Chapter 17
Sudan Thematic Implementation Plan for the Management of Invasive Red Palm Weevil (RPW), *Rhynchophorus ferrugineus* (Olivier)

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Abstract Date palm (*Phoenix dactylifera L.*) is believed to be cultivated in northern Sudan and upper Nubia since 3200 BC. Dry date cultivars might have originated in Southern Egypt and Northern Sudan. Date palm is an economic and food security crop in Sudan. Estimated annual date production from 8 million date palm trees is about 431,000 mt, which is far below the country's potential, that has been famous in the world for the production of dry dates. Six suitable local commercial cultivars are available, and research yielded a better composition of cultivars by local selection and foreign introduction from tissue culture laboratories. Sudan is still free from-devastating red palm weevil (RPW) and the destructive bayoud caused by *Fusarium oxysporum* f. sp. *albedensis.* RPW, *Rhynchophorus ferrugineus* (Olivier), is a category-1 pest on date palms in Middle-East countries. It is one of the biggest threats to global agriculture of these days. These little crimson pests eviscerate coconut, date and oil palms. They are native to South Asia. Over the last three decades, the pest spread to more than 60 countries from the Caribbean to Southern Europe. For farmers across East Asia, North Africa, Europe and the Middle East, the red palm weevil evokes serious anxiety. These pests, which attack 40 different species of palms, have caused economic losses in the millions of dollars annually, worldwide. One female weevil can lay up to 300 eggs – hiding them inside holes and cavities in the trunk of a palm. Once they hatch, the larvae burrow deep inside the palms, munching their way through the tree, and destroying it from the inside. Sudan is expecting that RPW would eventually come. The thematic implementation plan is the major component of a strategy to be adopted for a country that is not infested with RPW. It involves (1) Quarantine, (2) Monitoring/Surveillance and (3) Training/Capacity Building. Here are discussed some points that could be adopted to strengthen the components mentioned above should an infestation occur in Sudan. In this case, the strategy should aim at containing the spread and eradicating the pest.

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17.1 Introduction

Date palm (*Phoenix dactylifera*) L. is believed to be cultivated in northern Sudan and upper Nubia since 3200 BC. Dry date cultivars might have originated in Southern Egypt and Northern Sudan. It is considered as a key, economic and food security crop in Sudan. Estimated annual production of dates from 8 million date palm trees reaches about 431,000 mt (FAO 2010), which is far below the country's potential. Sudan has been famous in the world for the production of dry dates. Six suitable local commercial cultivars are available, and research is developing a better composition of cultivars by local selection and foreign s from tissue culture laboratories (Khairi 2015).

However, the date palm industry is facing many serious problems, related to low yields, lack of appropriate packing and presentation as well as limited processing of date products. The low yields in most countries, including Sudan, are due to soil salinity, poor fertility, insect pests and diseases, lack of maintenance and care due to the increasing cost of labour and to the shortage of personnel trained in improved cultural practices. As a result of the high cost of production and low prices of the produce, farmers tend to neglect or even abandon their orchards. Although the commonly known, insect pests i.e. the devastating red weevil and the destructive disease known as bayoud (caused by *Fusarium oxysporum* f. sp. *albedensis*), have not been reported yet in Sudan (Ahmed et al. 2013; Faleiro 2017; El Hassan 2006), the date palm crop is affected by many biotic factors among which insects are the most important.

17.2 Red Palm Weevil (RPW)

The red palm weevil (RPW) *Rhynchophorus ferrugineus* (Olivier), is a category-1 pest on date palms in all the Middle-East countries. It is one of the biggest threats to global agriculture in these days. The little crimson pests eviscerate coconut, date and oil palms. Over the last three decades, they spread from native South Asia to more than 60 countries, from the Caribbean to Southern Europe. For farmers across East Asia, North Africa, Europe and the Middle East, the red palm weevil represents a severe threat. RPW, which attacks 40 different species of palms, have caused economic losses in the millions of dollars annually, worldwide

Rhynchophorus ferrugineus is a lethal pest of the date palm tree. Its area of speciation corresponds to South and South-East Asia, where it has been a key pest of coconut. RPW is now reported from nearly 50 countries in all the continents from 40 palm species, worldwide (Wattanapongsiri 1966; Faleiro 2006; Giblin-Davis

et al. 2013; http://www.savealgarvepalms.com/en/weevil-facts/host-palm-trees). The global spread of RPW has been rapid during the last three decades, primarily through infested planting material. FAO has designated RPW as a category-1 pest of the date palm. Early detection of infested palms is the key to its successful control in countries where it occurs. In the case of Sudan, enforcing strict external and internal quarantine regimes is vital to prevent the entry of the pest (Table 17.1).

There is a good reason for all the panic. Citing Mark Hoddle, an entomologist at the University of California, Riverside: "*Red palm weevils are notoriously difficult to detect – until it is too late. One female weevil can lay up to 300 eggs – hiding them inside holes and cavities in the trunk of a palm. Once they hatch, the larvae burrow deep inside the palms, munching their way through the tree, and destroying it from the inside*".

17.3 The Thematic Implementation Plan

A thematic implementation plan is the major component of a strategy to be adopted for a country that is not yet infested by RPW. It revolves around the following actions: (1) Quarantine, (2) Monitoring/Surveillance and (3) Training/Capacity Building. Here are some points that could be adopted to strengthen the components as mentioned above, to be adopted in case an infestation occurs in Sudan. In this situation, the strategy should mostly be aimed at containing the spread and eradicating the pest.

17.3.1 Quarantine

- Registration of nurseries/importers: The Ministry of Agriculture/National Plant Protection Organization (NPPO) should keep a register for all palm nurseries/importers (growers, nurseries, dealers, etc.) and establish a database on importation and destination of palms.
- No palm tree should leave nurseries without a **movement certificate**, issued by NPPO.
- Prohibition of importation of palm trees from a particular site/origin (infested area/countries).
- Palm trees originating from authorized nurseries should only be imported, from non-infested countries.
- In case of the date palm, only date palms obtained by *in vitro* propagation could be imported in test-tubes, from officially certified nurseries.
- Offshoots produced within the country should be permitted to be transported under the close supervision of NPPO, preferably after treatment (dipping of the bole of offshoots in 0.004% Fipronil for 30 min). A simple, superficial spray does not help.

Table 17.1 Thematic implementation plan for the management of invasive Red Palm Weevil[a]

Theme	Recommended actions	Implementing agencies
Awareness, Training and Education	(i) Develop and implement a public awareness programs about that invasive pest and its impact on biodiversity and livelihood of the local communities.	Min. of Agric., Min. of Educ., NGOs, ARC, Universities
	(ii) Encourage media organizations and extension workers to participate in the dissemination of information about the impact of this invasive insect.	
	(iii) Support education institutions to incorporate issues of RPW, identification, prevention, eradication and management into their curricula.	
	(iv) Develop a database of RPW, identification guides and make the information accessible to Stakeholders.	
	(v) Qualify and train taxonomy specialists in insects.	
Policies	(i) Strengthen quarantine measures and border control to ensure that intentional plant introductions are subject to appropriate authorization.	Min. of Agric.
	(ii) Develop risk assessment and management programs and guidelines for newly introduced species.	
	(iii) Develop and implement effective response procedures for the prevention of new potentially invasive species.	
	(iv) Encourage and support the involvement of all stakeholders in alien invasive species management program.	
	(v) Develop invasive species management plans that emphasize prevention of introductions, control and eradication of invasive species.	
	(vi) Develop effective systems and tools for monitoring and evaluation of invasive species.	
Legislation	(i) Harmonize state and sectoral rules and regulations relevant to invasive species and formulate policies and legislation for the control of introductions, movement and management of date palm.	Min. of Agric.
	(ii) Enforcing the international regulation for RPW.	
Conservation	(i) Identify RPW problems and recommend management actions.	ARC
	(ii) Develop appropriate methods to monitor, prevent and stop the spread of invasive RPW.	
	(iii) Assess the movement of RPW and develop maps of the distribution of the invasive pest.	
	(iv) Formulate and implement result-oriented research on the characterization of invasive RPW; vulnerability of ecosystems, social and economic impact; prevention, control, eradication and management methods.	
	(v) Promote research on the use of traditional knowledge in the development and implementation of measures to manage RPW.	

(continued)

Table 17.1 (continued)

Theme	Recommended actions	Implementing agencies
Sustainable Use	(i) Strengthen existing institutions to coordinate research, management and eradication of invasive RPW.	Min. of Sc., ARC, Universities.
	(ii) Produce an inventory of RPW data and evaluate their economic, social and environmental impacts.	

[a]Summary of the thematic plan (with some modification) as reported in the **National Biodiversity Strategy and Action Plan 2015–2020**. Issued by Higher Council for Environment and Natural Resources (HCENR) of Ministry of Environment, Natural Resources and Physical Development, The Republic of Sudan, June 2015

- In case of tissue culture palms produced within Sudan, localize geographically (GIS) the mother tree, label it (each mother plant must be marked with the year, sampling area and serial number), under the supervision of NPPO.
- Movement of offshoots from one oasis to another across the country should not be permitted, to localize infestation in case of an outbreak.
- Nurseries should be inspected at least three times a year.
- Import of offshoots should be banned from infested countries.
- Develop regulation manuals with clear requirements for import, movement and nursery certification.
- Support the establishment of tissue culture laboratories for the production and supply of RPW-free planting material.
- Train Plant Quarantine Staff and other law enforcement authorities

17.3.2 Detection

- Create awareness among farmers and other stakeholders about the seriousness of the RPW issue.
- Develop a protocol for visual inspection in a simple and easy way to understand, in the languages of the farmer and other support staff.
- Urgent need to develop a quick and reliable, cost-effective, and easy to handle early detection device for RPW. These may include and rely on: remote sensing, acoustics, thermal imaging, chemical signatures, laser-induced breakdown spectroscopy, near-infrared spectroscopy, X-ray, biological and physiological stress indicators, sniffer dogs etc.

17.3.3 Measures for Surveillance, Monitoring and RPW Control

1. Regular inspection and monitoring
2. Population disruption (pheromone trapping)

3. Plant quarantine
4. Extension programs
5. RPW-IPM

In addition to regular visual inspection of date palms in the susceptible age group (<20 years), it is recommended to monitor the incidence of adult weevils during their peak activity from March to May and again from September to November. This could be achieved by setting food baited pheromone traps in plantations along roads, at a distance of 1 km between two monitor traps.

17.3.4 Awareness

1. Strengthen extension programs, activities, knowledge sharing mechanisms, communications, and farmers' organizations.
2. Establish defined coordination mechanisms with NGO's, private sector, and cooperatives to make the program more effective.
3. Introduce a participatory approach (Farmers Field School) for farmers and farm workers to empower them with knowledge and field practices.
4. Use of social media to expedite the transmission of information
5. Strengthen cooperation among institutions at the National level and initiate programs of cooperation at the Regional and International levels.

17.3.5 Capacity Building

Training and capacity building of all stakeholders (Farmers, Agriculture officers, Quarantine officials, NGOs, Cooperatives, Farmer Groups etc.) on the RPW eradication strategy (should the pest be detected) should be carried out/intensified.

Farmer participation and involvement in the RPW control programs is crucial for successful control. The advantage of involving the farmers and other stakeholders in the control program is considerable as they are present in the farm and can assist in detecting infested palms in the early stage of the attack. This action that constitutes the key to control and eradicate the pest.

Pilot projects to experiment and demonstrate the feasibility to involve farmers/stakeholders should be initiated in all the major date palm oasis of Sudan.

17.4 RPW-IPM Programs

1. Mass trapping to be taken up by lead/trained farmers.
2. Introduce attract and kill strategy in mass trapping programs.

3. Evaluate the dry trap using electro-magnetic technology.
4. Carry out a risk assessment of the area adopting visual observation and pheromone traps.
5. Develop good agronomic practices that limit the RPW attack.
6. Preventive measures should be practiced, including sanitation, wounds treatment, removal of neglected orchards, pheromone trapping, and insecticide applications via spray and injection.
7. Explore potential indigenous strains of entomopathogenic nematodes and fungi and develop an efficient delivery system.
8. Develop RPW-IPM programs and ensure farmers/stakeholder participation.

17.5 Data Management

1. Develop a GIS and spatial database to be used operationally by countries.
2. Managing mass trapping through the GIS with RFID (barcoding) of traps.
3. Use remote sensing imagery to geo-referenced palm trees in countries to be used as a primary base map in the GIS.
4. Develop a user-friendly mobile application for reporting, data collection and transmission.

17.6 Should an Infestation Occur – What Is to Be Done?

In this case, the goal should be to contain the spread and eradicate the pest. To achieve this:

- Remove (eradicate) all infested palms. Cut the infested portion of the palm into small bits (20 cm long) and drench with insecticide *in-situ*.
- Do not move the infested palm for eradication to another site.
- Establish a 10 km radius buffer zone.
- Intensify phytosanitary/quarantine regulations.
- Inspect all palms in the buffer zone at bi-monthly intervals.
- Mass intervention with traps in the area (1 km radius from the infested palm) at 1 trap/ha.
- Deploy attract and kill interventions, if infestation is severe, i.e. 3 weevils/trap/week.
- Prohibit movement of all palms from the buffer zone.
- Intensify training on RPW-IPM.
- Encourage farmers' participation in the RPW-IPM program, especially with regard to the detection of infested palms.
- The country is to be declared pest (RPW)-free if no new infestation/weevil is detected for three years.

17.7 Challenges in Red Palm Weevil Mentoring

1. Early detection difficulties of RPW infestation.
2. Farming system.
3. Lack of adequate human and financial resources
4. Lack of active involvement/ training of farmers.

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