

XIX International Plant Protection Congress

10-14 November, 2019

Hyderabad, Telangana, India



Red Palm

Weevil Symposium

Outsmarting the Red Palm Weevil:

A Global Challenge

(Book of Abstracts)



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Red Palm Weevil Symposium
Outsmarting the Red Palm Weevil: A Global Challenge
(Book of Abstracts)

Date: 11 November, 2019

Time: 14.00-18.00 hrs [4 hours]

Venue: *Hall MRG 2*

Symposium Organizers

Dr. B. Sarath Babu, ICAR, NBPGR, Hyderabad, India

Prof. Hassan Al-Ayedh, KACST, Riyadh, Saudi Arabia

Dr. Jose Romeno Faleiro, Ex-ICAR, Goa, India

Dr. Thaer Yaseen, FAO, Cairo, Egypt

Dr. Shoki Al-Dobai, FAO, Rome, Italy

Background

The Red Palm Weevil (RPW) *Rhynchophorus ferrugineus* Olivier has emerged as key pest of palms in diverse agro-ecosystems worldwide. RPW has rapidly expanded its geographical range during the last three decades and recent reports of RPW invasion suggest that the pest is establishing in the Caucasian region where it is detected in Abkhazia in the Republic of Georgia from East Africa in Djibouti and during 2019 in Southeastern Europe from Bosnia and Herzegovina.

There exist gaps and challenges in almost all the components of the current RPW-IPM strategy. During March, 2017 the Food and Agriculture Organization of the UN organized a ‘Scientific and High-Level Meeting on the Management of RPW’ and through the ‘Rome Declaration’ called for the urgent need to combat RPW by collaborative efforts and commitments at the country, regional and global levels to stop the spread of this devastating pest. Recently, the Bari meeting on RPW organized at CIHEAM, Bari, Italy emphasized strengthening of research on RPW to develop innovative and sustainable technologies for the control of this lethal pest.

Although, there are several research publications and ongoing research programs on RPW in many countries, there is an urgent need to further intensify RPW research to develop user friendly technologies with respect to early detection, phytosanitary measures, semiochemical techniques, preventive and curative treatments, biological control, removal of severely infested palms and decision-making data collection and management tools that will foster farmer/homestead owner participation in the management of this deadly pest.

This Symposium, entitled ‘*Outsmarting the red palm weevil: A global challenge*’ during IPPC, 2019 from 10-14 November, 2019 at Hyderabad, India aims to offer a platform to researchers from all over the world to showcase emerging user-friendly and practical technologies to control RPW and augment the efforts of International Organizations and National RPW control programs. In all, ten papers will be presented covering diverse aspects of RPW-IPM including, early detection, advances in RPW semiochemical research, chemical control, pesticide resistance, socio-personal dimensions of RPW management, phytosanitary aspects and innovative area wide RPW-IPM strategy.

Program: RPW Symposium at IPPC, 2019

XIX International Plant Protection Congress, IPPC-2019, Hyderabad, India

Symposium Title: <i>Outsmarting the red palm weevil: A global challenge</i> Date: 11 November, 2019 Time: 14.00-18.00 hrs [4 hours] Venue: <i>Hall MRG 2</i> Organizers: <i>B Sarath Babu, Hassan Al-Ayedh, Jose Romeno Faleiro, Thaer Yaseen, Shoki Al-Dobai</i>
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Session / Time	Particulars / Title	Speaker/Authors
• Opening Session		
[14:00-14:15]	Welcome and Opening Remarks	<ul style="list-style-type: none"> • Dr. Ibrahim Al-Jboory President, Arab Society of Plant Protection • Dr. Shoki Al-Dobai FAO, Rome • Dr. Hassan Al-Ayedh King Abdul Aziz City of Science & Technology, Saudi Arabia • Dr. B. Sarath Babu Co-Chair, IPPC-2019, India
• Technical Session [14:15-17:35] Chairman: <i>Dr. Hassan Al-Ayedh, KACST, Saudi Arabia</i> Co-Chairman: <i>Dr. Khaled Makkouk, Editor-in-Chief, Arab Journal of Plant Protection, Lebanon</i>		
14:15-14:35	Red palm weevil, <i>Rhynchophorus ferrugineus</i> (Olivier), management: Is it working?	Abdulrahman S. Aldawood , Khawaja G. Rasool and Mureed Husain. - Saudi Arabia

Session / Time	Particulars / Title	Speaker/Authors
14:35-14:55	Smart Vigilance and Stimulo-deterrence in the Bio-suppression of Red palm weevil infesting Coconut	Josephraj Kumar, A. , Chandrika Mohan, Jijo Paul, Regi J. Thomas, Vinayaka Hegde and Krishnakumar, - India
14:55-15:15	Updates on Pesticide Resistance in Red Palm Weevils: Challenges, Management strategies and Future Research Directions	Hassan Al-Ayedh and Abid Hussain -Saudi Arabia
15:15-15:35	Development of Date Palms Fumigation Technique for Controlling Red Palm Weevil Infestations in the Kingdom of Saudi Arabia	Ahmed Mohammed AlJabr , Abid Hussain, Suliman Ali AlKhateeb, Abdulaziz Muhammad Abdullah Al-Shiridi and Mansour Abdulrahman Albulaikhi - Saudi Arabia
15:35-15:55	Innovative Program to Control Red Palm Weevil <i>Rhynchophorus ferrugineus</i>	Suliman Ali AlKhateeb , Abdulaziz Muhammad Abdullah Al-Shiridi, Mohammad alhamdan and Mansour Abdulrahman Albulaikhi - Saudi Arabia
15:55-16:15	Socio- personal dimensions of red palm weevil management of coconut in homestead farming systems	Anithakumari. P , Selvamani. V, Chandran. K.P and K. Muralidharan - India
16:15-16:35	Red Palm Weevil: A Global Overview	J.R.Faleiro - India

Session / Time	Particulars / Title	Speaker/Authors
16:35-16:55	Enhanced vigilance, phytosanitation and enforcement of internal quarantine regulations to stop the spread of red palm weevil in the Near East and North Africa	Sarath Babu Balijepalli and J. R. Faleiro. -India
16:55-17:15	Controlled release dispenser for delivery of red palm weevil, <i>Rhynchophorus ferrugineus</i> pheromone	Kesavan Subaharan , M Eswarmorthy, Vibina Venugopal, N Chalapathi Rao, S. Gurav, S. Srinivasan, N. Ganesan, Bakthavatsalam and P.S.P.V.Vidyasagar - India
17:15-17:35	Essential oil repellents against red palm weevil <i>Rhynchophorus ferrugineus</i> Oliver (Curculionidae: Coleoptera) on coconut	PS Prathibha , A. Josephraj Kumar and Ravindran Patali - India
<ul style="list-style-type: none"> • [17:35-18:00] Discussion & Closing Remarks Chairman: Dr. Shoki Al-Dobai, FAO, Rome, Italy 		

ABSTRACTS

Red palm weevil, *Rhynchophorus ferrugineus* (Olivier), management: Is it working?

Abdulrahman S. Aldawood¹, Khawaja G. Rasool and Mureed Husain

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Red palm weevil (RPW) *Rhynchophorus ferrugineus* (Olivier) is a serious threat for the date palm, *Phoenix dactylifera* L., growers Worldwide. Based on its rapid transcontinental spread, increasing host range and massive economic losses, FAO has declared RPW as category-1 pest of date palms. This global menace is a great challenge for the scientists to develop the most effective and efficient management techniques to save this valuable natural resource. The core issue in successful management of RPW is the failure in early detection of its infestation. Our research team is working on integrated approaches including: RPW DNA barcoding, scrutinizing some non-invasive approaches for early detection of RPW infestation, searching for the most-suited pesticides/biopesticides and their delivery systems, and developing RNAi-biotech-based control measures of the RPW. Present talk will try to answer the question: is current RPW management working?



Smart Vigilance and Stimulo-deterrence in the Bio-suppression of Red Palm Weevil Infesting Coconut

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Asiatic red palm weevil, *Rhynchophorus ferrugineus* Olivier, a concealed tissue borer is the fatal enemy and destructive pest on coconut palms. Smart detection sensors based on vibration signals of grub activity was found as a non-disruptive innovative tool

for sensible early detection. In this attempt, a pattern could be decoded by the typical vibration and noises produced by the feeding grubs of red palm weevil in the lower order frequencies of 10 to 4000 hz. A time amplitude domain waveform devoid of ambient noises and persistent signals of grub feeding could be ascertained after subjecting to reverse transformation and several modes of normalization process. Sustained surveillance and systematic scouting on palms as part of smart vigilance is equally important for pest diagnosis and timely adoption of curative management strategies. Crop pluralism induced heterogeneity in coconut plantation by systematic planting of intercrops (nutmeg, rambuttan, banana, papaya, curry leaf) produced volatile cues that could disorient red palm weevils away from palm source by stimulo-deterrence (push-pull doctrine), thus infusing less susceptibility to weevil attack than in plantation with coconut as monocrop. No red palm weevil incidence was observed in such ecological engineering coconut garden whereas it exceeded the action threshold of 1% in monocropped garden. Diversity distraction of pests on the other hand could attract a wide array of pollinating foragers (bees, flies, ants) as well as defenders (entomophaga). Average yield of Kalpa Sankara palms for four years exceeded 135 nuts per annum in coconut plus intercrop system. This concept could frame coconut farming to fullness, double farmer's income and avoid invasion by the deadly pest.



Updates on Pesticide Resistance in Red Palm Weevils: Challenges, Management Strategies and Future Research Directions

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Red palm weevil, *Rhynchophorus ferrugineus* (Olivier), is a serious coleopterous pest of palms with wide host range. The populations of RPWs dispersed around the world due to negligence and bad practices of the custom and quarantine department. The invaded

populations of RPWs spread aggressively in the new habitat on date palm plantations in Gulf Cooperation Countries (GCC). They feed voraciously within the palm trunk, which ultimately kills the palms by destroying their vascular system. The concealed habitat of RPWs and high reproduction potential made it difficult to control their populations. Currently, numerous insecticides are being utilized for the management of RPWs. However, the date palm producers in the Kingdom complained the RPW control failure by insecticides. Reduced susceptibility of RPWs to insecticides probably because of the development of the resistance. In addition, the current published scattered reports on the development of pesticide resistance in RPWs worsen the situation regarding their management. This challenging situation demands the designing of an eco-friendly novel RPWs management strategy with special emphasis on the incorporation of newly discovered genome editing technologies.



Development of Date Palms Fumigation Technique for Controlling Red Palm Weevil Infestations in the Kingdom of Saudi Arabia

Ahmed Mohammed AlJabr^{1,2}, Abid Hussain¹, Suliman Ali AlKhateeb^{1,2}, Abdulaziz Muhammad Abdullah Al-Shiridi², Mansour Abdulrahman Albulaikhi²*

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Red palm weevil (RPW) is an invasive pest that has become the most devastating and widespread date palm trunk pest responsible for the destruction of date palm plantations in the Kingdom of Saudi Arabia. Due to cryptic mode of habitat, novel designing of environmentally safe control method of RPW is very important. Fumigants have long been praised as attractive alternative pest management option as they are known for their quickest action for controlling all life stages of pests. However, RPW Controlling Date Palm Fumigation Technique is a challenging task due to the escape of poisonous phosphine gas into the surrounding that demands over-dosing of Aluminum phosphide. In the current study, we have rationalized the Aluminum phosphide usage by reducing

phosphine gas escape using specially designed airtight date palm phosphine suit. Our refined application methodology led us to successfully control RPW populations within the palm trunk without the escape of phosphine gas. The findings of the current study enabled us to recommend Aluminum phosphide tablets in a right dose under specially designed unique date palm phosphine suit as a promising RPW controlling strategy.



Innovative Program to Control Red Palm Weevil *Rhynchophorus ferrugineus*

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The Ministry of Environment Water and Agriculture has developed an innovative multidisciplinary approach for integrated pest management of the red palm weevil, consisting of 12 components. These components are: Database, GIS and remote sensing, field monitoring, detection and early reporting of palm weevil, integrated pest management and control practices, good preventive practices, information and awareness program, research, extension and awareness program, training and capacity building program, mechanism to ensure participation of farmers and their associations, coordination mechanism and involvement of the private sector and stakeholders, nurseries for tissue culture offshoots, plant quarantine regulations and phytosanitary procedures, and finally monitoring and evaluation system. Each one of these components consists of many different activities and the benefits of each of these activities add up to ultimately give the expected strength of this program. The program was applied in the kingdom and principally depends on comprehensive periodic date palm inspection every 45 days. The program proved to be effective and has achieved the best results in terms of getting areas completely or partially free of infestation of the red palm weevil. This paper presents the main activities included in this innovative program and how it achieves these ultimate results.



Socio- personal Dimensions of Red Palm Weevil Management of Coconut in Homestead Farming Systems

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Coconut based farming system supports over 13.8 crores of farm families in India. The incidence of red palm weevil emerged as a serious problem of coconut cultivation causing yield loss and affecting livelihood security of small and marginal farmers. Series of studies conducted since 2010 among the farming community revealed the low level of knowledge and adoption of integrated pest management (less than 10 %) as well as lack of skill in identification of early symptoms of pest infestation. The existing extension approaches or strategies needs reorientation and paradigm shift in achieving optimal results depending on the technologies, social systems and resource of farming community. The spatial pattern of red palm weevil incidence in contiguous area of 2000 ha indicated aggregate distribution in patches as per indices of dispersion, patchiness, cluster dispersion and mean clouding. The field level infestation ranged from 1.54 to 19.9 percentages and significantly more in nonbearing palms. In terms of infestation, 18.67% of 5410 holdings studied in Edava Gramapanchayath, reported red palm weevil infested palms and survey in 7068 homesteads among 1,74,733palms in Bharanikkavu Gramapanchayath showed infestation in 5120 palms. It was also found that coconut gardens with more number of palms had more infested palms. Therefore, field situation of marginal and small holdings demands shifting the pest management strategies from adoption unit approach to area wide community approach. Spatial variation in pest population plays major role in developing strategies for an effective area-wide pest management programme at community level. This approach leads to a more effective and sustainable pest management than individual farmer based approach.

ICAR – CPCRI pilot tested area wide community management extension approach (AWCA) during 2016 as participatory action research programme involving all stakeholders. Coconut land-cover map was developed using satellite data. Spatial analysis of the pest distribution was carried out in GIS to understand the spatial pattern of the pest incidence in the coconut land-cover. Using this spatial analysis and social dimensions as decision making tool, management strategies were developed for the pest management. Innovative extension components such as poster campaigns, stakeholders

meetings, coconut Plant protection and Surveillance Groups (CPPSG), operation of integrated coconut field clinics (ICFC) and intense field extension activities organized for social mobilization and . The average red palm weevil incidence (percentage of palms) could be reduced to 0.38 percent from 2.93 percent with the integrated community extension interventions. The focus on community extension approach in wider area could overcome the inefficiency of individual level technology adoption and wide variation of farmers' socio-economic resource base.



Red Palm Weevil: A Global Overview

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The Red Palm Weevil (RPW), *Rhynchophorus ferrugineus* (Coleoptera: Curculionidae) has its home in South Asia where it is a major pest of coconut. After gaining foot hold on date palm in the Middle East during the mid-1980s it has significantly expanded its geographical and host range covering almost the entire globe, except the cold polar regions and is reported on 40 palm species worldwide.

Detection of palms in the early stage of attack is the key to the successful management of this pest. However, the hidden nature of RPW within the palm makes detection of RPW infested palms extremely difficult. Lack of efficient biological control agents for use in the field is also a major challenge.

There exist gaps and challenges in almost all the components of the current RPW-IPM strategy. FAO calls for the urgent need to combat RPW by collaborative efforts and commitments at the country, regional and global levels. This presentation gives an overview of the current situation of RPW and elaborates on the key elements of the core RPW-IPM techniques involving early detection, trapping of adult weevils, preventive and curative chemical treatments, removal and disposal of severely infested palms, implementing phytosanitary measures and GIS based data management in area-wide RPW-IPM programmes for efficient monitoring and evaluation of the control strategy.

Key words: Red Palm Weevil, IPM, overview



Enhanced Vigilance, Phytosanitation and Enforcement of Internal Quarantine Regulations to Stop the Spread of Red Palm Weevil in the Near East and North Africa

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The importance of formulating quarantine protocols to combat RPW as has been emphasized by FAO. This paper attempts to discuss the existing surveillance mechanism, lack of awareness on unauthorized movement of planting material and internal quarantine regulations in date palm growing countries of the Near East and North African region (NENA). The analysis lucidly brings out the challenges in enforcement of regulations on the internal movement of planting material while emphasizing the need for strict enforcement of these regulations in order to stop the alarming spread of RPW in the NENA region.

Although there are plant quarantine laws at GCC level and decrees banning the import of palms of all kinds exists in most of the NENA countries, there still occurs unauthorized movement of date palm offshoots for farming and large palms for ornamental gardening. The movement of planting material within the NENA countries has been a concern in spite of the regulation in force in most of the countries in the region, prohibiting the unauthorized movement of planting material with RPW infestations.

A weak surveillance mechanism in the region can't be allowed to continue as it hinders the sustenance of pest free areas, besides also diluting the success achieved in controlling the pest. The reporting obligations of new cases of infestation must be based on the relevant international standard for phytosanitary measures (ISPM). Small farmers in the entire NENA region maintain date palm orchards as a family property and as heritage in the affluent GCC countries where RPW management practices by the farmer are minimal. In the GCC countries the State intervenes to provide RPW control at no cost to the farmer.

Furthermore, the NENA countries do not have a consistent policy in place for the establishment of certified date palm nurseries and tissue culture production of palm saplings for supply of RPW-free palms, except for some efforts in this direction in countries like Algeria.

This paper highlights the challenges faced by the NENA countries to address the issue of, enhanced vigilance, phytosanitation and enforcement of internal quarantine regulations to stop the spread of red palm weevil in the Near East and North Africa.



Controlled Release Dispenser for Delivery of Red Palm Weevil, *Rhynchophorus ferrugineus* Pheromone

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Red palm weevil (RPW), *Rhynchophorus ferrugineus* is a key pest of coconut, *Cocos nucifera*, date palm and ornamental palms. Aggregation pheromone (4 methyl 5 nonanol + 4 methyl 5 nonanone (9:1) loaded in polymer membrane dispensers are being used for mass trapping of the weevils. Though effective, the polymer membrane dispensers have high release rate ranging from 10 – 30 mg/ day. This warrants replacement of the lure in 3 – 4 months interval which adds up to the cost of the labour and chemistry. Nano materials are a novel carrier/ dispenser for the volatile signaling molecules with controlled spatiotemporal release rates. A controlled release dispenser was developed for loading the RPW pheromone. Characterization by Field Scanning Electron Microscopy (FESEM) and X - ray Diffraction (XRD) confirmed the ordered structure of the pores on the matrix. Pheromone when loaded in nanomatrix showed delayed dissipation as compared to pheromone alone when assayed by Thermal gravity analysis (TGA). Fourier transform infrared (FT-IR) measurements confirmed the presence of pheromone in the

nanomatrix. Further, studies on release rate of the entrapped pheromone in the nanomatrix using the Gas Chromatography revealed lower release rate of volatiles compounds as compared to the commercial lures having polymer membrane. The release rate from the nanomatrix was sufficient to cause physiological response that was ascertained by electrophysiological techniques (electroantennogram). Field test of pheromone loaded in nanomatrix captured more weevils than unbaited traps. On longevity of pheromone lures the commercial lure containing 800 mg pheromone was exhausted in three months, whilst the pheromone loaded into nanomatrix could be used for a period of six months from installation date. The nanomatrix developed for delivery of RPW pheromone will aid to scale down the cost in trapping weevils.



Exploration of Potential Essential Oil Repellents Against Red Palm Weevil *Rhynchophorus ferrugineus* Olivier (Curculionidae: Coleoptera) on Coconut

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Red palm weevil (RPW) *Rhynchophorus ferrugineus* Olivier (Curculionidae: Coleoptera) is a deadly pest of coconut. Induction of injury, incidences of bud rot or leaf rot diseases predispose RPW infestation. Being a concealed pest, early diagnosis is tough. Hence prophylactic treatments with potential repellents would be an effective tool in IPM. Present study was undertaken to evaluate the behavioural response of weevil towards essential oils viz., citriodora oil (*Eucalyptus citriodora*), thymol oil (*Thymus vulgaris*), betel leaf oil (*Piper betle*), ajowan oil (*Trachyspermum ammi*), basil oil (*Ocimum basilicum*), black pepper oil (*Piper nigrum*), nutmeg oil (*Myristica fragrance*) and Cashew Nut shell liquid (CNSL) (*Anacardium occidentale*). The weevils were provided a choice between the odour arm containing essential oil (1000 ppm) and the control arm having zero air in Y-tube olfactometer. Thirty per cent of beetles oriented towards citriodora oil, 40 % towards CNSL and 55 % beetle towards black pepper oil. At the same time, 70 %, 60 % and 45 % of the beetles moved towards the control arm through

which pure air was passed. About 60 - 70 % of weevils moved towards the odour arm when other essential oils were tested. Repellent property of citriodora was confirmed by wind tunnel assay in which 13.33 % beetles exhibited up wind flight response. 23.33 % beetles exhibited downwind flight response after moving up to mid point. 63.33 % beetles remained at the point of release in the wind tunnel. Gel based slow release matrix (calcium alginate) of citriodora oil (5 %) was developed and place on coconut leaf axil @ 5 g /palm in two sachets. It reduced the incidence from 5.19 % to 1.3 %, over a period of three months.

Key words: *citriodora*, CNSL, calcium alginate beads, *essential oil*, *Rhynchophorus ferrugineus*, *wind tunnel*,

