal yellowing phytoplasmas
Desmoncus major	VA	*Rhynchophorus palmarum*
Dictyosperma album	VA	*Myndus crudus* *Rhynchophorus ferrugineus* Palm lethal yellowing phytoplasmas
Dypsis cabadae	VA	Palm lethal yellowing phytoplasmas
Dypsis decaryi	VA	*Rhynchophorus palmarum* Palm lethal yellowing phytoplasmas
Dypsis leptocheilos	VA	Palm lethal yellowing phytoplasmas
Dypsis lutescens	VA	*Myndus crudus* *Rhynchophorus palmarum*
Elaeis guineensis	VA	*Myndus crudus* Palm lethal yellowing phytoplasmas: *Candidatus* Phytoplasma *palmicola*-related strain 16SrXXII-A *Rhynchophorus palmarum*
Euterpe broadwayana	VA	*Rhynchophorus palmarum*
Euterpe edulis	VA	*Rhynchophorus palmarum*
Euterpe oleracea	VA	*Rhynchophorus palmarum*
Gaussia attenuata	VA	Palm lethal yellowing phytoplasmas

Plant species	Occurrence	Pests
Howea belmoreana	VA	Palm lethal yellowing phytoplasmas
Howea forsteriana	VA	*Ripersiella hibisci* *Rhynchophorus palmarum* Palm lethal yellowing phytoplasmas
Hyophorbe lagenicaulis	VA	*Rhynchophorus palmarum*
Hyophorbe verschaffeltii	VA	*Myndus crudus* Palm lethal yellowing phytoplasmas
Jubaea chilensis	VA	*Paysandisia archon* *Rhynchophorus palmarum*
Latania lontaroides	VA	Palm lethal yellowing phytoplasmas
Livistona australis	VA	Palm lethal yellowing phytoplasmas
Livistona chinensis	VA	*Rhynchophorus ferrugineus* Palm lethal yellowing phytoplasmas *Myndus crudus*
Livistona decipiens	VA	*Rhynchophorus ferrugineus*
Livistona decora	VA	*Paysandisia archon* *Rhynchophorus ferrugineus* *Rhynchophorus palmarum*
Livistona rotundifolia	VA	Palm lethal yellowing phytoplasmas
Livistona saribus	VA	*Paysandisia archon* *Rhynchophorus ferrugineus* *Rhynchophorus palmarum*
Manicaria saccifera	VA	*Rhynchophorus palmarum*
Mauritia flexuosa	VA	*Rhynchophorus palmarum*
Maximiliana caribaea	VA	*Rhynchophorus palmarum*
Metroxylon sagu	VA	*Rhynchophorus palmarum*
Nannorrhops ritchiana	VA	Palm lethal yellowing phytoplasmas
Oenocarpus bataua	VA	*Rhynchophorus palmarum*
Oncosperma horridum	VA	*Rhynchophorus ferrugineus*
Oncosperma tigillarium	VA	*Rhynchophorus ferrugineus*
Pandanus utilis	VA	Palm lethal yellowing phytoplasmas
Phoenix reclinata	VA	*Myndus crudus* Palm lethal yellowing phytoplasmas *Paysandisia archon* *Rhynchophorus palmarum*

Plant species	Occurrence	Pests
		Ripersiella hibisci
Phoenix roebelenii	VA	*Myndus crudus* Palm lethal yellowing phytoplasmas *Paysandisia archon* *Rhynchophorus palmarum* *Ripersiella hibisci*
Phoenix rupicola	VA	Palm lethal yellowing phytoplasmas *Ripersiella hibisci*
Phoenix sylvestris	VA	*Myndus crudus* Palm lethal yellowing phytoplasmas *Paysandisia archon* *Rhynchophorus ferrugineus*
Pritchardia affinis	VA	Palm lethal yellowing phytoplasmas
Pritchardia maideniana	VA	Palm lethal yellowing phytoplasmas
Pritchardia pacifica	VA	*Myndus crudus* *Rhynchophorus ferrugineus* Palm lethal yellowing phytoplasmas
Pritchardia remota	VA	Palm lethal yellowing phytoplasmas
Pritchardia thurstonii	VA	*Myndus crudus*
Ptychosperma elegans	VA	*Myndus crudus*
Ravenea hildebrandtii	VA	Palm lethal yellowing phytoplasmas
Ravenea rivularis	VA	Palm lethal yellowing phytoplasmas *Ripersiella hibisci*
Rhapis excelsa	VA	*Ripersiella hibisci* *Rhynchophorus palmarum*
Roystonea oleracea	VA	*Rhynchophorus palmarum* *Rhynchophorus ferrugineus*
Roystonea regia	VA	*Myndus crudus* Palm lethal yellowing phytoplasmas *Rhynchophorus ferrugineus*
Sabal bermudana	VA	*Rhynchophorus palmarum* *Ripersiella hibisci*
Sabal mexicana	VA	*Paysandisia archon* *Ripersiella hibisci*
Sabal minor	VA	*Paysandisia archon* *Ripersiella hibisci*
Sabal palmetto	VA	*Myndus crudus* Palm lethal yellowing phytoplasmas *Paysandisia archon* *Rhynchophorus ferrugineus* *Rhynchophorus palmarum* *Ripersiella hibisci*
Sabal umbraculifera	VA	*Rhynchophorus ferrugineus* *Ripersiella hibisci*

Plant species	Occurrence	Pests
Satakentia liukiuensis	VA	*Myndus crudus*
Serenoa repens	VA	*Myndus crudus*
Syagrus coronata	VA	*Rhynchophorus palmarum*
Syagrus orinocensis	VA	*Rhynchophorus palmarum*
Syagrus romanzoffiana	VA	*Myndus crudus* *Paysandisia archon* *Rhynchophorus ferrugineus* *Rhynchophorus palmarum*
Syagrus schizophylla	VA	*Myndus crudus* Palm lethal yellowing phytoplasmas *Rhynchophorus palmarum*
Syagrus vagans	VA	*Rhynchophorus palmarum*
Trachycarpus fortunei	VA	*Myndus crudus* Palm lethal yellowing phytoplasmas *Paysandisia archon* *Rhynchophorus ferrugineus* *Ripersiella hibisci*
Trachycarpus wagnerianus	VA	*Paysandisia archon*
Trithrinax campestris	VA	*Paysandisia archon*
Veitchia arecina	VA	Palm lethal yellowing phytoplasmas

* Considered as native even though it is endemic only to the Canary Islands.

Table 3: List of ornamental plant species, assigned occurrence in the EU and targeted pests (Table 1) known to use them as hosts (NAT: native; NNL: non-native locally abundant; VA: virtually absent)

Plant species	Occurrence	Pests
Calendula officinalis	NAT	*Nemorimyza maculosa*
Leucanthemum vulgare	NAT	*Nemorimyza maculosa*
Tanacetum parthenium	NAT	*Nemorimyza maculosa*
Ageratum conyzoides	NNL	*Nemorimyza maculosa*
Artemisia vulgaris	NNL	*Nemorimyza maculosa*
Baccharis halimifolia	NNL	*Nemorimyza maculosa*
Chrysanthemum x *morifolium*	NNL	Chrysanthemum stem necrosis virus *Nemorimyza maculosa*

Plant species	Occurrence	Pests
Cynara cardunculus	NNL	*Nemorimyza maculosa*
Dahlia pinnata	NNL	*Nemorimyza maculosa*
Dendranthema indicum	NNL	*Nemorimyza maculosa*
Ficus benjamina	NNL	*Ripersiella hibisci*
Gerbera jamesonii	NNL	*Nemorimyza maculosa*
Hibiscus rosa-sinensis	NNL	*Ripersiella hibisci*
Symphyotrichum novi-belgii	NNL	*Nemorimyza maculosa*
Tagetes erecta	NNL	*Nemorimyza maculosa*
Tagetes tenuifolia	NNL	*Nemorimyza maculosa*
Zinnia elegans	NNL	*Nemorimyza maculosa*
Callistemon spp.	VA	*Ripersiella hibisci*
Camellia sinensis	VA	*Ripersiella hibisci*
Cuphea hyssopifolia	VA	*Ripersiella hibisci*
Dieffenbachia maculata	VA	*Ripersiella hibisci*
Emilia coccinea	VA	*Nemorimyza maculosa*
Emilia fosbergii	VA	*Nemorimyza maculosa*
Emilia sonchifolia	VA	*Nemorimyza maculosa*
Erechtites hieraciifolius	VA	*Nemorimyza maculosa*
Erigeron canadensis	VA	*Nemorimyza maculosa*
Gaillardia aristata	VA	*Nemorimyza maculosa*
Gamochaeta pensylvanica	VA	*Nemorimyza maculosa*
Grindelia squarrosa	VA	*Nemorimyza maculosa*
Lagascea mollis	VA	*Nemorimyza maculosa*

Plant species	Occurrence	Pests
Leucanthemum x *superbum*	VA	*Nemorimyza maculosa*
Melaleuca citrina	VA	*Ripersiella hibisci*
Pelargonium x *hortorum*	VA	*Ripersiella hibisci*
Pericallis x *hybrida*	VA	*Nemorimyza maculosa*
Sansevieeria trifasciata	VA	*Ripersiella hibisci*
Tithonia rotundifolia	VA	*Nemorimyza maculosa*

3 Phenology

Data on the phenology of palms (family Arecaceae) suggest that most palm species are pleonanthic, continuing to grow vegetatively and produce inflorescences simultaneously throughout their lifespans, and are thus 'indeterminate' in phenology (Dransfield et al., 2008). As is the case with many tropical plant species, palm trees display conspicuous seasonal patterns in vegetative and reproductive phenologies (Steven et al., 1987). Tropical or subtropical ornamental palm species which occur throughout the EU can lack a flowering stage due to the colder climate. Therefore, the main phenological stages of palm trees, i.e. vegetative growth (leaf development) and flowering, cannot be more precisely determined in a vegetative year.

Palms have several developmental growth phases starting from the seed to reproductive adult; embryonic, seedling, establishment, adult vegetative and adult reproductive stage (Broschat et al., 2014). Palm growth pattern is essentially uniform, as the stems of palms grow continuously from a single apical meristem and produce new leaves. From two up to thirteen leaves are expanded per year, with a corresponding sequential withering and shedding of old leaves (Steven et al., 1987). A single axillary inflorescence bud can be initiated in each leaf node at the time of leaf formation. The flowering activity of date palms can be observed at any time of the year, but is usually between March and May in Spain (Rivera et al., 2015). Flowering is followed by the development of fruit. Similar to flowering, fruiting of most palm species in the EU is often conditioned by a relatively unsuitable climate. For example, depending on the microclimate, up to 50% of date fruits in Spain do not reach full maturity due to the colder temperatures (Rivera et al., 2015). The fruit development of palms can last from five to ten months, averaging a total of 200 days (Steven et al., 1987) (Table 4).

Nursery production managers deal mostly with palms in the embryonic, seedling and establishment phases while landscape managers deal mostly with palms in the adult vegetative and reproductive phases. Palm trees are unique among landscape plants for several phenological traits considered to have prominent ornamental value (Table 5).

Table 4: Provisional timing of the main phenological stages for crop species of palms in the EU known to be hosts of the pests included in Table 1 (V: vegetative growth; I: inflorescence; F: fruit development, F+: fruit maturation (adapted from Rivera et al., 2015))

Plant species	Occurrence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Phoenix dactylifera	NNL (Spain)	V	V	I,V	I,V	I,V	F,V	F,V	F,V	F+	F+	F+	F+

Table 5: List of the main phenological terms of palm tree species (Audsley et al., 2017)

Term	Definition*
The crown	The cluster of leaves growing at the top of the stem forming the canopy.
Meristem	The non-differentiated region of a plant where new cells and organs are developed.
The palm 'heart'	The central region of the crown including the apical meristem and the younger, developing leaves.
Shoot apical meristem	The meristematic region at the centre of the 'palm heart'. All new organs (leaves and inflorescences) are generated by the shoot apical meristem.
Stem/stipe (trunk)	The main axis of the palm. Unlike the trunk of most dicot trees, it has a rather constant diameter. Its outer portion is composed of leaf sheets.
Single stemmed palms/multi-stemmed (clustering)	Multi-stemmed palms are generated by branching of axillary meristems (buds) usually at the lower parts of the stem.
Offshoot	A new shoot branching from the main stem, growing from an axillary bud.
Vasculature, vascular bundles	Xylem (water-conducting tissue) and phloem (carbohydrate-conducting tissue) vascular bundles scattered throughout the central cylinder of the stem. They are interspersed within a matrix of parenchyma cells.
Palmate leaf	Shaped like a fan or the palm of the hand. All leaflet or leaf segments arise from a central area.
Pinnate leaf	Feather-like leaf, leaflets arising along a central axis (rachis).
Leaf sheath	The base of the leaf, where it is tubular and completely surrounds younger leaves. It can split after maturity.
Leaf blade	The open, wide part of the leaf (in palm it includes the leaflets or the leaf sections).
Leaflet	A leaf-like part of a compound leaf. Divisions of pinnate (and sometime palmate) leaf blades.
Spear leaf	The youngest, emerging, unopened palm leaf.

Primordial leaves	Developing leaves before emergence. Develop within the 'palm heart'.
Axillary buds	Meristems located at the base of leaves. They can form offshoots (branching) at the juvenile stage and inflorescences once the palm has transitioned into a reproductive state.
Inflorescence	A branch that bears flowers, including all its bracts and sub-branches.
Bracts	A modified leaf associated with the inflorescence.
Spathe	A large sheathing bract, covering the inflorescence. Botanically, depending on species, can be either the prophyll or the peduncular bract.
Peduncle	The fruit stalk, the primary stalk, the lower unbranched part of an inflorescence.
Petiole	The stalk of a leaf.
Rachis	In a leaf: the axis of a leaf beyond the petiole; in an inflorescence: the axis beyond the peduncle.
Rachilla	The inflorescence branches that bear the flowers (sometimes called spikelets).

* The current list of terms is a compromise between botanical morphological terms and common terms used by farmers, gardeners and at nurseries.

As already mentioned, ornamental plants other than palms are numerous and botanically very diverse (Cullen et al., 2011). It is estimated that about 28,000 species are grown and used as ornamental plants around the world (Khoshbakht and Hammer, 2008). The provisional phenology of most flowering ornamentals could be described in relation to their flowering period (Table 6). It should be pointed out that some ornamental plants have wild relatives in the natural environment all over the EU, and many are naturalised, originating from different parts of the world (Heywood and Zohary, 1995; Hammer, 2011; Barba-González et al., 2023). When introduced into horticulture, natural forms of wild plant species are subjected to extensive hybridisation, selection and breeding. Horticultural forms may differ substantially from their wild relatives (Vainstein, 2002). Generally, the flowering time of the most important ornamental plants in the EU is spring. Early-flowering species include daisies, primroses or certain types of daffodil. Early-flowering tulips bloom in March, while late-flowering types commonly give flowers in May. April and May are the main flowering seasons for many roses, carnations, pelargonium or hyacinths. Dahlias and lilies are famous for their summer flowering, while chrysanthemums are among the best-known autumn flowers, blooming from late August to September (Karlsson et al., 1989; Hidén and Larsen, 1994). Some species can have prolonged flowering, from early spring to early autumn, while some like *Viola* species can produce flowers even during the winter. Each species, or even type or variety, has particular requirements for a given development stage. For example, the optimal temperature for flowering of most chrysanthemum varieties (*Chrysanthemum* x *morifolium*) is about 18°C (De Jong, 1978; Van Der Ploeg and Heuvelink,

2006). Flower development is also stimulated by the light level (Cockshull and Hughes, 1971). In cut chrysanthemum cultivation, two different phenological phases can be distinguished. Firstly, a period of long days, when plants grow vegetatively, lasting between 10 and 25 days. Secondly, plants undergo short-day conditions, leading to flower induction and development, varying between 6 and 11 weeks (Van der Ploeg and Heuvelink, 2006). Similarly, particular temperatures and photoperiods influence chrysanthemum shoot development (Karlsson et al., 1989).

Due to a large number of different plant species regarded as ornamentals, the general BBCH scale (Hack et al., 1992) is the most suitable for presenting their phenological stages (Table 6).

Table 6: Description of the main phenophases of ornamental plant species based on the BBCH code (Hack et al., 1992)

Principal growth stage	**BBCH code (from – to)**
0: Germination, sprouting, bud development	00–09
1: Leaf development (main shoot)	10–19
2: Formation of side shoots/tillering	21–29
3: Stem elongation or rosette growth, shoot development (main shoot)	31–39
4: Development of vegetatively propagated organs/booting (main shoot)	40–49
5: Inflorescence emergence (main shoot)/heading	51–59
6: Flowering (main shoot)	60–69
7: Development of fruit	71–79
8: Ripening or maturity of fruit and seed	81–89
9: Senescence, beginning of dormancy	91–99

4 Agroecosystems

Agroecosystems represent the diverse environments in EU Member States where crops may occur. Twenty-four palm species regarded to be present in the EU can be assigned to three different categories, i.e., ornamental, natural/naturalised and plantations (Table 7). The category 'ornamental' refers to palm species planted in urban or peri-urban settings for ornamental purposes, including private gardens, households, collections, public parks, etc. The category 'plantations' refers to palm tree species cultivated on plantations as a crop. The category 'natural/naturalised' refers to palms which are native to the EU, or can be considered naturalised. The decision whether to include a certain palm species in a particular category was based on the distribution data (CABI, online; POWO, online; GBIF, online; PlantNET, online) and

information obtained from the available literature (Orsino and Olivari, 1987; Merlo et al., 1993; Vamvoukakis et al., 1988; García-Castaño et al., 2014; Rivera et al., 2015; Shabani et al., 2015; Fehr and Burga, 2016; Caudullo et al., 2017; Rochat et al., 2017; Obón et al., 2018; Spennemann, 2018; Ferry et al., 2019; Essl, 2019; Wazen et al., 2020; Tonellotto et al., 2022; EFSA et al., 2023a). As previously mentioned, only date palm is cultivated in the EU as a crop. Three palm species native to the EU (*Phoenix canariensis*, *P. theophrasti* and *Chamaerops humilis*) form scattered natural populations in their native habitats. They can also be regarded as ornamental plants, as they are cultivated, marketed and grown for ornamental purposes. All other palms in the EU can be considered as ornamental.

For the ornamental crop group, comprising 30 host plant species, their main and only agroecosystem can be described as ornamental. Limiting the species list to only the relevant hosts of the respective pests, a categorisation similar to that for palms is applied and presented in Table 8. The decision whether to include a certain ornamental species in a particular category was based on information from CABI (online), GBIF (online), INBO (online), POWO (online), PlantNET (online) and the available scientific literature (Mayer et al., 2017; Haeuser et al., 2018).

Table 7: Agroecosystems (land use = epidemiological units) in which palm tree species can be found in EU Member States

Plant species	Occurrence	Ornamental	Natural/naturalised	Plantations
Chamaerops humilis	NAT	yes	yes	no
Phoenix canariensis	NAT	yes	yes	no
Phoenix theophrasti	NAT	yes	yes	no
Phoenix dactylifera	NNL	yes	no	yes
Trachycarpus fortunei	NNL	yes	no	no
Washingtonia filifera	NNL	yes	no	no
Washingtonia robusta	NNL	yes	no	no
Brahea armata	VA	yes	no	no
Brahea edulis	VA	yes	no	no
Butia capitata	VA	yes	no	no
Caryota mitis	VA	yes	no	no
Copernicia alba	VA	yes	no	no
Dypsis decaryi	VA	yes	no	no
Dypsis lutescens	VA	yes	no	no
Howea belmoreana	VA	yes	no	no
Howea forsteriana	VA	yes	no	no
Jubaea chilensis	VA	yes	no	no
Livistona australis	VA	yes	no	no
Phoenix reclinata	VA	yes	no	no
Phoenix roebelenii	VA	yes	no	no
Phoenix rupicola	VA	yes	no	no
Phoenix sylvestris	VA	yes	no	no
Sabal palmetto	VA	yes	no	no
Syagrus romanzoffiana	VA	yes	no	no

Table 8: Agroecosystems (land use = epidemiological units) in which ornamental species can be found in EU Member States

Plant species	Occurrence	Ornamental	Natural/naturalised	Plantations
Calendula officinalis	NAT	yes	no	yes
Leucanthemum vulgare	NAT	yes	no	no
Tanacetum parthenium	NAT	yes	no	no
Ageratum conyzoides	NNL	yes	no	yes

Artemisia vulgaris	NNL	yes	no	yes
Baccharis halimifolia	NNL	yes	no	no
Chrysanthemum x *morifolium*	NNL	yes	no	yes
Cynara cardunculus	NNL	yes	no	yes
Dahlia pinnata	NNL	yes	no	no
Dendranthema indicum	NNL	yes	no	no
Ficus benjamina	NNL	yes	no	no
Gerbera jamesonii	NNL	yes	no	no
Hibiscus rosa-sinensis	NNL	yes	yes	no
Symphyotrichum novi-belgii	NNL	yes	no	no
Tagetes erecta	NNL	yes	no	no
Tagetes tenuifolia	NNL	yes	no	no
Zinnia elegans	NNL	yes	no	no
Callistemon spp.	VA	yes	no	no
Camellia sinensis	VA	yes	no	no
Cuphea hyssopifolia	VA	yes	no	no
Dieffenbachia maculata	VA	yes	no	no
Emilia coccinea	VA	yes	no	no
Emilia fosbergii	VA	yes	no	no
Emilia sonchifolia	VA	no	yes	no
Gaillardia aristata	VA	yes	no	no
Leucanthemum x *superbum*	VA	yes	no	no
Pelargonium x hortorum	VA	yes	no	no
Pericallis x hybrida	VA	yes	no	no
Sansevieeria trifasciata	VA	yes	no	no
Tithonia rotundifolia	VA	yes	no	no

5 Crop management

All non-native and native European palm species are cultivated as ornamental plants except the *P. dactylifera* which is the only palm that can be considered as a crop in the EU. The area of cultivation is very limited, comprising mostly Alicante province in the Valencian Community of Spain (Rivera et al., 2015). The city of Elche in Spain is recognised as a centre of date palm production in the EU (Rivera et al., 2015), and is famous for the date palm grove that was declared as a UNESCO World Heritage Site in 2000. Date palms are grown mostly from seeds or tissue cultures (Ferry et al., 2002; Rivera et al., 2015) and planted as seedlings previously grown in pots, with trunks approximately 10–20 cm in height. Standard planting spacing is usually 7 × 7 m. Plantations are drip-irrigated and fertilised according to the specific requirements. Although natural pollination may be sufficient for satisfactory fruit set, manual pollination with male flowers can be performed (Rivera et al., 2015). Fruit thinning from June to July may be carried out, depending on the preference for fruit dimensions and taste. Fruit clusters can be covered with anti-insect nets during ripening, preventing damage from insects like the date stone beetle (*Coccotrypes dacytiliperda*) or wasps (Rivera et al., 2015). Dates are harvested from October to January, depending on the variety and desirable fruit maturity stage (Ferry et al., 2002). Fruit maturity stages are often informally classified and known from the respective Arabic terms (*kimri*, *khalal*, *rutab* and *tamar*, the last one meaning 'date'). In Spanish conditions, up to 50% of date fruits do not fully ripen because of the lower temperatures than in the date palm's natural range (Rivera et al., 2015). The 'Medjoul' variety of date palm is the most common (Ferry et al., 2002). It is one of the most widespread date palm varieties in the world, known also as 'Medjool' or 'Majhool' (Zaid and Oihabi, 2022).

The management of ornamental palms in nurseries is dependent on the species grown. However, certain practices in cultivation are common. Plants are propagated by seed or from basal shoots retrieved from mother plants and used as seedlings (Dransfield et al., 2008). Young palms are grown in pots or containers of appropriate dimensions, in substrates adjusted to the particular species. Drip irrigation is standard practice. Humidity sensors are often used in advanced and specialised nurseries, allowing efficient management of irrigation regimes. Fertilisation is adapted to the particular species, growth stage and market requirements (Broschat, 1994; Broschat, 1999). Pruning is generally minimal on young plants. Pest management practices in palm nurseries comprise permanent monitoring, sanitary pruning, physical isolation, tree surgery, and treatments with fungicides and insecticides (Rivera et al., 2015). Fungicides on date palms are usually applied from January to April, from the pre-flowering to early post-flowering stages. On other palm species, fungicides may be applied to target different leaf diseases or *Phytophthora* root and stem rot. Insecticides are applied by spraying or drenching, especially when the plants are grown in pots (Garcerán, 2007). Where present, red palm weevil and palm borer are the main target pests (Rivera et al., 2015). Endotherapy may be used (Chihaoui-Meridja et al., 2020), but is a less common technique in nurseries. Beside chemical products, biological fungicides and insecticides are becoming more widely available for the control of particular pests and diseases on palms. These include entomopathogenic nematodes (e.g. *Steinernema carpocapsae*), fungi like *Beauveria bassiana* or *Trichoderma* spp., and beneficial bacteria like *Bacillus amyloliquefaciens* (Llácer et al., 2009; Dembilio et al., 2010; Manachini et al., 2013; Francesca et al., 2015; Nishad and Ahmed, 2020; Nurashikin-Khairuddin et al., 2022).

Outdoor palm species grown in the EU as ornamental plants differ in their requirements on soil types, moisture, humidity, cold tolerance, air pollution, exposition and ornamental value (Broschat et al., 2014). Planting positions for palms are usually previously assessed, with possible amelioration actions (Hosek and Roloff, 2016). Generally, they have higher growth (up to 5–6 m) but dwarf species (up to 2 m) are also used. When planted in the desired position, further management is generally limited to irrigation, pruning, removal of dead debris and sometimes basic fertilisation (Garcerán, 2007; Broschat et al., 2014). Pest and disease management of palms in public places is relatively limited, especially considering restrictions on the use of chemical plant protection products in public areas. This practice changed somewhat upon the establishment and rapid spread of red palm weevil in the EU and, to a lesser extent, palm borer (MacLeod and Hussein, 2017; Rochat et al., 2017). Until the development and practical adoption of endotherapy techniques, highly valuable ornamental palms in many European cities and communities were treated with insecticides (Gómez et al., 2009; Tapia et al., 2011). Crown treatments were mostly performed on Canary palms, considered as a palm species of the highest ornamental value in the EU, and highly sensitive to red palm weevil. Endotherapy with specially developed products (e.g. emamectin-based) has become a widely used technique in recent years. It has proven long-lasting effectiveness and is regarded as practical and more ecologically acceptable (Chihaoui-Meridja et al., 2020). A number of private enterprises offer palm endotherapy services nowadays, and it has become a regular practice for palm protection in many parks, arboreta in public places, hotel resorts and private gardens all along the Mediterranean part of the EU. In view of all these variables, and for a more specific description and details for each species, please refer to CABI (online).

Ornamental plant species cultivation for cut flowers in the EU is possible outdoors and in protected areas (e.g. glasshouses), the latter being more common. Some of the most notable species are *Chrysanthemum* x *morifolium*, *Dendranthema indicum*, *Cynara cardunculus*, *Tagetes*

spp. and *Hibiscus rosa-sinensis*. Specific practices during cultivation are related to species grown for cut flowers. For instance, chrysanthemum production requires pinching, de-shooting, the removal of buds or bud-netting, depending on the type grown (Daughtrey and Benson, 2005). Plant growth regulators are regularly applied on some ornamental species. Basic management practices that are common for ornamental flowering plants include certain general aspects of propagation, crop care and crop protection. Most ornamental plants are propagated by vegetative parts, i.e. seedlings, cuts or bulbs. Nurseries for propagation may be located in the EU, but also on other continents, such as Africa. Plant hygiene is regularly very strict in propagation material nurseries. Mother plants are isolated, regularly inspected, treated if necessary and sometimes tested to confirm freedom from certain diseases. For further growing, various substrates are used, often specially adapted to the plant species grown. If grown in soil, targeted amelioration is usually carried out, again depending on the species grown. Soil disinfection is relatively common in ornamental plant cultivation. Fumigation with chemicals like metam-sodium or dazomet is still used relatively frequently, although more ecologically sustainable practices have been explored over the last decade (Katan, 2015; De Corato, 2020; Andrzejak and Janowska, 2022). These include soil steaming, solarisation, biofumigation, or the application of biological products (Daughtrey and Benson, 2005). Biological products for soil or substrate treatment are becoming increasingly available on the market, and are applied in ornamental plant production. *Trichoderma*-based products are among those most widely used, mostly as a preventive treatment against root rot caused by pathogens like *Pythium*, *Phytophthora*, *Fusarium*, *Rhizoctonia* or *Thielaviopsis* (Woo et al., 2014; Andrzejak and Janowska, 2022). Disease management in cut flower production still relies heavily on chemical fungicides (Gullino and Garibaldi, 2007; Bethke and Cloyd, 2009). Crop resistance or humidity control can have a significant role in disease control, but there are limited options for certain pathogens. For example, chrysanthemum varieties tolerant or resistant to tomato spotted wilt virus, Chrysanthemum stunt viroid or white rust (*Puccinia horiana*) have been developed. On the other hand, host resistance to grey mould (*Botrytis cinerea*) is difficult to obtain. This is an example of a disease for which chemical control is still the most employed management practice. New techniques and technologies in ornamental plant breeding and production are rapidly developing (Noman et al., 2017; Koukounaras, 2021; Huylenbroeck and Bhattarai, 2022; Wani et al., 2023). For management description and details for each species, please refer to CABI (online).

6 Climate suitability and distribution

6.1 Climate suitability

In general, palms (Arecaceae), being subtropical and tropical tree species, rarely tolerate temperate climates (Dransfield et al., 2008; Riffle et al., 2012). They require high temperatures for their full development, and are cold-sensitive (Reichgelt et al., 2018). The climate in the EU is conductive for the growth and development of only a few palm species. These are considered to be palm species of considerable 'cold hardiness' (Smith, 1958; Barry, 1961; Popenoe, 1973; Larches and Winter, 1981; Uhl and Dransfield, 1987). The main representatives are *Chamaerops humilis*, *Jubaea chilensis*, *Phoenix canariensis*, *P. theophrasti*, *P. dactylifera*, *Sabal palmetto*, *Trachycarpus fortunei*, *Washingtonia fillifera* and *W. robusta* to a certain extent (Dransfield et al., 2008). Further, the origin of the particular palm species and its natural habitat is usually the main indicator of its climate suitability (Dransfield et al., 2008; Eiserhardt et al., 2011). The abovementioned species can be grown and may be well-adapted to the Mediterranean climate

type. Particularly, suitable climate types for these palms include Csa and Csb (temperate, dry, hot and warm summer, respectively), and BWh and BSh (arid, hot, desert and steppe, respectively) of Köppen-Geiger climate classification. These climate types comprise southern Portugal, southern Spain and almost whole Spanish Mediterranean coast (Andalusia, Murcia, Valencia, Catalonia), French Mediterranean coast (coastal Occitanie and Côte d'Azur), Italian Ligurian, Tyrrhenian, Ionian and Adriatic coast, Croatian and Slovenian Adriatic coast, large part of continental Greece, Greek Aegean and Ionian islands, and larger Mediterranean islands or archipelagos like Cyprus, Crete, Sicily, Sardinia, Corsica, Malta, Balearic Islands and Canary Islands. The latter are famous for the endemic species *P. canariensis*, today spread in many areas of the world as a species of very high ornamental value (Morici, 1998; Zona, 2008; Spennermann, 2021). Strictly tropical species do not find suitable climate in the EU, even in the most warm areas.

Particular local conditions can influence climate significantly, making them more or less suitable for palms in general, or for a particular palm species. As a rule, narrow coastal strips along the seaside are the most suitable locations for palms. How deep to the interior can the optimal range for palms extent, often depends on the effect of the warm sea air. This is the reason why Mediterranean islands, whether large or small, can have suitable climate conditions for palms even in the interior, further from the coastline. Similarly, suitable climate for particular palm species can extent relatively deep in the interior of areas like Alentejo and Algarve in Portugal, Andalusia in Spain, Southern Italy or Peloponnese in Greece. It should be noted that small groups or single specimens of palm trees can be found in public places or private gardens in Central or Western European cities, with continental climate types and cool or cold winters. The most cold-resistant species are usually planted in such locations, notably *Chamaerops humilis*, *Jubea chilensis* and *Trachycarpus fortunei*. Although palms may develop relatively well there, these examples are more of an exception, and can be considered as planted out of their suitable climate range. Exact climate suitability figures are available for 1 palm tree species and 2 ornamental plants occuring in EU from CABI (online) (Table 9).

Table 9: Climate types suitable for major host plants for pests from Table 1 (CABI, online)

Major host plant	Climate type	Preferred or tolerated
Phoenix canariensis	As-Tropical savanan climate with dry summer	Tolerated
	Aw – Tropical wet and dry savanna climate	Tolerated
	C – Temperate/Mesothermal climate	Prefered
	Cf - Warm temperate climate	Prefered
	Cs - Warm temperate climate with dry summer	Prefered
	Cw - warm temperate climate with dry winter	Prefered
Cuphea hyssopifolia	Af - Tropical rainforest climate	Preferred
	Am - Tropical monsoon climate	Preferred

	As – Tropical savanna climate with dry summer	Tolerated
	Aw – Tropical wet and dry savanna climate	Preferred
Hibiscus rosa-sinensis	Af – Tropical rainforest climate	Preferred
	Am – Tropical monsoon climate	Preferred
	As – Tropical savanna climate with dry summer	Preferred
	Aw – Tropical wet and dry savanna climate	Preferred
	Cs – Warm temperate climate with dry summer	Preferred
	Cw – Warm temperate climate with dry winter	Preferred
	Cf – Warm temperate climate	Preferred

As mentioned, there is a prominent gradation of the EU climate suitability among different palm species. European fan palm, *Chamaerops humilis*, is considered to be the northernmost native palm species in the world (Merlo et al., 1993; Dransfield et al., 2008). Its northernmost native standing is in Italian Liguria, approximately at 44° latitude (Orsino and Olivari, 1987). Winter temperatures are the main limiting factor in climate suitability for palms in the EU. *C. humilis* can tolerate temperatures down to -12°C (Larcher and Winter, 1981). Another European native palm, *Phoenix theophrasti*, is also considered to be relatively tolerant to winter temperatures below zero, but not under -10°C for prolonged periods. Chinese windmill palm, *Trachycarpus fortunei*, is also a relatively cold-tolerant species, and is sometimes considered to be the palm species most resistant to freezing temperatures (Larcher and Winter, 1981; Dransfield et al., 2008). It can tolerate temperatures from -9°C to even -14°C (Larcher and Winter, 1981). This palm is regarded as an urban landscape symbol in some areas of southern Switzerland, especially in Ticino canton (Tonellotto et al., 2022). It has become naturalised in some areas south of the Alps (Walther, 2002; Fehr and Burga, 2016), and has been officially designated as an invasive species (Tonellotto et al., 2022). Specimens of windmill palm escaped from gardens and have been found at several locations in Austria (Essl, 2019). One of the most notable ornamental palms in the EU, *Phoenix canariensis*, can tolerate temperatures down to -10°C (Smith, 1958; Larcher and Winter, 1981) and is generally well-suited to the Mediterranean climate. Date palm (*P. dactylifera*) is less tolerant to low winter temperatures, and can be damaged at temperatures of -5°C or below (Chao and Krueger, 2007). Several palms of North American and South American origin are also known for their relative winter hardiness (Smith, 1958; Larcher and Winter, 1981; Dransfield et al., 2008). Among them, the most frequent in the EU are *Washingtonia fillifera* and *W. robusta*. *Washingtonia* species are native to southern California and northern Mexico, where they can tolerate winter temperatures as low as -10°C (Larcher and Winter, 1981). Sabal palms (*Sabal* spp.), native to the southern United States, Mexico and Central America, also exhibit prominent resistance to low temperatures (Smith, 1958; Larcher and Winter, 1981). Other examples are the South American jelly palm (*Butia odorata*), originating from southern Brazil and northern Uruguay, or the Chilean wine palm (*Jubaea*

chilensis). As with more numerous *T. fortunei* or *P. canariensis*, all of the mentioned species can be found as solitary ornamental plants in European regions with a maritime or continental climate, sometimes without any protection from freezing during the winter. However, as previously stated, these areas cannot be considered as suitable for their growth. As is the case for all plants, low temperatures are not the only decisive factor for palm survival, the duration of such temperatures is also relevant. Another important factor is the age and the vigour of the plant; younger ones being regularly more sensitive to freezing (Martens, 1970; Larcher and Winter, 1981; Uhl and Dransfield, 1987).

Besides the risk from low temperatures, different species of palm require warm or hot seasons for their optimal development (Dransfield et al., 2008; Riffle et al., 2012). The date palm requires hot summers for optimal flowering and full fruit development (Allbed et al., 2017; Farooq et al., 2021). Currently, the climate in Europe is assessed as not suitable for date palm cultivation (Farooq et al., 2021). However, the predicted climate change could contribute to the spread of suitable areas for date palm cultivation (Shabani et al., 2012, 2015; Farooq et at al., 2021). Climate change may also affect other palm species in the EU, extending their potential range and transforming currently less suitable or suboptimal areas for their development (Walther et al., 2007; Eiserhardt et al., 2011). While temperatures may be considered as the main climatic factor in determining habitat suitability for different species of palms in the EU, water availability can be considered of secondary importance. In nurseries, irrigation is suited to the species grown, and a similar approach is followed for landscape palms in public green areas (Pittenger et al., 2009).

Ornamental plants comprise numerous species from different families, with prominent variations in climate suitability. Climate suitability basically does not apply to ornamental species cultivated for indoor use, as such species are grown in a human-mediated, artificial environment. Many of the popular indoor plants are of tropical origin, e.g. various orchids, *Diffenbachia*, *Anthurium* or *Canna*. Certain species of tropical or subtropical origin can be grown in the open, but only in particular micro-locations, mostly in the Mediterranean part of the EU (Mayer et al., 2017). Examples are *Passiflora* or *Strelitzia* species. In nurseries, such cold-sensitive species are grown almost exclusively in closed or semi-open conditions, in heated greenhouses, glasshouses or tunnels (Mayer et al., 2017).

Outdoor ornamental plants are grown according to their climate and environmental suitability in the EU. The most popular perennial species, e.g. those grown in parks and gardens, are usually well-adapted to local climatic conditions, and are sometimes abundant and widespread in their native, wild forms. Aside from the native plant species, the distribution of introduced perennial ornamentals also follows their climate suitability (Haeuser et al., 2018). For example, evergreen spindle (*Euonymus japonicus*) or common privet (*Ligustrum vulgare*) are very popular green hedge plants in central and northern Europe, as they are well-adapted to cold winters. On the other hand, plants like crape myrtle (*Lagerstroemia* spp.), *Bougainvillea* species or native laurel (*Laurus nobilis*) are grown in the warmer, mostly Mediterranean, parts of the EU.

Many of the most common herbaceous or perennial flowers are basically well-suited to most of the climate types in the EU. The exceptions are only polar types (ET and EF of the Köppen-Geiger classification), characteristic of some northern areas of Sweden and Finland, as well as for the high Alps. In other climates, spring or summer temperatures usually allow the development and flowering of plants like roses, daisies, chrysanthemums, lilies, hyacinths, violas or gladiolas. When produced as cut flowers in nurseries, plants are often produced in closed conditions, adjusting specific temperature, humidity and daylight regimes.

6.2 Distribution

For each palm tree species known to be a host of the pests included in Table 1, and occurring in the EU, the distribution was extracted from CABI (online) and from the available literature. Additional countries that are not reported in CABI (online), but for which at least one observation record exists (POWO, online; GBIF, online; PlantNET, online) are also listed. They are divided into the three categories: 'native', 'non-native locally abundant' and 'virtually absent' species.

Similarly, the distribution of ornamental host plants of pests included in Table 1, and occurring in the EU, was extracted using CABI (online), POWO (online), INBO (online), GBIF (online) and PlantNET (online), and divided into the same three categories..

6.2.1 Native palms

6.2.1.1 *Chamaerops humilis*

Endemic along the western coasts of Italy and the western Mediterranean basin from southern Portugal to Malta (CABI, online). The current natural distribution of *C. humilis* is confined to the western Mediterranean, occurring along the coasts of southern Portugal, Spain, France, western and southern Itay, including most of the major islands of the Mediterranean (García-Castaño et al., 2014).

Distribution based on CABI: Italy – Sicily, Portugal – Azores, Spain.

Additional records from GBIF: Austria, Croatia, Estonia, Germany, Greece, Italy, Malta, Netherlands, Sweden

Figure 1: Distribution of *Chamaerops humilis* in Europe (map modified from Caudullo et al., 2017)

6.2.1.2 *Phoenix canariensis*

Endemic to the Canary Islands, but it may even be found in subtropical and temperate areas of the EU, and can be considered naturalised in Europe (i.e. France and Italy) (Spennemann, 2018). It is also recorded at higher latitudes under special protected conditions. The Canary Island date palm grows in the wild in infra- and thermo-Mediterranean humid colluviums, dry ravines with temporary water flow (wadi), or near watercourses, palaeochannels and springs. *Phoenix canariensis* was widely sold in the past and thus can be found in most temperate and subtropical areas of the world (Spennemann, 2018). It is considered the main ornamental palm in the Mediterranean cities of the EU (Ferry et al., 2019).

Distribution based on CABI: Croatia, France, Greece, Italy – Sicily, Portugal – Azores, Portugal – Madeira, Spain, Spain – Canary Islands.

Additional records from GBIF: Germany, Hungary, Poland.

Additional records from literature: Bulgaria, Czechia, Malta (Spennemann, 2018).

6.2.1.3 *Phoenix theophrasti*

Endemic in Crete and some other parts of Greece.

Distribution based on CABI: —

Additional records from GBIF: Belgium, Greece, Italy, Sweden.

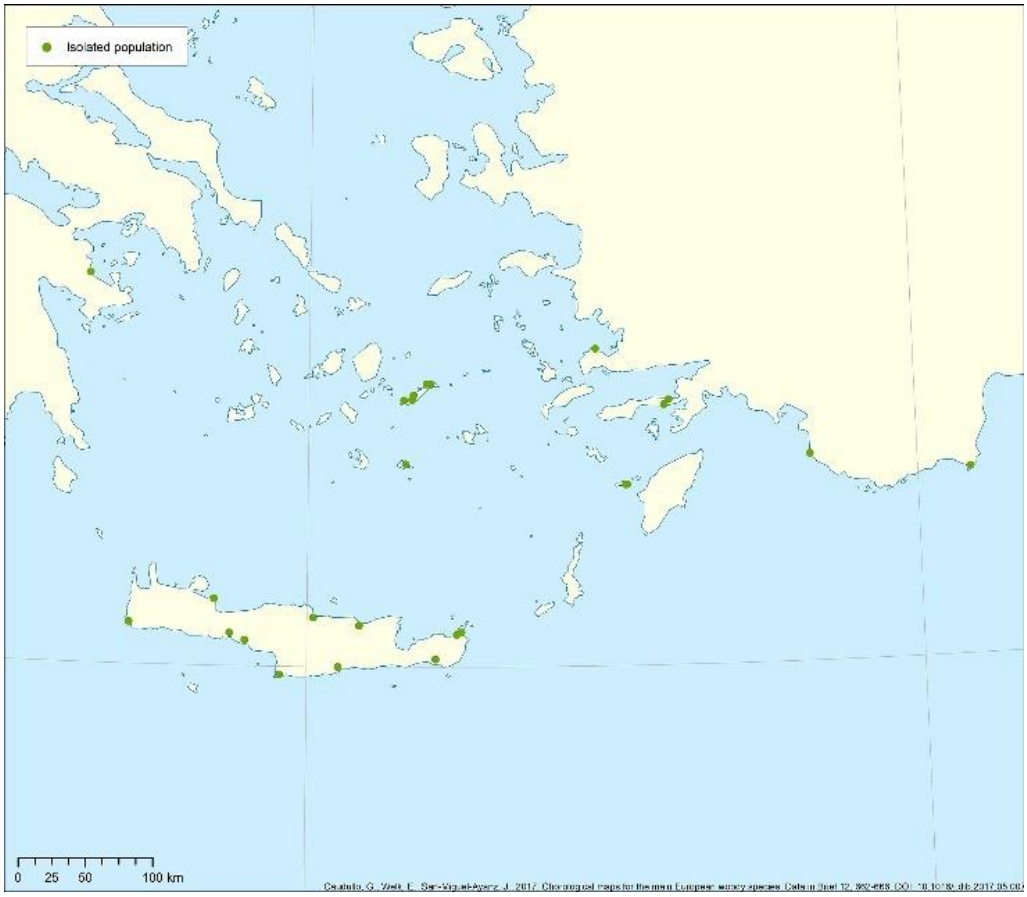

Figure 2: Distribution of *Chamaerops humilis* in Europe (map modified from Caudullo et al., 2017)

6.2.2 Non-native locally abundant palms

6.2.2.1 *Phoenix dactylifera*

Southeastern Spain is the main area for date palms in the EU with nearly one million trees as of the late 1900s, before the spread of the red palm weevil (*Rhycnhophorus ferrugineus*) (Rivera et al., 2015). Cultivated date palm populations are legally protected in the Palmeral de Elche and other localities of southeastern Spain (Obón et al., 2018). This is not the case for those in natural habitats (Rivera et al., 2015). Semi-natural populations of date palm in the Iberian Peninsula grow in stream and ravine beds and drier channels (Obón et al., 2018).

Distribution based on CABI: Austria, Italy, Netherlands, Poland, Slovenia, Spain.

Additional records from GBIF: Belgium, Croatia, Cyprus, France, Germany, Greece, Italy, Malta, Netherlands, Spain, Sweden.

6.2.2.2 *Trachycarpus fortunei*

Distribution based on CABI: Belgium, Croatia, Italy.

Additional records from GBIF: Belgium, Denmark, France, Germany, Greece, Ireland, Netherlands, Portugal, Slovenia, Sweden.

Additional records from literature: Austria (Essl, 2019).

6.2.2.3 *Washingtonia filifera*

Distribution based on CABI: Croatia, Greece – Crete.

Additional records from GBIF: Croatia, France, Greece, Italy, Portugal, Spain, Sweden.

Additional records from literature: Bulgaria, Czechia, Malta (Spennemann, 2018).

6.2.2.4 *Washingtonia robusta*

Distribution based on CABI: Greece – Crete.

Additional records from GBIF: Belgium, Croatia, Estonia, France, Greece, Italy, Malta, Portugal, Spain.

6.2.3 Virtually absent palms

6.2.3.1 *Brahea armata*

Distribution based on CABI: —

Additional records from GBIF: Croatia, France, Portugal, Spain.

6.2.3.2 *Brahea edulis*

Distribution based on CABI: —

Additional records from GBIF: Malta.

6.2.3.3 *Butia capitata*

Distribution based on CABI: —

Additional records from GBIF: France, Germany.

6.2.3.4 *Caryota mitis*

Distribution based on CABI: Spain – Canary Islands.

Additional records from GBIF: Belgium, Italy, Germany, Poland, Sweden.

6.2.3.5 *Copernicia alba*

Distribution based on CABI: —

Additional records from GBIF: —

6.2.3.6 *Dypsis decaryi*

Distribution based on CABI: Belgium, Italy, Sweden.

Additional records from GBIF: Belgium, Croatia, Italy, Sweden.

6.2.3.7 *Dypsis lutescens*

Distribution based on CABI: Cyprus.

Additional records from GBIF: Belgium, Italy.

6.2.3.8 *Howea belmoreana*

Distribution based on CABI: Portugal.

Additional records from GBIF: Belgium, Finland, Germany, Spain.

6.2.3.9 *Howea forsteriana*

Distribution based on CABI: Italy – Sicily.

Additional records from GBIF: Belgium, Estonia, Portugal, Spain.

6.2.3.10 *Jubaea chilensis*

Distribution based on CABI: —

Additional records from GBIF: France, Spain.

6.2.3.11 *Livistona australis*

Distribution based on CABI: —

Additional records from GBIF: France, Spain.

6.2.3.12 *Phoenix reclinata*

Distribution based on CABI: —

Additional records from GBIF: Belgium, Germany, Italy, Portugal, Spain.

6.2.3.13 *Phoenix roebelenii*

Distribution based on CABI: —

Additional records from GBIF: Belgium, Croatia, Italy, Sweden.

6.2.3.14 *Phoenix rupicola*

Distribution based on CABI: —

Additional records from GBIF: Belgium, Croatia, Italy.

6.2.3.15 *Phoenix sylvestris*

Distribution based on CABI: —

Additional records from GBIF: Belgium, Croatia.

6.2.3.16 *Sabal palmetto*

Distribution based on CABI: —

Additional records from GBIF: Belgium, Italy, Sweden.

6.2.3.17 *Syagrus romanzoffiana*

Distribution based on CABI: —

Additional records from GBIF: Belgium, Croatia, France, Germany, Italy, Portugal, Spain.

6.2.4 Native ornamental species

6.2.4.1 *Calendula officinalis*

Distribution based on CABI: Austria, Belgium, Bulgaria, Czechia, Estonia, France, Germany, Ireland, Italy, Lithuania, Poland, Portugal, Slovakia.

Additional distribution based on POWO: Croatia, Hungary, Latvia, Malta, Netherlands, Romania, Slovenia, Spain, Sweden.

Additional records from GBIF: Denmark, Finland.

6.2.4.2 *Leucanthemum vulgare*

Distribution based on CABI: Austria, Belgium, Croatia, Czechia, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Poland, Portugal, Romania, Slovakia, Slovenia, Sweden.

Additional distribution based on POWO: Bulgaria, Denmark, Netherlands, Spain.

6.2.4.3 *Tanacetum parthenium*

Distribution based on CABI: Austria, Belgium, Cyprus, Denmark, Estonia, France – Corsica, Ireland, Lithuania, Poland, Portugal – Azores, Slovakia, Slovenia, Sweden.

Additional distribution based on POWO: Bulgaria, Croatia, Germany, Greece, Hungary, Italy, Latvia, Malta, Netherlands, Romania, Spain.

Additional records from GBIF: Czechia, Finland, Ireland, Portugal.

6.2.5 Non-native locally abundant ornamental species

6.2.5.1 *Ageratum conyzoides*

Distribution based on CABI: Bulgaria, France, Italy, Portugal, Spain, Sweden.

Additional distribution based on POWO: Croatia, Slovenia.

Additional records from GBIF: Belgium, Estonia, Germany, Netherlands.

6.2.5.2 *Artemisia vulgaris*

Distribution based on CABI: Austria, Belgium, Czechia, Germany, Greece, Italy, Lithuania, Poland, Slovenia, Spain, Sweden.

Additional distribution based on POWO: Bulgaria, Croatia, Denmark, Estonia, France, Hungary, Ireland, Netherlands, Portugal, Slovakia.

Additional records from GBIF: Latvia, Romania.

6.2.5.3 *Baccharis halimifolia*

Distribution based on CABI: —

Additional distribution based on POWO: France, Netherlands, Spain.

Additional records from GBIF: Belgium, Germany, Italy, Poland, Portugal, Slovakia.

Additional records from literature: *Baccharis halimifolia* is now common on the Atlantic coast of Europe, from northern Spain to Belgium, and an emerging issue on the Mediterranean coast (Fried et al., 2016).

6.2.5.4 *Chrysanthemum x morifolium*

Distribution based on CABI: Austria, Croatia, Czechia, Hungary, Italy, Poland, Slovenia.

Additional records from GBIF: Finland, France, Germany, Netherlands, Spain, Sweden.

6.2.5.5 *Cynara cardunculus*

Distribution based on CABI: Austria, Belgium, Croatia, Cyprus, France, Germany, Greece, Ireland, Italy, Malta, Netherlands, Portugal – Madeira, Romania, Spain.

Additional distribution based on POWO: Bulgaria, Czechia, Portugal, Slovakia, Slovenia.

Additional records from GBIF: Denmark, Hungary, Sweden.

6.2.5.6 *Dahlia pinnata*

Distribution based on CABI: Austria, Ireland, Netherlands.

Additional distribution based on POWO: Bulgaria, Croatia, Estonia, France, Germany, Hungary, Italy, Latvia, Lithuania, Portugal, Romania, Slovenia, Spain.

Additional records from GBIF: Belgium, Czechia, Denmark, Finland, Poland, Slovakia, Sweden.

6.2.5.7 *Dendranthema indicum*

Distribution based on CABI: Bulgaria, Croatia, Italy, Lithuania, Slovenia.

Additional distribution based on POWO: France, Portugal, Romania.

Additional records from GBIF: Austria, Germany, Latvia, Poland, Spain, Sweden.

6.2.5.8 *Ficus benjamina*

Distribution based on CABI: Croatia, Estonia, Portugal – Madeira, Romania.

Additional records from GBIF: Belgium, Germany, Greece, Italy, Netherlands, Slovenia, Spain.

6.2.5.9 *Gerbera jamesonii*

Distribution based on CABI: Bulgaria, Croatia, Italy.

Additional records from PlantNET: France, Germany, Greece, Hungary, Latvia, Netherlands, Slovenia, Poland.

Additional records from GBIF: Portugal.

6.2.5.10 *Hibiscus rosa-sinensis*

H. rosa-sinensis is one of the most cultivated shrubs in the tropical and subtropical areas, and it is also used as an indoor or annual plant in temperate regions (CABI, online).

Distribution based on CABI: Bulgaria, Croatia, Denmark, France, Germany, Greece, Italy – Sicily (only in cultivation), Netherlands, Portugal (only in cultivation), Romania, Spain – Canary Islands.

Additional records from GBIF: Belgium, Estonia, Finland, Germany, Malta, Netherlands, Sweden.

6.2.5.11 *Symphyotrichum novi-belgii*

Distribution based on CABI: Austria, Belgium, Bulgaria, Croatia, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Netherlands, Poland, Romania, Slovakia, Slovenia, Spain, Sweden.

Additional distribution based on POWO: Malta.

Additional records from GBIF: Portugal.

6.2.5.12 *Tagetes erecta*

Distribution based on CABI: Belgium, Croatia, Cyprus, Czechia, Denmark, Estonia, France, Germany, Greece, Hungary, Italy, Lithuania, Portugal, Romania, Slovenia, Spain, Sweden.

Additional distribution based on POWO: Austria, Bulgaria, Ireland, Latvia, Luxembourg, Malta, Netherlands, Poland, Romania, Slovakia.

Additional records from GBIF: Finland.

6.2.5.13 *Tagetes tenuifolia*

Distribution based on CABI: Austria, Belgium, Czechia, Sweden.

Additional distribution based on POWO: Croatia, France, Estonia, Germany, Latvia, Lithuania, Romania, Slovenia.

Additional records from GBIF: Italy, Netherlands.

6.2.5.14 *Zinnia elegans*

Distribution based on CABI: Belgium, Bulgaria, Hungary, Italy.

Additional distribution based on POWO: Austria, Croatia, Czechia, France, Germany, Malta, Poland, Portugal, Romania, Slovakia, Slovenia, Spain.

6.2.6 Virtually absent ornamental species

6.2.6.1 *Callistemon* spp.

Distribution based on CABI: Italy (*C. citrinus*)

Additional records from GBIF: Belgium, Croatia, Estonia, France, Germany, Greece, Portugal, Spain, Sweden.

6.2.6.2 *Camellia sinensis*

Distribution based on CABI: Portugal – Azores.

Additional records from GBIF: Belgium, Estonia, Finland, Germany, Portugal, Sweden.

6.2.6.3 *Cuphea hyssopifolia*

Distribution based on CABI: —

Additional records from PlantNET: Austria, Belgium, Croatia, Cyprus, Czechia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden.

6.2.6.4 *Dieffenbachia maculata*

Distribution based on CABI: Belgium, Denmark, Hungary.

Additional records from GBIF: Germany, Italy, Spain, Sweden.

6.2.6.5 *Emilia coccinea*

Distribution based on CABI: Portugal – Madeira.

Additional records from GBIF: Austria, Belgium, Czechia, Germany, Slovakia, Spain.

Additional records from PlantNET: France.

6.2.6.6 *Emilia fosbergii*

Distribution based on CABI: Belgium.

Additional records from PlantNET: France, Germany, Italy, Portugal.

6.2.6.7 *Emilia sonchifolia*

Distribution based on CABI: —

Additional records from PlantNET: Austria, Italy, Portugal, Spain.

Additional records from GBIF: Belgium, France, Germany.

6.2.6.8 *Gaillardia aristata*

Distribution based on CABI: Austria, Belgium, Czechia, Estonia, France, Italy, Portugal, Slovakia.

Additional distribution based on POWO: Hungary, Latvia, Lithuania, Romania.

Additional records from GBIF: Croatia, Finland, Germany, Netherlands, Poland, Spain, Sweden.

6.2.6.9 *Leucanthemum* x *superbum*

Distribution based on CABI: —

Additional records from GBIF: Belgium.

6.2.6.10 *Pellargonium* x *hortorum*

Distribution based on CABI: —

Additional records from GBIF: Estonia, Germany, Italy, Netherlands, Portugal, Spain, Sweden.

6.2.6.11 *Pericallis* x *hybrida*

Distsribution based on CABI: Bulgaria.

Additional records from GBIF: —

6.2.6.12 *Sansevieria trifasciata*

Distribution based on CABI: Spain, Spain – Canary Islands.

Additional records from GBIF: Belgium, Croatia, Denmark, Germany, Italy, Portugal, Sweden

6.2.6.13 *Tithonia rotundifolia*

Distribution based on CABI: Belgium.

Additional records from GBIF: Denmark, France, Germany, Hungary, Netherlands, Poland, Portugal, Sweden.

7 Regulation

7.1 Overview

The import of palm tree species as well as ornamentals into the EU is regulated by:

1. Regulation (EU) 2016/2031[2] on protective measures against pests of plants (Plant Health Law). This Regulation sets out rules to determine the phytosanitary risks posed by any species, strain or biotype of pathogenic agents, animals or parasitic plants injurious to plants or plant products ('pests') and measures to reduce those risks to an acceptable level.
2. Commission Implementing Regulation (EU) 2019/2072[3] establishing uniform conditions for the implementation of Regulation (EU) 2016/2031, as regards protective measures against pests of plants. This Regulation implements Regulation (EU) 2016/2031, as regards the listing of Union quarantine pests, protected zone quarantine pests and EU-regulated non-quarantine pests, and the measures to be implemented for plants, plant products and other objects to reduce the risks of those pests to an acceptable level.

[2] Regulation (EU) 2016/2031 of the European Parliament of the Council of 26 October 2016 on protective measures against pests of plants, amending Regulations (EU) No 228/2013, (EU) No 652/2014 and (EU) No 1143/2014 of the European Parliament and of the Council and repealing Council Directives 69/464/EEC, 74/647/EEC, 93/85/EEC, 98/57/EC, 2000/29/EC, 2006/91/EC and 2007/33/EC. OJ L 317 23.11.2016, p. 4-104.
[3] Commission Implementing Regulation (EU) 2019/2072 of 28 November 2019 establishing uniform conditions for the implementation of Regulation (EU) 2016/2031 of the European Parliament and the Council, as regards protective measures against pests of plants, and repealing Commission Regulation (EC) No 690/2008 and amending Commission Implementing Regulation (EU) 2018/2019. OJ L 319, 10.12.2019, p. 1–279.

3 Commission Implementing Regulation (EU) 2018/2019[4] establishing a provisional list of high-risk plants, plant products or other objects, within the meaning of Regulation (EU) 2016/2031 Article 42 and a list of plants for which phytosanitary certificates are not required for introduction into the EU, within the meaning of Article 73 of that Regulation. Plants, plant products and other objects listed in Annex I are considered to be high-risk plants, plant products and other objects within the meaning of Regulation (EU) 2016/2031 Article 42(1), and their introduction into EU territory is prohibited pending a risk assessment. Article 2 states that a phytosanitary certificate is required for the introduction into the EU of plants, other than the plants included in the list referred to in Regulation (EU) 2016/2031 Article 72(1). However, fruit listed in Annex II are excluded from this requirement.

7.2 General regulations for palms (Arecaceae) and ornamental plants

According to the Commission Implementing Regulation 2019/2072, different requirements apply to the selected palms and ornamental host plants (Tables 10 and 11).

Table 10: Specific regulatory requirements for commodities of palms (Arecacae) known to be hosts of at least one of the species in Table 1

Plant species	Regulation
Palmae	Commission Implementing Regulation (EU) 2019/2072, Annex VII, sets special requirements for the introduction of plants for planting of Palmae other than seeds, originating in third countries other than exceptions, in respect to palm lethal yellowing phytoplasmas and *Myndus crudus*, and coconut cadang-cadang viroid (point 55).
Brahea spp. *Brahea armata* *Brahea edulis*	Commission Implementing Regulation (EU) 2019/2072, Annex X, sets special requirements for the introduction into, or movement within protected zones (Ireland, Malta, United Kingdom (northern Ireland)), of plants for planting of Palmae, having a diameter of the stem at the base of over 5 cm and belonging to genus Brahea Mart., in respect to *Paysandisia archon* (point 30). Commission Implementing Regulation (EU) 2019/2072, Annex X, sets special requirements for the introduction into, or movement within protected zones (Ireland, Portugal (Azores), United Kingdom (northern Ireland)), of plants for planting of Palmae, having a diameter of the stem at the base of over 5 cm and belonging to taxa *Brahea armata* and *B. edulis*, in respect to *Rhynchophorus ferrugineus* (point 31).
Butia spp. *Butia capitata*	Commission Implementing Regulation (EU) 2019/2072, Annex X, sets special requirements for the introduction into, or movement within protected zones (Ireland, Malta, United Kingdom (northern Ireland)), of plants for planting of Palmae, having a diameter of the stem at the base of over 5 cm and belonging to genus *Butia* Mart., in respect to *Paysandisia archon* (point 30). Commission Implementing Regulation (EU) 2019/2072, Annex X, sets special requirements for the introduction into, or movement within protected zones (Ireland, Portugal (Azores), United Kingdom

[4] Commission Implementing Regulation (EU) 2018/2019 of 18 December 2018 establishing a provisional list of high risk plants, plant products or other objects, within the meaning of Article 42 of Regulation (EU) 2016/2031 and a list of plants for which phytosanitary certificates are not required for introduction into the Union, within the meaning of Article 73 of that Regulation. C/2018/8877 OJ L 323, 19.12.2018, p. 10–15.

	(northern Ireland)), of plants for planting of Palmae, having a diameter of the stem at the base of over 5 cm and belonging to taxon *Butia capitata*, in respect to *Rhynchophorus ferrugineus* (point 31).
Chamaerops sp. *Chamaerops humilis*	Commission Implementing Regulation (EU) 2019/2072, Annex X, sets special requirements for the introduction into, or movement within protected zones (Ireland, Malta, United Kingdom (northern Ireland)), of plants for planting of Palmae, having a diameter of the stem at the base of over 5 cm and belonging to genus *Chamaerops* L., in respect to *Paysandisia archon* (point 30). Commission Implementing Regulation (EU) 2019/2072, Annex X, sets special requirements for the introduction into, or movement within protected zones (Ireland, Portugal (Azores), United Kingdom (northern Ireland)), of plants for planting of Palmae, having a diameter of the stem at the base of over 5 cm and belonging to taxon *Chamaerops humilis*, in respect to *Rhynchophorus ferrugineus* (point 31).
Copernicia spp.	Commission Implementing Regulation (EU) 2019/2072, Annex X, sets special requirements for the introduction into, or movement within protected zones (Ireland, Portugal (Azores), United Kingdom (northern Ireland)), of plants for planting of Palmae, having a diameter of the stem at the base of over 5 cm and belonging to taxon *Copernicia*, in respect to *Rhynchophorus ferrugineus* (point 31).
Howea forsteriana	Commission Implementing Regulation (EU) 2019/2072, Annex X, sets special requirements for the introduction into, or movement within protected zones (Ireland, Portugal (Azores), United Kingdom (northern Ireland)), of plants for planting of Palmae, having a diameter of the stem at the base of over 5 cm and belonging to taxon *Howea forsteriana*, in respect to *Rhynchophorus ferrugineus* (point 31).
Jubaea sp. *Jubaea chilensis*	Commission Implementing Regulation (EU) 2019/2072, Annex X, sets special requirements for the introduction into, or movement within protected zones (Ireland, Malta, United Kingdom (northern Ireland)), of plants for planting of Palmae, having a diameter of the stem at the base of over 5 cm and belonging to genus *Jubaea* Kunth, in respect to *Paysandisia archon* (point 30). Commission Implementing Regulation (EU) 2019/2072, Annex X, sets special requirements for the introduction into, or movement within protected zones (Ireland, Portugal (Azores), United Kingdom (northern Ireland)), of plants for planting of Palmae, having a diameter of the stem at the base of over 5 cm and belonging to taxon *Jubaea chilensis*, in respect to *Rhynchophorus ferrugineus* (point 31).
Livistona spp. *Livistona australis*	Commission Implementing Regulation (EU) 2019/2072, Annex X, sets special requirements for the introduction into, or movement within protected zones (Ireland, Malta, United Kingdom (northern Ireland)), of plants for planting of Palmae, having a diameter of the stem at the base of over 5 cm and belonging to genus *Livistona* R. Br., in respect to *Paysandisia archon* (point 30). Commission Implementing Regulation (EU) 2019/2072, Annex X, sets special requirements for the introduction into, or movement within protected zones (Ireland, Portugal (Azores), United Kingdom (northern Ireland)), of plants for planting of Palmae, having a diameter of the stem at the base of over 5 cm and belonging to taxa *Livistona australis*, *L. decora* and *L. rotundifolia* in respect to *Rhynchophorus ferrugineus* (point 31).

Phoenix spp. *Phoenix canariensis* *Phoenix dactylifera* *Phoenix reclinata* *Phoenix roebelenii* *Phoenix rupicola* *Phoenix sylvestris* *Phoenix theophrasti*	Commission Implementing Regulation (EU) 2019/2072, Annex VI, prohibits the introduction of plants of *Phoenix* spp. other than fruit and seeds, from Algeria and Morocco. Commission Implementing Regulation (EU) 2019/2072, Annex X, sets special requirements for the introduction into, or movement within protected zones (Ireland, Malta, United Kingdom (northern Ireland)), of plants for planting of Palmae, having a diameter of the stem at the base of over 5 cm and belonging to genus *Phoenix* L., in respect to *Paysandisia archon* (point 30). Commission Implementing Regulation (EU) 2019/2072, Annex X, sets special requirements for the introduction into, or movement within protected zones (Ireland, Portugal (Azores), United Kingdom (northern Ireland)), of plants for planting of Palmae, having a diameter of the stem at the base of over 5 cm and belonging to taxa *Phoenix canariensis*, *P. dactylifera*, *P. reclinata*, *P. roebelenii*, *P. sylvestris* and *P. theophrasti*, in respect to *Rhynchophorus ferrugineus* (point 31).
Sabal palmetto	Commission Implementing Regulation (EU) 2019/2072, Annex X, sets special requirements for the introduction into, or movement within protected zones (Ireland, Portugal (Azores), United Kingdom (northern Ireland)), of plants for planting of Palmae, having a diameter of the stem at the base of over 5 cm and belonging to taxon *Sabal palmetto*, in respect to *Rhynchophorus ferrugineus* (point 31).
Syagrus spp. *Syagrus romanzoffiana*	Commission Implementing Regulation (EU) 2019/2072, Annex X, sets special requirements for the introduction into, or movement within protected zones (Ireland, Malta, United Kingdom (northern Ireland)), of plants for planting of Palmae, having a diameter of the stem at the base of over 5 cm and belonging to genus *Syagrus* Mart., in respect to *Paysandisia archon* (point 30). Commission Implementing Regulation (EU) 2019/2072, Annex X, sets special requirements for the introduction into, or movement within protected zones (Ireland, Portugal (Azores), United Kingdom (northern Ireland)), of plants for planting of Palmae, having a diameter of the stem at the base of over 5 cm and belonging to taxon *Syagrus romanzoffiana*, in respect to *Rhynchophorus ferrugineus* (point 31).
Trachycarpus spp. *Trachycarpus fortunei*	Commission Implementing Regulation (EU) 2019/2072, Annex X, sets special requirements for the introduction into, or movement within protected zones (Ireland, Malta, United Kingdom (northern Ireland)), of plants for planting of Palmae, having a diameter of the stem at the base of over 5 cm and belonging to genus *Trachycarpus* H. Wendl., in respect to *Paysandisia archon* (point 30). Commission Implementing Regulation (EU) 2019/2072, Annex X, sets special requirements for the introduction into, or movement within protected zones (Ireland, Portugal (Azores), United Kingdom (northern Ireland)), of plants for planting of Palmae, having a diameter of the stem at the base of over 5 cm and belonging to taxon *Trachycarpus fortunei*, in respect to *Rhynchophorus ferrugineus* (point 31).
Washingtonia spp.	Commission Implementing Regulation (EU) 2019/2072, Annex X, sets special requirements for the introduction into, or movement within protected zones (Ireland, Malta, United Kingdom (northern Ireland)), of plants for planting of Palmae, having a diameter of the stem at the

	base of over 5 cm and belonging to genus *Washingtonia* Raf., in respect to *Paysandisia archon* (point 30). Commission Implementing Regulation (EU) 2019/2072, Annex X, sets special requirements for the introduction into, or movement within protected zones (Ireland, Portugal (Azores), United Kingdom (northern Ireland)), of plants for planting of Palmae, having a diameter of the stem at the base of over 5 cm and belonging to taxon *Washingtonia*, in respect to *Rhynchophorus ferrugineus* (point 31).

Table 11: Specific regulatory requirements for commodities of the ornamental plants known to be hosts of at least one of the species listed in Table 1

Plant species	Regulation
Herbaceous species, other than bulbs, corms, plants of the family Poaceae, rhizomes, seeds, tubers, and plants in tissue culture	Commission Implementing Regulation (EU) 2019/2072, Annex VII, sets special requirements for the introduction into the Union territory, of plants for planting of herbaceous species, other than bulbs, corms, plants of the family Poaceae, rhizomes, seeds, tubers, and plants in tissue culture, from third countries, in respect to *Nemorimyza maculosa* (point 8).
Herbaceous perennial plants for planting, other than seeds, of the families Caryophyllaceae (except *Dianthus* L.), Compositae (except *Chrysanthemum* L.), Cruciferae, Leguminosae and Rosaceae (except *Fragaria* L.)	Commission Implementing Regulation (EU) 2019/2072, Annex VII, sets special requirements for the introduction into the Union territory of herbaceous perennial plants for planting, other than seeds, of the families Caryophyllaceae (except *Dianthus* L.), Compositae (except *Chrysanthemum* L.), Cruciferae, Leguminosae and Rosaceae (except *Fragaria* L.), from third countries other than exceptions, in respect to harmful bacteria, viruses and virus-like organisms, and signs or symptoms of harmful nematodes, insects, mites and fungi (point 9).
Chrysanthemum spp.	Commission Implementing Regulation (EU) 2019/2072, Annex VII, sets special requirements for the introduction into the Union territory of plants for planting of *Chrysanthemum*, from all third countries, in respect to Chrysanthemum stem necrosis virus (point 26). Commission Implementing Regulation (EU) 2019/2072, Annex VII, sets special requirements for the introduction into the Union territory of cut flowers of *Chrysanthemum*, from all third countries, in respect to *Nemorimyza maculosa* (point 28).

8 Trade and import

No specific database is available to address the market movement of palm trees and ornamental plant species at the level of Member States. Information is available on the plants for planting pathway as a whole (Table 12), without specifying plants for planting of Palmae. There is more detailed information on the trade of date fruits (fruits of *P. dactylifera*) and on palm oil trade. France, Germany and Spain are the biggest importers of date fruits, and Germany, Italy and

Spain are the biggest importers of palm oil in the EU (Eurostat, 2024a). Spain is the only EU Member State with cultivated date production (Table 13) (FAO, online).

Regarding ornamental plants, the flower market of the EU is very developed and globally relevant. The market comprises fresh or dried cut flowers, seedlings, saplings, shrubs, bulbs, corms, rhizomes and other types of planting material, foliage – present in the composition of bouquets, potted plants – for interior decoration, etc. The statistical data show that the EU accounts for 10% of the world's cultivation area for flowers and 31% of the production value of flowers and potted plants for the year 2016 (Chiurciu et al., 2018). The Netherlands is by far the biggest producer of ornamental plants in the EU, currently followed by Italy, Germany, Spain and France (Table 14) (Eurostat, 2024b). The value of flowers and ornamental plants production in the EU is projected at EUR 9,159 billion (AIPH Statistical Yearbook, 2022). The highest production value shares in 2019 were: 30% the Netherlands; 13% Italy, Germany; 12% France; 10% Spain; 3% Belgium (European Commission, 2020).

The main countries importing floriculture products from the EU are Germany (29.7%), the UK (12.7%) and France (13%). As far as the EU exports of floriculture products are concerned, in 2016 they reached a value of EUR 2,025,486,000. The category 'cut flowers' and 'cut foliage' accounted for 33.4% of total exports, calculated at EUR 677,114. Also in 2016, the other categories recorded the following values: 'potted plants' EUR 552,066,000 (27.3%); 'bulbs and corms' EUR 538,990,000 (26.6%), 'conifers and perennial plants' EUR 257,316,000, amounting to 12.7%. The main flowers exported by the EU in 2016 were: chrysanthemums 49% (291,315,825 items), roses 40% (235,661,803 items), carnations 7% (43,215,754 items), lilies 3% (16,687,900 items) and 1% orchids (5,272,501) (Table 15) (Chiurciu et al., 2018).

Table 12: The quantity of plants for planting expressed in kilograms imported into each EU Member State from extra-EU countries and from other EU Member States. The category 'plants for planting' considered here includes: (i) already and not yet planted, bonsai, aquatic plants and carnivorous plants; (ii) cuttings; (iii) underground organs (EFSA et al., 2023b)

Member State	Extra-EU	Intra-EU	Total
Austria	73,710	4,215,148	2,296,456
Belgium	85,364	8,204,155	3,007,866
Bulgaria	149,283	282,451	217,744
Croatia	171,283	1,730,186	949,434
Cyprus	82,302	303,914	181,161
Czechia	52,126	2,535,671	1,030,982
Denmark	74,754	2,823,684	1,319,785
Estonia	4,157	322,321	213,561
Finland	37,605	1,672,976	923,795
France	50,575	11,984,590	3,818,382
Germany	105,077	27,895,107	7,908,267
Greece	36,612	1,037,155	600,298
Hungary	70,646	1,647,707	699,604
Ireland	43,245	1,715,731	862,033
Italy	187,930	5,933,207	2,022,523

Member State	Extra-EU	Intra-EU	Total
Latvia	15,415	710,641	460,580
Lithuania	32,382	1,635,030	1,055,349
Luxembourg	2,234	696,534	585,347
Malta	7,363	483,800	336,638
Netherlands	1,298,536	11,595,427	3,897,607
Poland	52,555	4,989,772	1,982,822
Portugal	82,794	2,401,673	1,027,047
Romania	144,128	3,035,451	1,866,718
Slovakia	83,961.37	965,884.88	665,506.97
Slovenia	76,761.38	639,007.76	404,824.41
Spain	256,231	3,557,123	1,218,653
Sweden	29,046	3,892,587	1,846,898

Table 13: Historical production of dates in the EU (2013–2017) (FAO, online)

Member State	Production (t)	Area (ha)
Spain (2013)	2,872	588
Spain (2014)	4,000	700
Spain (2015)	2,929.48	603
Spain (2016)	1,975	577
Spain (2017)	1,848	492

Table 14: Areas cultivated in the EU with flowers and ornamental plants (excluding nurseries) (values in ha) (Eurostat, 2024a)

Member State	2018	2019	2020	2021	2022
Austria	350	350	34	430	420
Belgium	5,380	5,230	3,060	3,250	3,250
Bulgaria	0	0	0	0	0
Croatia	300	300	190	180	210
Cyprus	90	100	50	60	60
Czechia	240	220	290	210	220
Denmark	300	100	100	220	230
Estonia	10	10	10	10	20

Finland	0	0	0	0	0
France	8,840	8,740	5,070	5,004	5,005
Germany	6,900	6,900	6,900	6,600	6,400
Greece	440	440	440	440	440
Hungary	680	810	990	730	680
Ireland	200	190	210	200	220
Italy	8,340	8,310	6,700	6,380	6,730
Latvia	100	100	100	0	0
Lithuania	150	150	100	0	140
Luxembourg	10	20	20	10	30
Malta	40	40	70	70	70
Netherlands	34,430	34,300	34,450	35,130	36,023
Romania	310	320	280	350	310
Poland	5,700	8,770	4,800	4,800	2,380
Portugal	3,170	3,170	2,000	2,000	2,000
Slovakia	140	160	10	0	0
Slovenia	0	30	50	40	40
Spain	6,220	6,190	6,090	5,950	6,100
Sweden	180	180	180	180	180
Total					71,400

Table 15: The selling price of some floral species in some Member States (expressed in EUR/100 items) in 2016 (Eurostat, 2024b)

Member State	Chrysanthemums	Roses	Carnations	Gladioli	Tulips
Belgium	33.98	31.19	21.17	29.65	16.82
France	33.40	72.60	47.20	88.30	112.70
Hungary	49.31	44.83	13.92	15.14	14.01
Latvia	72.93	56.88	56.88	32.83	35.38
Netherlands	28.00	39.47	20.00	17.00	18.54

Portugal	33.77	27.89	9.25	44.74	31.04
Romania	49.88	49.22	35.41	39.64	42.76

References

AIPH Statistical Yearbook (2022). International statistics flowers and plants yearbook. Volume 70, compiled by Finn Awisus, Centre for Business Management in Horticulture and Applied Research, Leibniz University, Hanover, Germany.

Allbed A, Kumar L and Shabani F, 2017. Climate change impacts on date palm cultivation in Saudi Arabia. The Journal of Agricultural Science, 155(8), 1203–1218.

Andrzejak R and Janowska B, 2022. *Trichoderma* spp. improves flowering, quality, and nutritional status of ornamental plants. International Journal of Molecular Sciences, 23(24), 15662.

Audsley N, Soroker V and Colazza S, 2017. Introduction. In: Soroker V and Colazza S (eds.), Handbook of major palm pests: Biology and Management. John Wiley & Sons, pp. 17–18.

Barba-González R, Tapia-Campos E, Soria Arteaga S, Vargas Merino HK and Rodríguez-Domínguez JM, 2023. From wild species to ornamental crops: a never-ending story. Acta Horticulturae, 1383:, 1–10.

Barry D, 1961. Notes on the hardiness of palms on the French Riviera. Principes, 5, 100–110.

Bethke JA and Cloyd RA, 2009. Pesticide use in ornamental production: what are the benefits? Pest Management Science, 65, 345–350.

Broschat TK, 1994. Nutrition of ornamental palms. Acta Horticulturae, 360, 217–222.

Broschat TK, 1999. Nutrition and fertilization of palms. Palms, 43, 73-76.

Broschat TK, Elliot ML and Hodel DR, 2014. Ornamental palms: Biology and horticulture. Horticultural Reviews, 42, 1–120.

CABI (Centre for Agriculture and Bioscience International), online. CABI Compendium. Wallingford, CABI. Available online: https://www.cabidigitallibrary.org/journal/cabicompendium [Accessed: 12 February 2024].

Caudullo G and Welk E and San-Miguel-Ayanz J, 2017. Chorological maps for the main European woody species. Data in Brief, 12, 662–666.

Chao CT and Krueger RR, 2007. The date palm (*Phoenix dactylifera* L.): Overview of biology, uses, and cultivation. HortScience, 42(5), 1077–1082.

Chihaoui-Meridja S, Harbi A, Abbes K, Chaabane H, La Pergola A, Chermiti B and Suma P, 2020. Systematicity, persistence and efficacy of selected insecticides used in endotherapy to control the red palm weevil *Rhynchophorus ferrugines* (Olivier, 1790) on *Phoenix canariensis*. Phytoparasitica, 48, 75–85.

Chiurciu IA, Zaharia I, Soare E, Dobre C and Morna AA, 2018. Research on the European flower market and main symbolic values of the most traded species. Scientific Papers-Series Management Economic Engineering in Agriculture and Rural Development, 18(2), 107–118.

Cockshull KE and Hughes AP, 1971. The effect of light intensity at different stages in flower initiation and development of *Chrysanthemum morifofium*. Annals of Botany, 35. 915–926.

Cullen J, Knees SG, Cubey HS, 2011. The European garden flora: Manual for the identification of plants cultivated in Europe, both out-of-door and under glass. Second edition. Cambridge University Press, , Cambridge, UK.

Daughtrey M and Benson DM, 2005. Principles of plant health management for ornamental plants. Annual Review of Phytopathology, 43(1), 141–169.

De Corato U, 2020. Disease-suppressive compost enhances natural soil suppressiveness against soil-borne plant pathogens: A critical review. Rhizosphere, 13, 100192.

De Jong J, 1978. Invloed temperatuur op bloei jaarondchrysanten. Vakblad voor de Bloemisterij, 5, 64–65.

Dembilio O, Quesada-Moraga E, Santiago-Álvarez C and Jacas JA, 2010. Potential of an indigenous strain of entomopathogenic fungus *Beauveria bassiana* (Ascomycota; Hypocreales) against the red palm weevil, *Rhynchophorus ferrugineus* (Coleoptera: Curculionidae). Journal of Invertebrate Pathology, 104, 214–221.

Dransfield J, Uhl NW, Asmussen CB, Baker WJ, Harley MM, and Lewis CE, 2008. *Genera Palmarum* – the evolution and classification of palms. Kew: Royal Botanic Gardens, London, UK.

EFSA (European Food Safety Authority), Chiumenti M and Graziosi I, 2023a. Pest survey card on coconut cadang-cadang viroid. EFSA supporting publication 2023:EN-8041. doi:10.2903/sp.efsa.2023.EN-8041.

EFSA (European Food Safety Authority), Andrea Battisti, Francesco Pecori, Davide Rassati, Alberto Santini, Alice Delbianco, Ignazio Graziosi, Melanie Camilleri, 2023b. Characterisation of conifers in the EU: a tool for crop-based survey of Union quarantine pests. EFSA supporting publication 2023:EN-8471. doi:10.2903/sp.efsa.2023.EN-8471.

Eiserhardt WL, Svenning J-C, Kissling WD and Balslev H, 2011. Geographical ecology of the palms (Arecaceae): determinants of diversity and distributions across spatial scales. Annals of Botany, 108, 1391–1416.

Essl F, 2019. First records of causal occurrences of Chinese windmill palm *Trachycarpus fortunei* (Hook.) H. Wendl. in Austria. BioInvasions Records, 8(3), 471–477.

European Commission, 2020. Horticultural Products, Flowers and ornamental plants – production, Statistics 2010-2019, Working Document, DGAGRI-G2, 10 February 2020.

Eurostat, 2024a. Statistical data on crop production in EU standard humidity, flowers and ornamental plants (excluding nurseries). Available online: https://ec.europa.eu/eurostat/databrowser/view/apro_cpsh1/default/table?lang=en&category=agr.apro.apro_crop.apro_cp.apro_cpsh[Accessed: 12 February 2024].

Eurostat, 2024b. Agricultural prices and price indices, selling prices of agricultural products (absolute prices). Available online: https://ec.europa.eu/eurostat/databrowser/view/apri_ap_crpouta/default/table?lang=en&category=agr.apri.apri_ap[Accessed: 12 February 2024].

FAO (Food and Agriculture Organization), online. FAOSTAT Statistical Database. FAO, Rome. Available online: https://www.fao.org/faostat/en/#data/QCL [Accessed: 12 February 2024].

Farooq S, Maqbool MM, Bashir MA, Ullah MI, Shah RU, Ali HM, Al Farraj DA, Elshikh MS, Hatamleh AA, Bashir S and Wang Y-F, 2021. Production suitability of date palm under changing climate in a semi-arid region predicted by CLIMEX model. Journal of King Saud University – Science, 33, 101394.

Fehr V and Burga CA, 2016. Aspects and causes of earlier and current spread of *Trachycarpus fortunei* in the forests of southern Ticino and northern Lago Maggiore (Switzerland, Italy). Palms, 60, 125–136.

Ferry M, Cousin R, Chabernaud D and Ferrero F, 2019. An effective strategy to obtain very rapidly the red palm weevil decline in an area planted with ornamental palms. Arab Journal of Plant Protection, 37(2), 188–197.

Ferry M, Gòmez S, Jimenez E, Navarro J, Ruiperez E and Vilella J, 2002. The date palm grove of Elche, Spain: research for the sustainable preservation of a World Heritage Site. Palms, 46(3), 139–148.

Francesca N, Alfonzo A, Lo Verde G, Settanni L, Sinacori M, Lucido P and Moschetti G, 2015. Biological activity of *Bacillus* spp. evaluated on eggs and larvae of red palm weevil *Rhynchophorus ferrugineus*. Annals of Microbiology, 65, 477–485.

Fried G, Caño L, Brunel S, Beteta E, Charpentier A, Herrera M, Starfinger U and Panetta FD, 2016. Monographs on Invasive Plants in Europe: *Baccharis halimifolia* L. Botany Letters, 163(2), 127–153.

Garcerán T, 2007. El gran libro de las palmeras. Especies y variedades – cultivo – prevención y tratamiento de las enfermedades. De Vecchi, Barcelona, Spain.

García-Castaño JL, Terrab A, Ortiz MA, Stuessy TF and Talavera S, 2014. Patterns of phylogeography and vicariance of *Chamaerops humilis* L. (Palmae). Turkish Journal of Botany, 38(6), 1132–1146.

GBIF (Global Biodiversity Information Facility), online. GBIF Backbone Taxonomy [dataset]. Available online: https://doi.org/10.15468/39omei [Accessed: 12 February 2024].

Gómez S, Ferry M, Barbado J, Hernández F and Montero F, 2009. Aplicación de una estrategia de control integrado del picudo rojo de las palmeras (*Rhynchophorus ferrugineus*). Phytoma España, 206, 29–36.

Gullino ML and Garibaldi A, 2007. Critical aspects in management of fungal diseases of ornamental plants and directions in research. *Phytopathologia Mediterranea*, 46(2), 135–149.

Hack H, Bleiholder H, Buhr L, Meier U, Schnock-Fricke U, Weber E and Witzenberger A, 1992. The extended BBCH-Scale. In: Meier U (ed.), Growth stages of mono- and dicotyledonous plants BBCH Monograph, Federal Biological Research Centre for Agriculture and Forestry. Wissenschafts-Verlag, Berlin, Germany.

Haeuser E, Dawson W, Thuiller W, Dullinger S, Block S, Bossdorf O, Carboni M, Conti L, Dullinger I, Essl F, Klonner G, Moser D, Münkemüller T, Parepa M, Talluto VM, Kreft H, Pergl J, Pyšek P, Weigelt P, Winter M, Hermy M, Van der Veken S, Roquet C and van Kleunen M, 2018. European ornamental garden flora as an invasion debt under climate change. Journal of Applied Ecology, 55, 2386–2395.

Hammer K, 2011. European crop wild relative diversity. International Journal of AgriScience, 1, 340–342.

Heywood VH and Zohary D, 1995. A catalogue of the wild relatives of cultivated plants native to Europe. Flora Mediterranea, 5, 375–415.

Hidén C and Larsen RU, 1994. Predicting flower development in greenhouse grown chrysanthemum. Scientia Horticulturae, 58, 123–138.

Hosek L-K and Roloff A, 2016. Species site matching: Selecting palms (Arecaceae) for urban growing spaces. Urban Forestry & Urban Greening, 2016, 20: 113-119.

Huylenbroeck JV and Bhattarai K, 2022. Ornamental plant breeding: Entering a new era? Ornamental Horticulture, 28, 297–305.

INBO (Research Institute for Nature and Forest), online. DAISIE – Inventory of alien invasive species in Europe. Available online: https://www.gbif.org/dataset/39f36f10-559b-427f-8c86-2d28afff68ca [Accessed: 12 February 2024].

Karlsson MG, Heins RD, Erwin JE, Berghage RD, Carlson WH and Biernbaum JA, 1989. Temperature and photosynthetic photon flux influence chrysanthemum shoot development and flower initiation under short-day conditions. Journal of American Society for Horticultural Science, 114, 158–163.

Katan J, 2015. Soil solarization: the idea, the research and its development. Phytoparasitica, 43, 1–4.

Khoshbakht K and Hammer K, 2008. How many plant species are cultivated? Genetic Resources and Crop Evolution, 55, 925–928.

Koukounaras A, 2021. Advanced greenhouse horticulture: New technologies and cultivation practices. Horticulturae, 7, 1.

Larcher W and Winter A, 1981. Frost susceptibility of palms: Experimental data and their interpretation. Principes, 25(4), 143–152.

Llácer E, Martínez de Altube MM and Jacas JA, 2009. Evaluation of the efficacy of *Steinernema carpocapsae* in a chitosan formulation against the red palm weevil, *Rhynchophorus ferrugineus*, in *Phoenix canariensis*. BioControl, 54, 559–565.

MacLeod A and Hussein M, 2017. Economic and social impact of *Rhynchophorus ferrugineus* and *Paysandisia archon* on palms. In: Soroker V and Colazza S (eds). Handbook of major palm pests: Biology and management, John Wiley & Sons, Chichester, UK, pp. 54–68.

Manachini B, Schillaci D and Arizza B, 2013. Biological responses of *Rhynchophorus ferrugineus* (Coleoptera: Curculionidae) to *Steinernema carpocapsae* (Nematoda: Steinernematidae). Journal of Economic Entomology, 106, 1582–1589.

Martens O, 1970. Observations of frost damage at a palm nursery. Principes, 14, 66-68.

Mayer K, Haeuser E, Dawson W, Essl F, Kreft H, Pergl J, Pyšek P, Weigelt P, Winter M, Lenzner B and van Kleunen M, 2017. Naturalization of ornamental plant species in public green spaces and private gardens. Biological Invasions, 19, 3613–3627.

Merlo ME, Alemán MM, Cabello J and Peñas J, 1993. On the Mediterranean fan palm (*Chamaerops humilis*). Principes, 37, 151–158.

Morici C, 1998. *Phoenix canariensis* in the wild. Principes, 42(2), 85–93.

Nishad R and Ahmed TA, 2020. Survey and identification of date palm pathogens and indigenous biocontrol agents. Plant Disease, 104, 2498–2508.

Nurashikin-Khairuddin W, Aishikin Abdul SN, Saiful Mansor M, Bharudin I, Othman Z and Jalinas J, 2022. A review of entomopathogenic nematodes as a biological control agent for red palm weevil, *Rhynchophorus ferrugineus* (Coleoptera: Curculionidae). Insects, 13(3), 245.

Obón C, Rivera D, Alcaraz F, Carreño E, Ríos S, Laguna E, Sánchez-Balibrea J, del Arco M, Bergmeier E and Johnson D, 2018. What are palm groves of *Phoenix*? Conservation of *Phoenix* palm groves in the European Union. Biodiversity and Conservation, 27, 1905–1924.

Orsino F and Olivari S, 1987. The presence of *Chamaerops humilis* L. on Portofino promontory (East Liguria). Webbia, 41(2), 261–272.

Pittenger DR, Downer AJ, Hodel DR and Mochizuki M, 2009. Estimating water needs of landscape palms in Mediterranean climates. HortTechnology, 19, 700–704.

PlantNET (The NSW Plant Information Network System), online. Royal Botanic Gardens and Domain Trust, Sydney. Available online: https://plantnet.rbgsyd.nsw.gov.au/ [Accessed: 12 February 2024].

Popenoe J, 1973. The hardiest palms. Fairchild Tropical Garden Bulletin, 28(2), 11–14.

POWO (Plants of the World Online), online. Facilitated by the Royal Botanic Gardens, Kew. Available online: htpps://www.plantsoftheworldonline.org/ [Accessed: 12 February 2024].

Reichgelt T, West CK and Greenwood DR, 2018. The relation between global palm distribution and climate. Scientific Reports, 8, 4721.

Riffle RL, Craft P and Zona S, 2012. An Encyclopaedia of Cultivated Palms. Timber Press, Portland, USA.

Rivera D, Obón C, Alcaraz F, Carreño E, Laguna E, Amorós A, Johnson DV, Díaz G and Morte A, 2015. Date palm status and perspective in Spain. In: Al-Khayri JM, Jain SM and Johnson DV (eds). Date palm genetic resources and utilization: Volume 2: Asia and Europe. Springer Science, pp. 489–526.

Rochat D, Dembilio O, Jaques JA, Suma P, La Pergola A, Hamidi R, Kontodimas D, Soroker V, 2017. *Rhynchophorus feerrugineus*: Taxonomy, distribution, biology, and life cycle. In: Soroker V and Colazza S (eds). Handbook of major palm pests: Biology and management, John Wiley & Sons, Chichester, UK, pp. 69–104.

Shabani F, Kumar L and Taylor S, 2012. Climate change impacts on the future distribution of date palms: A modelling exercise using CLIMEX. PLoS One, 7, e48021.

Shabani F, Kumar L and Taylor S, 2015. Distribution of date palms in the middle east based on future climate scenarios. Experimental Agriculture, 51, 244–263.

Smith D, 1958. Cold tolerance of the cultivated palms. Principes, 2, 116–126.

Spennemann DHR, 2018. Geographical distribution of the four key ornamental and production palm species *Phoenix canariensis*, *P. dactylifera*, *Washingtonia filifera* and *W. robusta*. A Data Set. Institute for Land, Water and Society, Charles Sturt University, Albury, NSW.

Spennemann DHR, 2021. The role of Canary Island Date Palms in physical amenity provisioning for urban landscape settings. Horticulturae, 7, 201.

Steven DD, Windsor DM, Putz FE and de Leon B, 1987. Vegetative and reproductive phenologies of a palm assemblage in Panama. Biotropica, 19(4), 342–356.

Tapia G, Ruiz MA and Téllez MM, 2011. Recommendations for a preventive strategy to control red palm weevil (*Rhynchophorus ferrugineus*, Olivier) based on the use of insecticides and entomopathogenic nematodes. OEPP/EPPO Bulletin 41, 136–141.

Tonellotto M, Fehr V, Conedera M, Hunziker M and Pezzatti GB, 2022. Iconic but invasive: The public perception of the Chinese windmill palm (*Trachycarpus fortunei*) in Switzerland. Environmental Management, 70, 618–632.

Uhl NW and Dransfield J, 1987. Genera palmarum. Allen Press, Lawrence, Kan, UK.

Vamvoukakis JA, 1988. *Phoenix theophrasti* on Crete. Principes, 32, 82–83.

Van Der Ploeg A and Heuvelink E, 2006. The influence of temperature on growth and development of chrysanthemum cultivars. The Journal of Horticultural Science and Biotechnology, 81(2), 174–182.

Vainstein A, 2002. Breeding for ornamentals: Classical and molecular approaches. Kluwer Academic Publishers, Amsterdam, The Netherlands.

Walther GR, 2002. Die Verbreitung der Hanfpalme *Trachycarpus fortunei* im Tessin 50 Jahre nach der Erstaufnahme. Schweizerische Beiträge zur Dendrologie, 47,29–41.

Walther GR, Gritti ES, Berger S, Hickler T, Tang ZY and Sykes MT, 2007. Palms tracking climate change. Global Ecology and Biogeography, 16, 801–809.

Wani MA, Din A, Nazki IT, Rehman TU, Al-Khayri JM, Jain SM, Lone RA, Bhat ZA and Mushtaq M 2023. Navigating the future: exploring technological advancements and emerging trends in the sustainable ornamental industry. Frontiers in Environmental Science, 11, 1188643.

Wazen N, Garavaglia V, Picard N, Besacier C and Fady B, 2020. Distribution maps of twenty-four Mediterranean and European ecologically and economically important forest tree species compiled from historical data collections. Annals of Silvicultural Research, 44(2), 95–101.

Woo SL, Ruocco M, Vinale F, Nigro M, Marra R, Lombardi N, Pascale A, Lanzuise S, Manganiello G and Lorito M, 2014. *Trichoderma*-based products and their widespread use in agriculture. Open Mycology Journal, 8, 71–126.

Zaid A and Oihabi A, 2022. Origin and distribution of the Mejhoul date variety. In: Zaib A and Oihabi A (eds), Mejhoul variety, the jewel of dates – origin, distribution and international markets, Khalifa International Award for Date Palm and Agricultural Innovation, United Arab Emirates.

Zona S, 2008. The horticultural history of the Canary Island Date Palm (*Phoenix canariensis*). Garden History, 36, 301–308.

Relevant EFSA outputs

- Index of the EFSA Plant Pest Survey Toolkit: https://efsa.europa.eu/plants/planthealth/monitoring/surveillance/index
- Characterisation of crops in the EU: https://efsa.europa.eu/plants/planthealth/monitoring/surveillance/characterisation-crops-eu