Threat of the Red Palm Weevil, *Rhynchophorus ferrugineus* (Olivier) to Date Palm Plantations in North Africa

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Abstract

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The Maghreb region of North Africa comprising of Morocco, Algeria, Tunisia, Mauritania and Libya accounts for 15% of the global date production. The region has tried to avoid attack of the red palm weevil (RPW) *Rhynchophorus ferrugineus* (Olivier) until December, 2008, when RPW was reported from the Tangier region in Northern Morocco. This was remarkable considering that the region is in the vicinity of Egypt in Africa and Spain in Europe where RPW was reported in the mid 1990s. In addition to date palm, the region has several Canary Island Palms, one of the most preferred hosts of the weevil. Previous experiences from the Gulf region in the Middle-East and the Mediterranean countries have shown that RPW had spread rapidly through infested planting material transported mainly for ornamental purposes and date palm farming. RPW was detected from Morocco in December, 2008, in Libya (May, 2009) and in Tunisia (December, 2011) and is a potential threat to both date palm and Canary Island Palm in these countries. This paper describes its status as well as proposes a strategy to combat the threat of the spread of RPW in the region.

Keywords: Red palm weevil, *Rhynchophorus ferrugineus*, Maghreb region, Morocco, Libya, Tunisia

Status of Date Palm Plantations in the Maghreb Region

The Maghreb region of North Africa has contributed some of the best known commercial date varieties (Madjoul and Deglet Nour) and still has an excellent potential for date palm farming in spite of the presence of Bayoud, a lethal disease of palms, caused by *Fusarium oxysporum albedinis* which destroyed 12 million palms in Morocco and 3 million palms in Algeria (17). Recent occurrence of the red palm weevil (RPW), *Rhynchophorus ferrugineus* (Olivier) in the Maghreb countries (Morocco (December, 2008), Libya (May, 2009) and Tunisia (December, 2011)) (13, 19 and 42) and its spread if not curtailed poses a major threat along with Bayoud disease to the date palm plantations of the region.

There has been a significant increase in the area under date palm in the Maghreb region of North Africa which has almost doubled during the last two decades (29) (Table 1). Date farming plays an important role in the agrarian economy of the region. In Tunisia, 12% of the population depends on date farming for their livelihood (12). RPW is reported to mostly infest young date palms less than 20 years old (2). Commercial date plantations accommodate 100 palms/hectare at spacing of 10x10 m (12). At this plant density, the Maghreb region is estimated to have 25 million palms, producing nearly 0.8 million tone of dates (Table 1).

In the last 20 years (1987-2007), an additional area of 120,430 ha has been brought under date cultivation in the region, with an estimated 12 million palms (29). These young plantations, in the susceptible age group of less than 20 years, are estimated to account nearly 50% of the total area of date palm in the Maghreb countries (Table 1).

Host Range and Geographical Spread of RPW

Host Plants - host range of RPW as reported by Nirula (37) has significantly increased from just four palm species (*Cocos nucifera*, *Phoenix dactylifera*, *Metroxylon sagu* and *Corypha umberaculifera*) in the mid 1950's to 40 palm species can be infested as recently reported from Portugal (http://www.savealgarvepalms.com/en/weevil-facts/host-palm-trees); (*Areca catechu*, *Arenga saccharifera*, *A. engleri*, *A. pinnata*, *Bismarckia nobilis*, *Borassus flabellifer*, *B.* sp., *Brahea armata*, *B. edulis*, *Butia capitata*, *Calamus merrillii*, *Caryota cumingii*, *C. maxima*, *Cocos nucifera*, *Corypha utan*, (= *C. gebanga*, *C. elata*), *C. umbraculifera*, *Chamærops humilis*, *Elæis guineensis*, *Livistona australis*, *L. decipiens*, *L. chinensis*, *L. saribus* (= *L. cochinchinensis*), *L. subglobosa*, *Metroxylon sagu*, *Oncosperma horrida*, *O. tigillarium*, *Phoenix canariensis*, *P. dactylifera*, *P.* roebelinii, *P. sylvestris*, *P. theophrastii*, *Pritchardia pacifica*, *P. hillebrandii*, *Ravenea rivularis*, *Roystonea regia*, *Sabal umbraculifera*, *Trachycarpus fortune*, *Washingtonia filifera*, *W. robusta*, *Syagrus romanzoffiana*) (23, 24, 35 and 40).

Variety Preference - the Canary Island Palm, *Phoenix canariensis*, Date Palm, *Phoenix dactylifera* and Coconut, *Cocos nucifera* are the most preferred hosts of this pest. *Chamaerops humilis* is reported to be resistant to RPW in Spain (11), while *Washingtonia filifera* and *C. humilis* to be resistant to RPW due to antibiotic and antixenotic mechanisms, respectively (15).

Table 1. Cultivated area with date palm and production of dates in the Maghreb countries

Country	Cultivated area (ha)* 1987	2007	Area with date palm < 20years old (ha)	Palms < 20 years old (million)	% increase in area since 1987	Yield (tones)*
Algeria	73,000	140,000	67,000	6.7	47.86	468,000
Morocco	22,100	36,000	13,900	1.4	38.61	52,000
Tunisia	20,000	39,830	19,830	2.0	49.79	120,000
Libya	15,000	30,000	15,000	1.5	50.00	175,000
Mauritania	3,500	8,200	4,700	0.5	57.31	22,000
Total	133,600	254,030	120,430	12.1	47.41	837,000

* Source: FAOSTAT (http://faostat.fao.org)

The date palm variety Mazafati was found to be the most preferred cultivar for RPW in Iran (30). Date varieties with high calcium levels were found to inhibit growth of RPW as compared to varieties with high sugar levels that enhanced egg laying and growth while reducing mortality of the pest (30). Choice test studies from Saudi Arabia indicated that the variety Khalas is highly preferred for egg laying by RPW as compared to the varieties Shahal and Murheim, which exhibiteda high degree of antixenosis (3). There are no reports on the preference/tolerance to RPW in Deglet Nour the most popular date variety in Tunisia and Algeria as also for several date varieties cultivated in the Maghreb countries.

Spread - spread of RPW in the Middle–Eastern and the Mediterranean region (Table 2) has been rapid since 1985 when the pest was reported from Ras–Al–Khaima in UAE (46), where it probably got introduced through infested planting material (ornamental palms) from South/South-East Asia. In Saudi Arabia, RPW was first detected in an ornamental nursery in Al Qatif in early 1987, from where it spread to the entire Kingdom through date palm offshoots and also through bigger palms transported for ornamental purposes (8). It crossed the red sea in early 1990's and was recorded in Egypt in 1992 and in Spain in 1995 (10 and 14). The entire Mediterranean basin is currently reporting RPW infestations mostly on *P. canariensis* (25 and 40). Previous experiences suggest that shipments of ornamental palms without quarantine certification have contributed significantly to the spread of RPW (25 and 39) (Figure 1).

The Maghreb region of North Africa is critically situated between several RPW infested countries including Egypt on the East, the Canary Islands on the West and European countries including Spain, Portugal, France and Italy in the North (42). This region has around 12 million date palms in the susceptible age group of less than 20 years (Table 1) and several avenue plantings/nurseries of *P. canariensis* offering RPW an ideal agro-climatic zone to establish and spread in the region. It is relevant to point out that during 2 years (2008-10), RPW was recorded in the Maghreb region (Tangier in Northern Morocco and Libya) (42), the American continent (Dutch Antilles Island in the Caribbean), Laguna Beach area of Orange County, California, USA and Eastern Europe (Georgia) (42). With regard to the Orange County report, lack of response by the weevil to the pheromone (ferrugineol) traps and limited spread of the weevil in the Laguna Beach area suggest that it may not be *Rhynchophorus ferrugineus*. However, all these reports are attributed to palms maintained (garden nurseries) or shipped for ornamental purposes. Reports from area-wide RPW-IPM programme in KSA indicated that 75% of the infested date palms are in the age group of 6 to 15 years (8 and 39). This is the age group of palms preferred for ornamental landscaping purposes as stated in the first report of RPW in the Caribbean Island of Curacao (Dutch Antilles) when date palms imported from Egypt for ornamental purposes (41 and 42). It is evident that the initial source of infestation occurred in most of the countries through imports of palms for ornamental purposes which subsequently spread to date palm plantations (42). Therefore, the Maghreb countries should impose a ban on the imports and regulate internal movement of palms for ornamental gardening.

Life Cycle of RPW

The entire life cycle of RPW is concealed inside the palm trunk except the partially exposed adult stage. Recently, Ju, *et. al.,* 2010 (33) reported from China that the host has a significant influence on the development survival and reproduction of RPW. Based on the population growth parameters of RPW studied in five palm species (*Phoenix canariensis*, *Washingtonia filifera*, *Phoenix silvestris*, *Butia capitata* and *Trachycarpus fortunei*) at a constant temperature of 26^{o}C, it was concluded that *P. canariensis* and *W. filifera* were the most suitable host plants while *P. silvestris* was least suitable.

Female weevils lay eggs mostly on wounds, cracks and crevices on the trunk from the collar region near the roots to the base of fronds near the crown of young date palms mostly below the age of 20 years (8). In Canary Island Palm infestation occurs in the crown, making detection of infestation extremely difficult. Reports from different laboratories suggest that a single RPW female lays 58-531 eggs (28-30^{o}C and 70-75% relative humidity). They incubated for 1–6 days, before hatching to legless larvae that inflict tissue damage. The larvae live for 25–105 days (1, 9 and 45). Larval instars unknown inside the palm trunk, in laboratory vary from 7-16 (4 and 32). The grubs on hatching move towards the interior of the palm leaving behind chewed up plant fibers (frass) which has a typical fermented odour. Grubs pupate in cocoons (approximately 80x35mm) made from chewed fibers. The pupal period ranges from 11-45 days. The duration of the life cycle from egg to adult stage was reported to vary from 45 days to 139 days while adult weevils were reported to live for 50-90 days (1, 9 and 45). Infested palms often harbor several overlapping generations comprising of different stages of

the insect. RPW population is highly aggregated in nature (27). Adult weevils are least active when extreme weather conditions prevail. In the Middle-East, RPW adults exhibit low activity during the peak of the summer and winter (25). In tropical South and South-East Asia where the pest was reported to be originated, RPW activity was low during the monsoon (25).

Nature of Damage and Symptoms of Infestation of RPW

The grubs on hatching tunnel into the plant tissue and damaged palms are reported by Abraham *et al*. (2) to exhibit one of the following symptoms depending on the stage of attack: (i) presence of tunnels on the trunk and base of leaf petiole, (ii) oozing out of thick brown fluid from the tunnels, (iii) appearance of chewed plant tissues in and around opening of tunnels with a typical fermented odour, (iv) fallen empty pupal cases and dead adults around a heavily infested palm, and (v) breaking of the trunk or toppling of the crown in case of severe and prolonged infestation. Infested offshoots of date palm become dry. El-Ezaby (18) categorized RPW infestation in date palm on a scale of 0-5, where zero represents palms showing no stages of the pest or damage symptoms, while five indicates advanced stage of attack where an infested palm topples. The above damage symptoms can be perceived either through sight, sound (caused by feeding of grubs) or by smelling the typical fermented odour of infested palm tissue. Currently there is no reliable gadget to detect infestation in the field. Sniffer dogs have been trained and used to detect infested palm in Israel (36).

Satellite aided Global Positioning System (GPS) using Geographical Information System (GIS) could serve as a valuable aid in tracking the spread of the pest by logging data on weevil activity (pheromone trap captures) and infestations.

Predisposing Factors for RPW Infestation and Build up

There are several factors that predispose date palm plantations to attack by RPW. Infestation begins with female weevils laying eggs on palm tissue. Usually, female weevils get attracted to plant volatiles released by fresh wounds on palm tissue after shaving of fronds and removal of offshoots (2, 7).

In particular the practice of repeated frond shaving in the Canary Island Palm for ornamental purposes leaves the palm vulnerable to attack by RPW. Root exposure at the collar region of the palm often attracts female weevils for egg laying. In-groove humidity has also been reported to influence the activity and infestation levels of RPW in date plantations of the Middle–East (5, 6). In-groove humidity levels could in turn be influenced by the type of irrigation (open flood/drip irrigation) and plant density. Often palms are planted at a distance less than the recommended spacing leading to reduced sunlight penetration there by enhancing the in-groove humidity levels leading to an ideal micro-climate for RPW. Maintaining palm and field sanitation is vital to prevent attack by RPW. In this context offshoot management is critical. Too many offshoots on a single palm render such palms inaccessible to inspection to detect infestation by RPW besides offering a conducive ecological niche for the pest to survive and multiply. Hidden breeding sites *viz* cut palms and closed gardens that are neglected and beyond periodical inspection are also potential sources for the pest to breed.

Integrated Pest Management (IPM) of RPW

With the synthesis and availability of the male produced aggregation pheromone ferrugineol (31) food baited pheromone traps have been extensively used to manage RPW. The main components of the strategy as outlined by Abraham *et al*. (2) in date palm are as follows:

i) Pest surveillance based on periodic field surveys of date palm plantations, avenue palm grooves and palm nurseries for detecting infestations. The pest can also be monitored through pheromone traps to locate adult weevil activity.
ii) Mass trapping of adults in endemic pockets.
iii) Locating infestations in the field by inspecting palms in the susceptible age (20 years old) for symptoms of infestation.
iv) Treating hidden breeding sites including neglected and closed gardens.
v) Maintaining palm and field sanitation.
vi) Preventive and curative chemical treatments.
vii) Eradicating severely infested palms.
viii) Implementing quarantine measures.
ix) Training and education.

IPM Program Against the Pest in the Maghreb Region

Eradication of Infested Palms - Since RPW recently recorded in the Maghreb region, all infested palms should be eradicated in situ at the site of the infestation. Transferring infested palms for eradication to another site away from the infested garden/avenue/nursery may result in the spread of the pest. Eradication should be carried out by shredding the infested palm to powder. Whenever this is not possible, breaking the infested palm into small pieces and soaking in insecticide is recommended. Care should be taken to ensure that all the stages of the pest are completely destroyed. It has been observed that palms eradicated by burning may still harbor the pest if complete burning of the palm is not ensured. In countries where RPW has established itself and several palms have to be eradicated, palm tissue pulverizing machines are used for this purpose. If infested palms have to be eradicated away from the infested garden, such palms have to be transported in closed trucks to ensure that adult weevils if any on the palms do not spread on the way.

Quarantine Measures - Implementing strict quarantine protocols for tackling the problem of RPW in the Maghreb region is crucial. The concealed and lethal nature of RPW calls for a ban of import of palms from infested farms/regions/countries. Where ever this is not possible implementing strict quarantine regimes with regard to transport/shipment of palms is essential. Faleiro (25)

suggested a nine month period for pre-departure (3 months) and post-entry (6 months) quarantine observations for palms, before imported planting material is certified as RPW free and cleared for planting in the field. As mentioned earlier, RPW was reported in Northern Morocco; which calls for strict internal quarantine in relation to transport of planting material within Morocco/ Libya/Tunisia and international quarantine regimes by the Maghreb countries should go a long way to check the threat of RPW in the region applied to both date palm and the Canary Island Palm. As the Maghreb region is surrounded by several RPW infested countries, it is assumed that the region already has strong quarantine regulations for import of palms, which have to be strengthened in light of the recent invasion of the pest in Morocco, Libya and Tunisia.

Pheromones for Monitoring and / or Mass Trapping - Pheromone trapping is an important component of the current RPW-IPM programme. This IPM component involves manipulation of insect behavior and it is vital to adopt the correct trapping protocols with regard to trap design, servicing (replacement of food bait and insecticide solution), trap density and lure longevity.

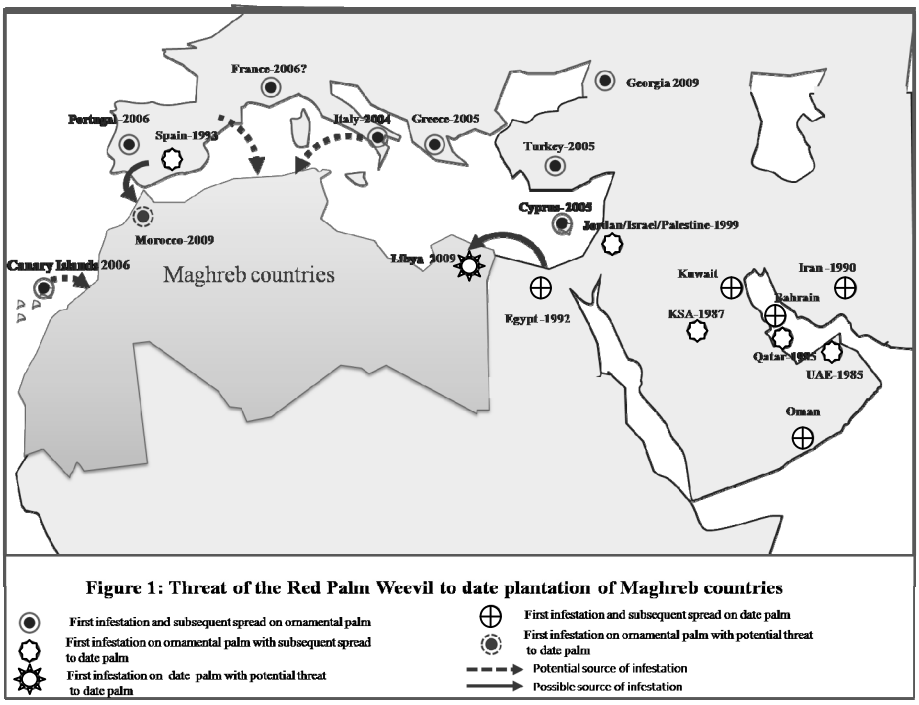

Figure 1: Threat of the Red Palm Weevil to date plantation of Maghreb countries

Table 2. First report of RPW-infestation in Middle-East, North African and Mediterranean countries

Country	Year of first infestation	Source of first infestation	Reference
UAE	1985	Palm (coconut) imports from South/ South-East Asia	(46)
Qatar	1985	Palm (coconut) imports from South/ South-East Asia	(46)
Saudi Arabia	1987	Ornamental palms in Al Qatif	(39)
Kuwait/Bahrain	1988-1993	Date offshoots /palms for ornamental gardening	(42)
Iran	1990	Date palm	(42)
Egypt	1992	Date palm	(14)
Jordan/Israel/Palestine	1999	Date palm/ *Phoenix canariensis*	(34)
Spain	1995	Date offshoots/ *Phoenix canariensis*	(10)
Canary Islands	2006	*Phoenix canariensis*	(21)
Greece	2005	*Phoenix canariensis*	(22, 42)
France	2006	*Phoenix canariensis*	(22)
Turkey	2005	*Phoenix canariensis*	(42)
Malta	2007	*Phoenix canariensis*	(16)
Cyprus	2006	*Phoenix canariensis*	(42)
Morocco	2008	*Phoenix canariensis*	(20, 42)
Georgia	2009	*Howea forsteriana* (syn. *Kentia forsteriana*)	(42)
Portugal	2006	*Phoenix canariensis*	(42, 44)
Libya	2009	*Washingtonia* sp.	(42)
Tunisia	2011	*Phoenix canariensis*	(13, 19)

Trapping efficiency is sustained by changing the food bait and insecticide solution every week. It is recommended to set the traps under shade so as to maintain a uniform and sustained release of chemical into the environment and replace lures when 5% of the lure remains in the dispenser. Pheromone lures have to be replaced faster in summer than in winter (28). Traps are to be hung to the palm trunks of old palms with hardened trunk tissue (>25 years old). Ground or surface trapping can also be practiced (38).

Monitoring of RPW can be achieved by setting traps at a density of 1 trap/hectare. High density monitoring of the pest was carried out in Israel at 3 traps/hectare (43). Mass trapping at density 1-10 traps/hectare has given the desired control in several countries, depending on the severity of the problem and available resources (25).

Chemical Treatments - Preventive insecticidal showers are essential on palms in the vicinity (100 m radius) of traps captured weevil (25). Palms within the early stage of infestation can be cured by cleaning the infested parts and blocked with mud and insecticide. However, we are doubtful of stem/trunk injection, which has been recommended by several workers, wherein insecticide solution is poured into the infested cavities through artificially drilled holes into the palm trunk so as to reach the cavity. Repeating the injection until the infestation is completely controlled is advisable. It is essential to closely monitor and certify the complete recovery of these palms. Transporting of treated and pest free planting material for farming and landscaping purposes is essential to sustain the achievements of control and also curtail spread of the weevil.

Initiative by FAO

Upon initial report of RPW in Morocco and Libya and in order to eradicate/control RPW in these countries and prevent its spread to other countries of the Maghreb region, the Food and Agriculture Organization (FAO) of the United Nations initiated a short expert consultation entitled "FAO, consultation for strengthening national capacities on the management of the red palm weevil in North Africa" during February, 2010 (26).

In the infested countries of Morocco and Libya the above mission recommended to implement (i) quarantine regulations banning imports of palms from abroad and movement of palms from the infested regions (Tangier in Morocco and Tabruk in Libya), (ii) a pheromone based strategy comprising of mass trapping adult weevils in the infested regions and surveillance in the major non-infested date plantations of Morocco and Libya , (iii) preventive insecticidal treatments and (iv) eradication of infested palms.

With respect to the non-infested countries, it was recommended to continue to implement a complete ban on import of palms from other countries, additionally taking up seasonal pheromone trap based surveillance in the date plantations and periodic sensitizing of important stake holders (quarantine and agricultural field technicians, prospectors/inspectors/custom officers, municipality officials, palm nursery dealers/hotel owners) on RPW and its management.

A network programme to share experiences on RPW research and control by the concerned national organizations of countries within the Maghreb region of North Africa will go a long way in combating RPW in the region.

With the infestation report from Tunisia in December 2011, FAO initiated a Technical Cooperation Program for the Maghreb region with a goal to develop a pest risk analyses for RPW and also enhance the capacity of national plant protection officials from these countries.

الملخص

فاليرو، ر. ج.، ع. بن عبد الله، م. بلاج، ع. العجلان، ع. الوهيبي. 2012. تهديد سوسة النخيل الحمراء لزراعة نخيل التمر في شمال أفريقيا. مجلة وقاية النبات العربية، 30: 274−280.

تنتج منطقة المغرب العربي في شمال أفريقيا والتي تضم كلاً من دول المغرب والجزائر وتونس وموريتانيا وليبيا نحو 15% من الإنتاج العالمي للتمور.. وتمكنت المنطقة من حماية نفسها من الإصابة بأخطر حشرة تصيب النخيل وهي سوسة النخيل الحمراء *Rhynchophorus ferrugineus* (Olivier) حتى كانون الأول/ديسمبر 2008 حينما ظهرت الإصابة بهذه الحشرة في مدينة طنجة بشمال المغرب. ومن الملاحظ أن منطقة المغرب العربي قريبة حدودياً من كل من مصر وإسبانيا والتي سُجلت الإصابة فيهما في منتصف 1990. فبالإضافة إلى زراعة نخيل التمر بمنطقة المغرب العربي، يُزرع أيضاً نخيل جزر الكناري، أحد أنواع نخيل الزينة المفضلة للسوسة. وقد أشارت التقارير السابقة في منطقة الخليج ودول بحر الأبيض المتوسط إلى أن سبب سرعة انتشار سوسة النخيل الحمراء أساساً هو نقل الفسائل المصابة لأغراض الزينة وزراعة نخيل التمر للإنتاج. لم تكتشف الإصابة بسوسة النخيل الحمراء في منطقة المغرب العربي إلا في الآونة الأخيرة ففي المغرب (كانون الأول/ديسمبر 2008)، وفي ليبيا (أيار/مايو، 2009) وفي تونس (كانون الأول/ديسمبر 2011). هنا نسلط الضوء على التهديد المحتمل من سوسة النخيل الحمراء لنخيل التمر ونخيل جزر الكناري في دول منطقة المغرب العربي ووضع السوسة بالمنطقة بالإضافة إلى اقتراح استراتيجية لمكافحة تهديدها وانتشارها بالمنطقة.

كلمات مفتاحية: سوسة النخيل الحمراء، *Rhynchophorus ferrugineus*، المغرب العربي، المغرب، ليبيا، تونس.

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References

1. **Abraham, V.A., J.R. Faleiro, C.P.R. Nair and S.S. Nair.** 2002. Present management technologies for red palm weevil *Rhynchophorus ferrugineus* Olivier (Coleoptera: Curculionidae) in palms and future thrusts. Pest Management in Horticultural Ecosystems, 8: 69-82.
2. **Abraham, V.A., M.A. Al Shuaibi, J.R. Faleiro, J. R., R.A. Abozuhairah and P.S.P.V. Vidyasagar.** 1998. An integrated approach for the management of red palm weevil, *Rhynchophorus ferrugineus* Oliv. a key pest of date palm in the Middle East.. Sultan Qaboos University Journal for Scientific Research, Agricultural Science, 3: 77-83.
3. **Al-Bakshi, M., S. Al-Saroj, Abdallah Ben Abdallah and J.R. Faleiro.** 2008. Extent of antixenosis in date palm for egg laying by red palm weevil *Rhyncophorus ferrugineus*. Indian Journal of Plant Protection, 36: 292-293.
4. **Al-Dhafer, H.M.H.** 1997. Biological and morphological characteristics of red palm weevil *Rhynchophorud ferrugineus* (Olivier) (Curculionidae: Coleoptera) in Saudi Arabia. M.S. Thesis. College of Agriculture, King Saud University, 126 pp.
5. **Aldryhim, Y. and A. Khalil.** 2003. Effect of humidity and soil type on survival and behavior of red palm weevil *Rhynchophorus ferrugineus* (Oliv.) adults. Sultan Qaboos University Journal for Scientific Research, Agricultural and Marine Sciences, 8: 87-90.
6. **Aldryhim, Y. and S. Al- Bukiri.** 2003. Effect of irrigation on within – grove distribution of red palm weevil *Rhynchophorus ferrugineus*. Sultan Qaboos University Journal for Scientific Research, Agricultural and Marine Sciences, 8: 47-49.
7. **Al-Hudaib, K., A.M . Al-Ajlan, A. Ben Abdullah and J.R. Faleiro.** 2008. Date palm farming practices in relation to red palm weevil, *Rhynchophorus ferrugineus* (Olivier) infestation in the Gulf region of the Middle East. Presented (Tele conference) in the Plant-Insect Ecosystems Symposium at the Annual Meeting of the Entomological Society of America at Reno, USA, November 18, 2008.
8. **Anonymous.** 1998. Final report of the Indian Technical Team (Part A), Red palm weevil control project, Ministry of Agriculture and Water, Kingdom of Saudi Arabia. 65 pp.
9. **Avand Faghih, A.** 1996. The biology of red palm weevil, *Rhynchophorus ferrugineus* Oliv. (Coleoptera: Cuculionidae) in Saravan region (Sistan and Balouchistan Province, Iran). Applied Entomology and Phytopathology, 63: 16-18.
10. **Barranco, P., J. De la Peña, and T. Cabello.** 1996. Un nuevo curculionido tropical para la fauna Europea, *Rhynchophorus ferrugineus* (Olivier 1790) (Coleoptera: Curculionidae). Boletin de la Asociacion Espanola de Entomologia, 20: 257-258.
11. **Barranco, P., J.A. De la Peña, M.M. Martín and T. Cabello.** 2000. Rango de hospedantes de *Rhynchophorus ferrugineus* (Olivier, 1790) y diámetro de la palmera hospedante (Coleoptera:Curculionidae). Boletin de Sanidad Vegetal Plagas, 26: 73-78.
12. **Ben Abdallah, A.** 1990. La phoeniciculture. Les systèmes agricoles oasiens. V. Dollé and G. Toutain. Tozeur, CIHEAM/CCE DG VIII**:** Pages 105-120.
13 **Chebbi, H.** 2011. First record of *Rhynchophorus ferrugineus* on *Phoenix canariensis* in Tunisia. Tunisian Journal of Plant Protection. 6(2): 1-5.
14. **Cox, M.L.** 1993. Red palm weevil, *Rhynchophorus ferrugineus* in Egypt. FAO Plant Protection Bulletin, 41: 30-31.
15. **Dembilio, O., J.A. Jacas and E. Llacer.** 2009. Are the palms of *Washingtonia filifera* and *Chamaerops humilis* suitable hosts for red palm weevil *Rhynchophorus ferrugineus* (Col. Curculionidae)? Journal of Applied Entomology, 133: 565-567.
16. **Department of Plant Health warns of red palm weevil threat** November 12, 2010 www.gozonews.com/item/department-of-plant-health-warns-of-red-palm-weevil-threat/
17. **Djerbi, M.** 1988. Les maladies du palmier dattier [Diseases of the date palm]. Report No: FAO-AGO--RAB/84/018**.** 151 pp.
18. **El Ezaby, F.A.** 1997. Injection as a method to control *Rhynchophorus ferrugineus*. Arab Journal of Plant Protection, 15: 31-38.
19 **EPPO (European and Mediterranean Plant Protection Organization)** November 1, 2011 www.eppo.org
20. **EPPO (European and Mediterranean Plant Protection Organization)** November 12, 2010 www.eppo.org
21. **EPPO.** 2008. Data sheets on quarantine pests: *Rhynchophorus ferrugineus*. EPPO Bulletin, 38: 55-59.
22. **EPPO Reporting Service.** 2006. First record of *Rhynchophorus ferrugineus* in France and Greece and Italy, 2006/225, 226 & 227.
23. **EPPO Reporting Service.** 2009. *Rhynchophorus ferrugineus* found on *Howea forsteriana* in Sicilia, Italy, No. 3 2009/051.
24. **Esteban-Duran, J., J.L. Yela, F. Beitia Crespo and A. Jimenez Alvarez.** 1998. Biology of red palm weevil, *Rhynchophorus ferrugineus* (Olivier) in the laboratory and field, life cycle, biological characteristics in its zone-of introduction in Spain, biological method of detection and possible control. (Coleoptera: Curculionidae: Rhynchophorinae). Boletin de Sanidad Vegetal Plagas, 24: 737-748.
25. **Faleiro, J.R.** 2006. A review of the issues and management of red palm weevil *Rhyncophorus ferrugineus* (Coleoptera: Rhynchophoridae) in coconut and date palm during the last one hundred

years. International Journal of Tropical Insect Science, 26: 135-154.

26. **Faleiro, J.R.** 2010. Consultancy Report, submitted to FAO on completion of a 21 day consultancy to strengthen national capacities for the management of the red palm weevil in North Africa. 43 pp.
27. **Faleiro, J.R., J. Ashok Kumar and P.A. Rangnekar.** 2002. Spatial distribution of red palm weevil *Rhynchophorus ferrugineus* Oliv. (Coleoptera: Cuculionidae) in coconut plantations. Crop Protection, 21: 171-176.
28. **Faleiro, J. R., M. Al Shuaibi, V.A. Abraham and T. Premkumar.** 1999. A technique to assess the longevity of the palm weevil pheromone (Ferrolure) under different conditions in Saudi Arabia. Sultan Qaboos University Journal for Scientific Research, Agricultural Science, 4: 5-9.
29. **FAOSTAT.** November 12, 2010 http://faostat.fao.org
30. **Farazmand, H.** 2002. Investigation on the reasons of food preference of red palm weevil, *Rhynchophorus ferrugineus* Oliv. Applied Entomology and Phytopathology, 70: 49-62.
31. **Hallett, R.H., G. Gries, J.H. Borden, E. Czyzewska, A.C. Oehlschlager, H.D. Pierce, Jr., N.P.D. Angerilli and A. Rauf.** 1993. Aggregation pheromones of two Asian palm weevils, *Rhynchophorus ferrugineus* and *R. vulneratus*. Naturwissenschaften, 80: 328-331.
32. **Jaya, S., T. Suresh, R.S. Sobhitha Rani and S. Sreekumar.** 2000. Evidence of seven larval instars in *Rhynchophorus ferrugineus* reared on sugarcane. Journal of Entomological Research, 24: 27-31.
33. **JU, R.T., F. Wang, F.H. Wan and B. Li.** 2010. Effect of host plants on development and reproduction of *Rhynchophorus ferrugineus* (Olivier) (Coleoptera: Curculionidae). Journal of Pest Science, 84:33-39.
34. **Kehat, M.** 1999. Threat to Date Palms in occupied Palestine, Jordan and the Palestinian Authority by the Red Palm Weevil, *Rhynchophorus ferrugineus.* Phytoparasitica, 27: 107-108.
35. Malumphy C. and Moran H. (2009). Red palm Weevil, *Rhynchophorus ferrugineus*. Plant Pest fact sheet. Available online at www.fera.defra.gov.uk/plants/publications/factsheets/redpalmweevil.
36. **Nakash, J., Y. Osam and M. Kehat.** 2000. A suggestion to use dogs for detecting red palm weevil (*Rhynchophorus ferrugineus*) infestation in Date Palm in occupied Palestine. Phytoparasitica, 28: 153-154.
37. **Nirula, K.K.** 1956. Investigation on the pests of coconut palm, Part-IV. *Rhynchophorus ferrugineus*. Indian Coconut Journal, 9: 229-247.
38. **Oehlschlager, A.C.** 2005. Current status of trapping palm weevils and beetles. *Proceedings*, Date palm regional workshop on ecosystem-based IPM for date palm in the Gulf countries. 28-30 March 2004, Al-Ain, UAE. Planter, 81(947): 123-143.
39. **Oehlschlager, A.C.** 1994. Use of pheromone baited traps in control of red palm weevil in the kingdom of Saudi Arabia. Consultancy Report- submitted to Ministry of Agriculture, Saudi Arabia. 17 pp.
40. **OJEU.** 2008. Commission decision of 6 October, 2008 amending decision of 2007/365/EC on emergency measures to prevent the introduction into and the spread within the community of *Rhynchophorus ferrugineus* (Olivier) (notified under document number C (2008) (5550). Official Journal of the European Union, L 266: 14.
41. **RPW, First Report RPW in Caribbean,** http://www.redpalmweevil.com/newlook/RPWReport/Caribbean.htm (Accessed on November 12, 2010)
42. **RPW, Red Palm Weevil,** http://www.redpalmweevil.com/
43. **Soroker, V., D. Blumberg, A. Haberman, M. Hamburger-Rishad, S. Reneh, S. Talebaev, L. Anshelevich and A.R. Harari.** 2005. Current status of red palm weevil infestation in date palm plantations in occupied Palestine. Phytoparasitica, 33: 97-106.
44. **The Red Palm Weevil, A serious threat to the Portuguese landscape,** November 12, 2010 http://www.aambiental.org/palmweevil/
45. **Wattanapongsiri, A.** 1966. A revision of the genera *Rhynchophorus* and *Dynamis* (Coleoptera: Cuculionidae). Bangkok, Thailand: Department of Agriculture Science Bulletin, 1, 328 pp.
46. **Zaid, A., P.F. De Wet, M. Djerbi, and A. Oihabi.** 2002. Chapter XII: Diseases and pests of date palm (Chapter XII). In: Date palm cultivation. A Zaid (ed.). FAO plant production and protection paper 156, Review 1. (Available on http://www.fao.org/DOCREP/006/Y4360E/y4360e0g.htm#bm16)

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