EPPO Datasheet: *Rhynchophorus ferrugineus*

Last updated: 2020-04-22

IDENTITY

Preferred name: *Rhynchophorus ferrugineus*
Authority: (Olivier)
Taxonomic position: Animalia: Arthropoda: Hexapoda: Insecta: Coleoptera: Dryophthoridae
Other scientific names: *Calandra ferruginea* (Fabricius), *Curculio ferrugineus* Olivier, *Rhynchophorus signaticollis* Chevrolat
Common names: Asiatic palm weevil, coconut weevil, palm weevil, red palm weevil, red stripe weevil
view more common names online...
EPPO Categorization: A2 list
view more categorizations online...
EU Categorization: Emergency measures (formerly), PZ Quarantine pest ((EU) 2019/2072 Annex III), RNQP ((EU) 2019/2072 Annex IV)
EPPO Code: RHYCFE



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Notes on taxonomy and nomenclature

The genus *Rhynchophorus* contains ten species, of which seven are known to attack palms (Booth *et al*., 1990, Wattanapongsiri, 1966), including, in addition to *R. ferrugineus*, the EPPO A1 listed pest *Rhynchophorus palmarum* (OEPP/EPPO, 2005). Reginald (1973) considers *R. ferrugineus* as the typical *Rhynchophorus* species. A number of records previously attributed to *R. ferrugineus* are now thought likely to be *R. vulneratus* or *R. bilineatus* (CABI/EPPO, 2016).

HOSTS

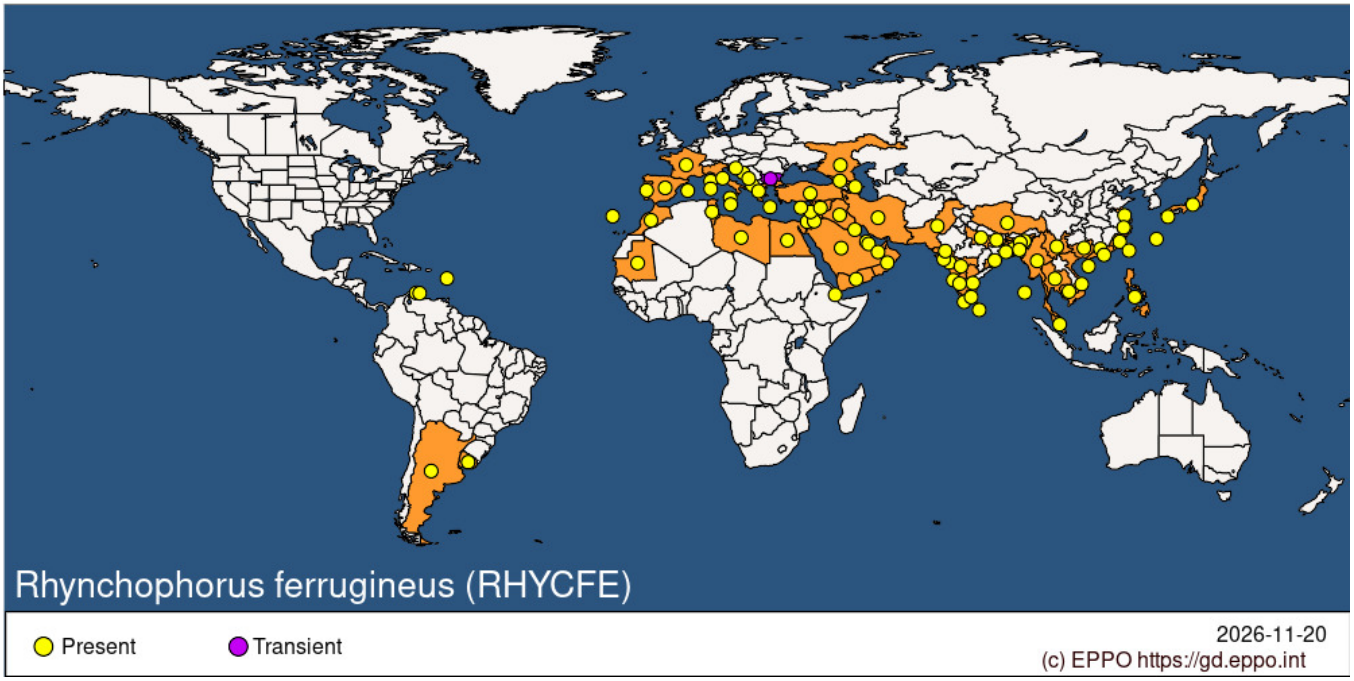
R. ferrugineus is essentially a pest of palms (Arecaceae). The host range of *R. ferrugineus* has increased tenfold since the mid-1950s when Nirula (1953) reported the pest on only four palm species as compared to its present host range of over 40 palm species (Anonymous, 2013). Preferred hosts of the pest in different parts of the world have been *Cocos nucifera* (coconut), *Phoenix dactylifera* (date palm) and *Phoenix canariensis* (Canary palm) (Esteban-Duran *et al.*, 1998). When introduced into new areas, *R. ferrugineus* has attacked a wide range of palms used for ornamental purposes. In addition to palms, *R. ferrugineus* has been recorded on *Strelitzia nicolai* (Fiorello *et al*., 2015). Records on the non-Arecaceae species *Saccharum officinarum* (sugarcane) and *Agave americana* were related to experiments, and *R. ferrugineus* has not been found attacking these plants in the field to date.

Host list: *Agave americana, Areca catechu, Arecaceae, Arenga pinnata, Bismarckia nobilis, Borassus flabellifer, Brahea armata, Brahea edulis, Butia capitata, Calamus merrillii, Caryota cumingii, Caryota maxima, Chamaerops humilis, Cocos nucifera, Corypha umbraculifera, Corypha utan, Dictyosperma album, Elaeis guineensis, Howea forsteriana, Jubaea chilensis, Livistona chinensis, Livistona decora, Livistona saribus, Livistona subglobosa, Metroxylon sagu, Oncosperma horridum, Oncosperma tigillarium, Phoenix canariensis, Phoenix dactylifera, Phoenix sylvestris, Phoenix theophrasti, Pritchardia pacifica, Roystonea regia, Sabal palmetto, Saccharum officinarum, Strelitzia nicolai, Syagrus romanzoffiana, Trachycarpus fortunei, Washingtonia filifera, Washingtonia robusta*

GEOGRAPHICAL DISTRIBUTION

R. ferrugineus originates from South and Southeast Asia. However, since the 1980s its geographical range has been expanding, as the pest invaded other parts of the world, including the EPPO region and the Near East, as well as

parts of Northern Africa and of the Caribbean. Ecological niche modeling has predicted that *R. ferrugineus* can expand its global range still further (Fiaboe *et al*., 2012).



EPPO Region: Albania, Azerbaijan, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, France (mainland, Corse), Georgia, Greece (mainland, Kriti), Israel, Italy (mainland, Sardegna, Sicilia), Jordan, Malta, Montenegro, Morocco, Portugal (mainland, Madeira), Russian Federation (Southern Russia), Spain (mainland, Islas Baleares), Tunisia, Türkiye
Africa: Djibouti, Egypt, Libya, Mauritania, Morocco, Tunisia
Asia: Bahrain, Bangladesh, Cambodia, China (Fujian, Guangdong, Guangxi, Hainan, Jiangsu, Xianggang (Hong Kong), Xizhang, Yunnan, Zhejiang), India (Andaman and Nicobar Islands, Andhra Pradesh, Assam, Bihar, Damman, Diu, Goa, Gujarat, Karnataka, Kerala, Maharashtra, Meghalaya, Odisha, Tamil Nadu, Tripura, Uttar Pradesh, West Bengal), Iran, Islamic Republic of, Iraq, Israel, Japan (Honshu, Kyushu, Ryukyu Archipelago), Jordan, Kuwait, Lebanon, Malaysia (West), Myanmar, Oman, Pakistan, Philippines, Qatar, Saudi Arabia, Sri Lanka, Syrian Arab Republic, Taiwan, Thailand, United Arab Emirates, Vietnam, Yemen
Central America and Caribbean: Aruba, Guadeloupe, Netherlands Antilles
South America: Argentina, Uruguay

BIOLOGY

Adults of *R. ferrugineus* are active during the day and night, although flight and crawling is generally restricted to daytime. Leefmans (1920) reported that adults are capable of long flights and can find their host plants in widely separated areas; his studies suggested that they can detect breeding sites at distances of at least 900 m. Flight mill studies have demonstrated that *R. ferrugineus* has the capacity to fly up to 50 km in a day with flight activity being predominantly diurnal. However, most individuals within a population are short distance fliers (<100 m) which would explain the aggregated/clumped distribution of infestation (Faleiro *et al.*, 2002; Ávalos *et al.*, 2014; Hoddle *et al.*, 2015).

Mating takes place at any time of day, and males and females mate many times during their lifetime. The pre-oviposition period lasts 1–7 days. Oviposition is generally confined to the softer portions of the palm and continues for approximately 45 days. During this period, the adult female lays over 200 eggs. Oviposition in *R. ferrugineus* is strongly affected by temperature and less than one generation per year can be expected in areas with a mean annual temperature (MAT) below 15^{O}C, and more than two generations in those with MAT above 19^{O}C and several overlapping generations of the pest may occur inside a single infested palm (Dembilio & Jacas, 2012).The pest gains entry into a palm when female weevils are attracted to palm tissue volatiles to lay eggs that hatch into damage-inflicting grubs. Fresh wounds on frond bases (petioles) attract gravid females for oviposition which results in

infestation (Abraham *et al*., 1998; Faleiro 2006). Eggs are laid in wounds along the trunk or in petioles, and also in wounds caused by the beetle *Oryctes rhinoceros*.

On hatching, the apodal larvae begin feeding towards the interior of the palm. In palms up to 5 years old, the larvae may be found in the bole, stem or crown. As palms advance in age, the grubs are generally confined to the portions of the stem close to the growing point. In palms more than 15 years old, the larvae are generally found in the stem about 1 m below the crown, in the crown and bases of leaf petioles. In India, the larval period is 36–78 days (average 55 days) (Nirula *et al*., 1953). In the Mediterranean region, larval development can be completed in about 40 days in summer and up to 160 days in winter-spring (Dembilio & Jacas, 2012). Jaya *et al*. (2000) recorded seven larval instar stages when *R. ferrugineus* was reared on sugarcane. In Spain, Dembilio and Jacas (2012) recorded 13 larval instar stages. When about to pupate, larvae construct an oval-shaped cocoon of fibre (Menon & Pandalai, 1960).

The complete life cycle of the weevil, from egg to adult emergence, takes an average of 82 days in India (Menon & Pandalai, 1960). After emergence from the pupal case, the adult remains inside the cocoon for 4–17 days (average 8 days) (Menon & Pandalai, 1960). According to Hutson (1933), it becomes sexually mature during this period of inactivity. Adults live 2–3 months, irrespective of sex. In captivity, the maximum life span of the adult was 76 days for the female and 113 days for the male. It has been suggested that a single pair of weevils can theoretically give rise to more than 53 million progeny in four generations in the absence of controlling factors (Leefmans, 1920; Menon & Pandalai, 1960). In Egypt, El Ezaby (1997) reported that the weevil has three generations per year, the shortest generation (first) of 100.5 days and the longest (third) of 127.8 days. The study also showed that the upper temperature threshold of the egg was 40°C. In the Mediterranean basin countries, it takes 2–3 generations before a Canary Island palm (*P. canariensis*) or a date palm (*P. dactylifera*) will be killed by an *R. ferrugineus* infestation. Depending on temperature, these generations can take place in one single year, but often require a minimum of 2 years.

For laboratory rearing of adults, freshly shredded sugarcane tissue served both as food and oviposition medium can be used (Rananavare *et al*., 1975). Rahalkar *et al*. (1978) reported that an artificial diet containing sugarcane bagasse, coconut cake, yeast, sucrose, essential minerals and vitamins, agar, water and food preservatives could be used for the weevil. More recently, *R. ferrugineus* was reared on a meridic diet consisting of agar, distilled water, commercial yeast as well as laboratory produced amino and fatty acid rich brewer's yeast (*Saccharomyces cerevisiae*), wheat meal, corn flour, benzoic acid, ascorbic acid, sorbic acid, vitamin mix and tetracycline hydrochloride (El-Shafie *et al.*, 2013).

DETECTION AND IDENTIFICATION

Symptoms

The pest affects stems and growing points. It is very difficult to detect *R. ferrugineus* in the early stages of infestation. Generally, it is detected only after the palm has been severely damaged. Careful observation may reveal the following signs, which are indicative of the presence of the pest: holes in the crown or trunk from which chewed-up fibres are ejected (this may be accompanied by the oozing of brown viscous liquid); crunching noise produced by the feeding grubs can be heard when the ear is placed to the trunk of the palm; withered bud/crown.

Morphology

Eggs

Creamy white, oblong, shiny; average size 2.62 x 1.12 mm (Menon & Pandalai, 1960). Eggs hatch in 3 days and increase in size before hatching (Reginald, 1973). The brown mouth parts of the larvae can be seen through the shell before hatching.

Larvae

Up to 35 mm long; brown head, white body composed of 13 segments; mouthparts well developed and strongly chitinized; average length of fully-grown larvae 50 mm, and width (in middle) 20 mm.

Pupae

Pupal case 50–95 x 25–40 mm; prepupal stage of 3 days and pupal period of 12–20 days; pupae cream, then brown, with shiny surface, greatly furrowed and reticulated; average size 35 x 15 mm.

Adults

Reddish brown, about 35 x 10 mm, with long curved rostrum; dark spots on upper side of thorax; head and rostrum comprising about one third of total length. In male, dorsal apical half of rostrum covered by a patch of short brownish hairs; in female, rostrum bare, slenderer, curved and a little longer than in male (Menon & Pandalai, 1960). See Booth *et al*. (1990) for a full description.

The morphological identification of *R. ferrugineus* is described in the EPPO diagnostic protocol for *Rhynchophorus ferrugineus* and *Rhynchophorus palmarum* (OEPP/EPPO, 2007).

Detection methods

Visual inspection to detect infested palms is still the most common detection practice. Regular 45-day interval inspection of palms in the susceptible age group (less than 20 years old) is essential to break the cycle of the pest by locating infested palms before adults emerge (FAO, 2020).

Adult weevils are attracted to food baited pheromone traps (Hallett *et al.*, 1993; Oehschlager, 2016), indicating the presence of the pest in the vicinity. Conventional light traps do not attract *R. ferrugineus* (Sadakathulla & Ramachandran, 1992).

Advanced techniques such as detecting chemical signatures, acoustic detection, use of infrared cameras, thermal imaging, satellite imaging/IoT, sniffer dogs, are being researched (Pugliese *et al.*, 2018; Mankin, 2017; Soroker *et al.* , 2017, FAO, 2019). To increase the overall efficiency and speed of detection, there is a need for further testing and refinement of promising detection technologies to develop a quick, reliable, cost-effective and easy-to-handle early detection device for *R. ferrugineus* (FAO, 2019).

PATHWAYS FOR MOVEMENT

Import and movement of infested plant material within a country are the main pathways to the introduction and spread of *R. ferrugineus*. The pest can be spread over long distances in infested plants for planting of host palms. Short-distance spread is possible by adult flight (see under *Biology*).

PEST SIGNIFICANCE

Economic impact

R. ferrugineus is a lethal pest of palms. It has caused massive losses in Asia, the Middle East and the Mediterranean area, including on *Cocos nucifera* (coconut), *Phoenix dactylifera* (date palm) and *P. canariensis* (Canary palm), which are the main palm species infested by this pest, as well as also attacking other palm species worldwide (see host range above). In the Mediterranean basin, *R. ferrugineus* has become the major pest of palms, in particular on *Phoenix canariensis* which is very sensitive (Dembilio *et al.*, 2009). *R. ferrugineus* has also caused extensive damage to several world heritage palm sites, such as in Elche in Spain and Siwa in Egypt.

Direct losses due to *R. ferrugineus* are due to the loss of palms and the reduction in yield, as well as to the high cost of management programs. In 2009, the loss incurred by the removal of severely infested palms in the Gulf region of the Middle East was estimated to 5.18 to 25.92 million USD (at 1 and 5% infestation, respectively). In the period 2004-2009, in the autonomous community of Valencia (Spain), around 20 000 palms (mostly *P. canariensis*) were killed by *R. ferrugineus*, and losses were estimated to be 16 million EUR (FAO-CIHEAM, 2017).

Furthermore, indirect costs are also substantial. The most significant of these is due to the restricted movement of trees, especially their offshoots, resulting in drastic reduction in trade. In addition, chemical treatments and removal of the infested palms have negative impact on the environment and landscape, respectively, as well as on ecosystem services (FAO-CIHEAM, 2017).

Control

FAO (2020) provides guidelines for the management of *R. ferrugineus*.

Chemical control

Preventive and curative chemical treatments are widely practiced for the control of *R. ferrugineus*.

Preventive: Preventive chemical treatments should only be carried out in areas with high weevil activity as gauged from high infestation and removal of infested palms, high trap captures, and high seasonal activity. It is recommended to treat all fresh wounds on palm trees, in particular immediately after frond and offshoot removal (Barranco *et al.,* 1998; Faleiro, 2006; Dembilio *et al*., 2015; Al-Dosary *et al.,* 2016; FAO, 2019). Regular, periodic and preventive insecticide treatments are often unnecessary and excessive.

Curative: Palms in the early stage of attack can recover with insecticide treatment (Cabello *et al.,* 1997; Ferry & Gomez, 2014; Aldawood *et al.,* 2013; Gomez & Ferry, 2019). The simple diffusion method consists of pouring an insecticide solution into holes drilled around the infested site on the palm. The treatment should be repeated after 15 days. Several pressure injectors are available on the market, but these should be used with extreme caution to avoid rupture of palm tissue that can lead to death of the treated palm. Only a limited number of stem injections may be carried out in ornamental palms, while stem injection cannot be performed in palms grown as food crops (Ferry & Gomez, 2014).

Biological control

The current *R. ferrugineus* control program, could be significantly strengthened if the known biological control agents (Mazza *et al.*, 2014), could be delivered to the target site and sustained in the field. However, for the moment, no biological control solutions have been successful when applied at a significant field scale and for a long period of time (FAO, 2019). Although various parasitic mites have been reported in India as parasites of *R. ferrugineus* (Nirula *et al*., 1953; Peter, 1989, Al-Deeb *et al*., 2011), these are only phoretic in nature (Al-Deeb *et al*., 2011). Reports from Spain suggest that the entomopathogenic nematodes *Steinernema* sp. (Dembilio *et al*., 2010) and the entomopathogenic fungi *Beauveria bassiana* (G?erri-Agulló *et al*., 2011) are promising in the field.

Cultural and sanitary methods

FAO (2019) emphasized the need to adopt good agronomic practices with respect to frond and offshoot removal, irrigation, palm density and field sanitation to minimize the build-up of *R. ferrugineus* in the field. Although, palm cultivars are reported to be tolerant or susceptible to *R. ferrugineus* (Dembilio *et al.,* 2009; Al-Ayedh, 2008; Faleiro *et al*., 2014), this has not been exploited in the field.

Pheromones and other behavioural chemicals

Pheromones are increasingly being used as a management tool against *R. ferrugineus*. Protocols for pheromone-based mass trapping of the weevil using food-baited pheromone traps are provided by Hallett *et al*. (1999). Subsequently, several other *R. ferrugineus* pheromone-trapping protocols have also been reported (Faleiro, 2006; Al-Saoud, 2013; Vacas *et al.*, 2014, Soroker *et al.,* 2015; Oehlschlager, 2016). It is essential to adopt the best trapping protocols for *R. ferrugineus* food baited pheromone traps with respect to trap design, colour, trap surface, trapping density, trap servicing (bi-weekly replacement of the food bait and water). Efforts need to be made towards development of synthetic lures that stand alone without the use of natural food baits. In this context, *R. ferrugineus* trapping techniques, involving 'Attract and Kill' (El-Shafie *et al.*, 2011) or the use of the Electrap^{TM} (Al-Saroj *et al.* , 2017) are efficient in capturing adult *R. ferrugineus*. Automatic data collection and transmission on weevil captures involving smart traps needs further improvement (Aldryhim & Al-Ayedh, 2015). Weevil captures in pheromone

traps and infestation reports could be used to assess the spatial and temporal spread of *R. ferrugineus* using Geographic Information System (GIS) and this is important for decision making to assess the performance of the control strategy (Fajardo *et al*., 2017).

Although *R. ferrugineus* pheromone traps are known to curtail the build-up of the pest in the field (Vidhyasagar *et al*. , 2000a), only about 35 % of the test insects (males and females) in controlled olfactometer assays were attracted to the pheromone (El-Shafie & Faleiro, 2017), indicating that pheromone trapping alone cannot be relied upon to control *R. ferrugineus*, but should be deployed with other management tactics.

Sterile insect technique

Though there has been some research on use of sterile insect techniques against *R. ferrugineus* (Rahalkar *et al*., 1973, 1975; Ramachandran, 1991), this has not led to any practical applications. As most of the adults are known to mate before emerging from the brood (Abraham *et al.*,2001), any control strategy of *R. ferrugineus* involving population reduction through mating (SIT, Release of Insects with Lethal Dominant Gene-RILD) are bound to have limited success in the field.

IPM programmes

Area-wide integrated pest management for *R. ferrugineus* has been widely practiced in several countries. *R. ferrugineus*-IPM was developed and tested in coconut palms in India and subsequently on date palms in Saudi Arabia (Kurian *et al*., 1976; Sathiamma *et al*., 1982, Abraham *et al*., 1989, 1998). The main components of an IPM programme against *R. ferrugineus* are: surveillance with regular inspection of palms to detect infestations and trapping the weevil using pheromones lures; cultural measures such as plant and field sanitation; physical methods (preventing entry of weevils through cut ends of petioles and wounds); use of attractants and other chemicals; preventive and curative chemical treatments; removal of severely infested palms. In Saudi Arabia, an IPM programme was successfully developed which, in addition to mass pheromone trapping, included a survey of all cultivated gardens, systematic checking of all palms for infestation, periodic soaking of palms with insecticide, and mass removal of palms from neglected farms (Abraham *et al*., 2000; Vidyasagar *et al*.,2000b). Reviews of control strategies and IPM for *R. ferrugineus* have also been presented by various other authors (Nair *et al*., 1998; Ramachandran, 1998; Murphy & Briscoe, 1999, Faleiro, 2006; Al-Dosary *et al*., 2016; Milosavljevi? *et al*., 2018). Reports on successful area-wide *R. ferrugineus*-IPM are available from several countries including Israel, United Arab Emirates and Saudi Arabia (Soroker *et al*., 2005; El-Ezaby *et al*., 1998; Al-Shawaf *et al*., 2012; Hoddle *et al*., 2013).

Containment and eradication

Recent country reports on the successful containment and eradication of *R. ferrugineus* come from Mauritania on date palm and the Canary Islands (FAO, 2019), as well as from Slovenia (EPPO, 2020 [Global Database]).

Phytosanitary risk

R. ferrugineus attacks many species of palms and causes serious damage by killing individual trees. It can probably become a serious pest in any EPPO country where palms are widely cultivated. *R. ferrugineus* has spread to many countries of the EPPO region. On the basis of experience in Spain, Esteban-Duran *et al*. (1998) warned that *R. ferrugineus* could readily be introduced into other countries of the EPPO region with imported plants for planting. All date-producing countries are particularly at risk, and Mediterranean countries which grow palms as amenity trees in towns and on sea fronts also face a serious risk (Hamburger *et al*., 2003; Faleiro, 2006; FAO, 2019).

Several other *Rhynchophorus* spp. attack palms in different parts of the world, in particular *Rhynchophorus bilineatus* and *Rhynchophorus vulneratus* in Southeast Asia, *Rhynchophorus phoenicis* in tropical Africa and *Rhynchophorus palmarum* in Central and South America. *R. palmarum* is already on the EPPO A1 List (OEPP/EPPO, 2005). The risk from the other species has not been evaluated in detail. *R. ferrugineus* is probably the species which is potentially most damaging in practice. In addition, no native *Rhynchophorus* species are found on palms in the EPPO region.

PHYTOSANITARY MEASURES

R. ferrugineus was added in 2005 to the EPPO A2 List of pests recommended for regulation as quarantine pests. Outbreaks have already occurred in several EPPO countries, and the pest has spread. It seems that, in the short term at least, domestic phytosanitary measures can contain outbreaks if they are detected sufficiently early (see containment and eradication above). However, it is clear that the best strategy for any uninfested area in the EPPO region is to exclude the pest by requiring appropriate phytosanitary measures, such as that imported plants for planting of palms originate from a pest-free area or pest-free place of production, or requirements on the type or size of plants. Within an infested country, measures should be applied, including the delimitation of infested areas and buffer zones, and regulation of the movement of palm trees or offshoots from infested areas (FAO, 2020).

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