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NEW INITIATIVES FOR MANAGEMENT OF RED PALM WEEVIL THREATS TO HISTORICAL ARABIAN DATE PALMS*

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ABSTRACT

The date palm is an important part of the religious, cultural, and economic heritage of the Arabian Peninsula. This heritage is threatened by the recent invasion of the red palm weevil (RPW) from Southeast Asia. In Saudi Arabia, a national campaign for control of RPW by containment/destruction of infested plants, injection and spraying of biochemical and chemical pesticide treatments in heavily infested and newly infested areas, and the use of pheromone/kairomone traps for monitoring and reduction of RPW populations has been only partially successful in controlling its spread. New methods are needed to help manage the RPW populations. At a workshop in Riyadh in March 2010, plans were recommended to 1) devise and test new biological, chemical, and biotechnological methods to manage RPW in farms and urban palms; 2) compare the economic and logistic feasibility of acoustic and other detection methods against RPW larvae; and 3) develop biosensor indicators of RPW infestation in date palms. If these initiatives are successful, they will be of great assistance to landscape and orchard managers dealing with such a challenging pest of a highly valuable tree.

Key Words: *Rhynchophorus ferrugineus*, *Phoenix dactylifera*, biosensor, acoustic detection

RESUMEN

La palmera datilifera es considerada una parte importante del patrimonio religioso, cultural y económico de la Península Arábiga. Este patrimonio está amenazado por la reciente invasión del picudo rojo de las palmeras (PRP) del sudeste de Asia. En un taller celebrado en marzo de 2010, se recomendaron las siguientes planes: 1) diseñar y probar nuevos métodos biológicos, químicos y biotecnológicos para manejar el PRP en granjas y palmas urbanas, 2) comparar la viabilidad económica y logística del método acústico y otros métodos de detección contra las larvas de PRP y 3) elaborar indicadores biosensores para infestaciones de PRP en las palmeras datiliferas. Si estos esfuerzos tienen éxito, será de gran ayuda para los administradores que trabajan en el campo y las huertas que tienen que enfrentar esta desafiante plaga de un árbol de alto valor para la región.

For many people in the Arabian Peninsula, the date palm (*Phoenix dactylifera* L.) is more than just a fruit tree; it is a symbol of their religious, cultural, and economic heritage. Saudi Arabia is home to more than 23 million date palms and ranks third worldwide in fruit yield and area un-

der cultivation (Erskine et al. 2004). Saudi date palms came under threat in the early 1980s with the arrival of the red palm weevil (RPW) (*Rhynchophorus ferrugineus*) (Olivier) (Abraham et al. 2001). Infestations of RPW have been reported in over 50% of the date palm growing countries, sparing none in the Middle East (Faleiro 2006).

The destructiveness of RPW in Saudi Arabia is abetted by several traditional farming practices, including the use of flooding rather than drip irrigation, which provides good harborage for adult RPW during dry periods, and the removal of leaves during harvesting or pruning of offshoots, which causes incidental injuries to trees (Aldryhim & Khalil 2003). Injured trees release highly volatile compounds (kairomones) that attract male weevils (Gunawardena et al. 1998). Upon their arrival, males produce aggregation pheromones that attract both sexes, and the females begin laying eggs in soft or injured areas on the lower trunk of the tree. The newly hatched larvae feed on the soft plant tissue, digging deep into the plant trunk, compromising its structural integrity and disrupting nutrient transport to the upper part of the tree, which ultimately culminates in death of the plant if not managed (Murphy & Briscoe 1999).

Different control measures that have been considered, including containment/destruction of infested plants, biochemical and chemical pesticide treatments, biological control, and sterile insect techniques have been only partially successful in controlling the spread of RPW in Saudi Arabia (Prabhu et al. 2010) as has been found also in other countries (Khalifa et al. 2004; Abbas 2010). Efforts to develop biological management of RPW, for example, are only in their early stages (Abdullah 2009; Güerri-Agulló et al. 2010). Preliminary field trials suggest that an entomopathogenic fungus, *Beauveria bassiana*, partially controls the RPW (Dembilio et al 2010a). Combination trials of imidacloprid and entomopathogenic nematode *Steinernema carpocapsae* Weiser were initiated to observe synergy of two different formulations in controlling RPW, but surprisingly, no synergy was observed (Dembilio et al, 2010b).

Early detection of infestation is an important component of RPW management. Improved methods with high throughput capability for early detection of RPW are urgently needed. Several detection methods, including visual inspections, acoustic sensors (Potamitis et al. 2009; Mankin et al. 2011), sniffer dogs (Nakash et al. 2000), and pheromone traps (Faleiro & Kumar 2008) have been tested to assist quarantine efforts and identify infestations at early stages. However, each of these detection methods has suffered logistic and implementation issues.

Pheromone traps have been tested for RPW control in conjunction with pesticides in Al-Hassa and other important date-growing areas (Faleiro et al. 2011, Massoud et al. 2011), but with only partial success. Recently, Geographic Information System (GIS) based techniques were used to check efficiency of pheromone traps in areas of high and low RPW activity. A statistical model has been proposed based on weevil capture information and support use of GIS in weevil management strategies (Massoud et al 2011). In addition, recent testing of variations in design and height of traps suggest that RPW are captured most efficiently in red color traps (Al-Saoud et al. 2010).

A national campaign for control of RPW in Saudi Arabia has been initiated based on the most successful of the management programs developed to date. The campaign currently involves:

- Agricultural sanitation.
- Removal of heavily infested palms and grinding them into small pieces, using resultant material as a plant growth medium in place of peat moss.
- Treatment of all palm trees (infested and uninfested) in heavily infested areas using biochemical and chemical pesticide injection and sprays.
- Injection and spray treatment of infested trees as well as those within 3 km of infested trees in newly infested areas or areas of low infestation. Pheromone/ kairomone traps are used to evaluate the control program.

Despite efforts such as the above, an estimated 80,000 palm trees in Saudi Arabia are infested with RPW and it continues to pose a danger to other surrounding plants (Al-Sheaby 2010). There are strong indications that regional movement of infested plant material is one of the major sources for the spread of this insect. To avoid further spread, there is an urgent need for strong quarantine measures to restrict RPW movement, even within different regions of each affected country.

Saudi Arabia Basic Industries Corporation (SABIC) recently convened an on-site visit to infested orchards near Al-Hassa followed by a workshop in Riyadh (29-31 Mar 2010) where different methods for controlling RPW in Saudi Arabia and elsewhere were discussed. In a meeting at Rashid Farms, near Riyadh, the Minister for Agriculture shared the Saudi Government perspective on RPW management and other insects detrimental to date palm fruit yields. He reiterated the need for a unified strategy including farmer education relevant to insect infestation and management in trees, development of methods for earlier detection, and strict quarantine procedures applied across the globe. The Minister discussed in detail experiences that the Saudi Arabian government has faced relevant to quarantine issues.

After reviewing and discussing the different problems faced by orchard and urban landscape managers and the methods available for RPW detection and management, the workshop participants proposed that the following initiatives be pursued vigorously in future date palm pest research:

- Devise and test new integrated pest management strategies including biological, chemical, and biotechnological methods as proof of concept of efficient RPW control in farm and urban palms.
- Compare currently available detection technologies (e.g., acoustic detection and X-ray digital analysis) in terms of their economic and logistic feasibility.
- Develop biosensor indicators of RPW infestation by identifying peptides that are differentially expressed in the tree after it is attacked.

The 2010 workshop, a recent symposium in Spain (Organiza Phytoma-España 2010) and several papers on RPW management presented here in this journal issue herald a likely expansion of efforts in the area of RPW control. Saudi Arabia is uniquely situated to host a Center of Excellence for Red Palm Weevil Management in Date Palms and has begun planning efforts. Already under way is a joint Saudi-Sino Date Palm Genome Project (DPGP), a collaborative program among King Abdulaziz City for Science and Technology, King Faisal University of Saudi Arabia, and Beijing Institute of Genomics of Chinese Academy of Sciences. Recent progress on genomic initiatives includes a draft assembly and release of the date palm genome (cultivar 'Khalas') by a Qatari sequencing initiative in collaboration with Cornell University (Malek 2009). An objective of this integrated genomic initiative, besides the sequencing of various varieties of Saudi date palm, is to unravel the RPW genome. A proposed focus is to harness molecular information for understanding the major physiological needs and weaknesses of the RPW in date palm orchards.

Progress reported from a study of date palm molecular defense responses associated with inoculation of entomopathogenic fungi highlights the need for improved knowledge about palm tree genomes and traits associated with susceptibility (Gómez-Vidal et al. 2009). More than 400 cultivars of dates are grown in Saudi Arabia but limited information is available about their relative susceptibility to RPW infestation. In addition, it may be worthwhile to investigate environmental, biological and other factors involved in differential susceptibility of date palm cultivars grown in Saudi Arabia and nearby gulf countries. Such factors would include interactions among plants and microbial communities in areas that are resistant to RPW infestations (Macías et al. 2003).

Besides date palm, several other species, including coconut and royal palm, also are potential host for weevils (Abbas 2010). Lessons learned from the research conducted in this initiative will not only help date palm growing countries but provide benefits for management of pests in other palm species (Abe et al. 2009).

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