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The future of RPW control in Tunisia: from Management to Eradication
The Red Palm Weevil (RPW) Has Been Eradicated From Mauritania Using HOOK RPW
RPW Integrated Pest Management

- Quarantine
- National PALM Geo Reference
- Efficient monitoring: Adults & Palms
- No Gap in Control
RPW Integrated Pest Management

In Tunisia

Confidential – Do not use without permission
1. Monitor
   Local: ISCA ABS SMART TRAPS
   Areawide: DATE-GIS

2. Control
   Attract & Kill: HOOK RPW
   Repellency: BEETLE REPEL

3. Maintenance
   Repellency: BEETLE REPEL
1. Monitor

Local: ISCA ABS SMART TRAPS
Areawide: DATE-GIS
Local RPW Monitoring

ISCA ABS SMART TRAPS
Quality Pheromone Lures are the Same

Optimizing components of pheromone-baited trap for the management of red palm weevil, *Rhynchophorus ferrugineus* (Coleoptera: Curculionidae) in date palm agro-ecosystem

<table>
<thead>
<tr>
<th>Pheromone lure tested</th>
<th>Mean weevil captures*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Trial-I</td>
</tr>
<tr>
<td>IT189 ISCA Lure-ferrugineus, ISCA Technologies, USA</td>
<td>1.50 (2.00)</td>
</tr>
<tr>
<td>Ferrolure+, Chem Tica International, Costa Rica</td>
<td>1.14 (1.20)</td>
</tr>
<tr>
<td>CD ($p = 0.05$)</td>
<td>NS</td>
</tr>
</tbody>
</table>

* Data transformed using square root transformation. Figures in parenthesis are original mean values of five replications. NS Non-significant.
Current Trapping RPW
Cumbersome

Trick
Water
Insecticide
Pheromone Bait
Dates/Sugar Cane
Monitoring RPW

RPW Monitoring should be simpler, faster better

ISCALURE RPW EtAc + EtOH
Service-Less Traps for Red Palm Weevil

Water
Insecticide
Pheromone Bait
Dates/Sugar Cane

ISCALURE RPW
EtAc + EtOH

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Service-Less Traps for Red Palm Weevil

ISCALURE RPW
EtAc + EtOH
Service-Less Traps for Red Palm Weevil

But Still Inefficient:
People Still Need to Go to the Field Just to Count RPW Catches

Autonomous Bug Sensors (ABS) Digital Detection
Autonomous Bug Sensors (ABS) Digital Detection

1. Field Ready
2. Reliable
3. Efficient
4. INEXPENSIVE

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Autonomous Bug Sensors (ABS) Digital Detection

ABS Bayesian classifier: real-time detection and classification of insects

A mosquito flying across the laser beam

Wingbeat frequency at 354 Hz

Amplitude Spectrum

This is just one physical realization of our sensor, which is polymorphic and be adapted to any environment.
ABS: Reliable Insect Taxonomy
Autonomous Bug Sensors (ABS) Digital Detection

1. Proprietary Hardware Sensor

2. Machine Learning Algorithm
WingBeat Frequency + External Features (eg. Temperature, Humidity, Time of day (circadian rhythms), etc.)

3. Predictive Capabilities
Autonomous Bug Sensors (ABS)
Digital Detection

DATE-GIS

Low-Power Wide-Area Wireless Network
Range > 15KM

GateWay

FarmSense AI Engine

Real Time Actionable Intelligence
Automated Insect Counts
Pest Pressure Notifications

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DateGIS is GIS data gathering platform:

- **Governments**: Support the development and management of a national RPW control program for the government

- **Farmers**: Support the increase date production, quality, yield and reduces losses caused by RPW infestation
Areawide Date Palm Monitoring

DATE-GIS

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DateGIS

Sustainable e-farming of dates

EO satellites (Landsat, Sentinel-2, WorldView)

DateGIS IT-System

Aerial (drone / aircraft) service providers

Integrated Geo-Information System (GIS) for date farming
DateGIS

Sustainable e-farming of dates

EO satellites (Landsat, Sentinel-2, WorldView) DateGIS IT-System Aerial (drone / aircraft) service providers

Integrated Geo-Information System (GIS) for date farming

Regional RPW spread and infestation maps

Date farm and palm information

RPW infested palm geo-location

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DateGIS

How Does it Work?

- Big data acquired by satellites, small airplanes/drones and in-situ systems
The high temperature regions are often areas of bare soil. There are more areas of bare soil in the east farm plot, indicating a less healthy plot. Based on the full extent, the plots of the Khaledia farm appear to be more homogenous. There are some plots in the East farm with very low temperatures, indicating high canopy cover. The temperatures in Figures a and b have been scaled differently based on local temperature. The original data was stored as 256-greyscale, so has been multiplied by a factor of 0.195325 to derive the equivalent temperature in degrees centigrade.
DateGIS
Pilot Area KSA

Palm fields in GIS database

Geo-located trees
DateGIS

Time Series Data from Satellite Images
DateGIS
RPW Anomalies
Drone Check
Date Palm Monitoring
DateGIS
Pilot Area KSA

Zoom in on field and notice the different colors of the palm trees:
- yellow: tree is geo-located
- green: tree is alive and healthy
- orange: tree is infested with RPW
- red: tree is dead
- gray: tree is removed (only visible upon clicking “Show removed trees”)
From DateGIS pilot project indicated RPW infestation at field level is indicated with aerial remote sensing.

- All fields in neighboring farm (red) are under siege of RPW.
- Central fields have low RPW infestation in most fields (green).
- Except fields adjacent to neighboring farm, which have medium RPW infestation (orange).
2. Control

Efficient
No GAP in coverage

Attract & Kill: HOOK RPW
Repellency: BEETLE REPEL
Current Mass Trapping: <2 traps/ha

One to Two traps per hectare is MONITORING, NOT CONTROL via Mass Trapping.
One to Two traps per hectare is MONITORING, NOT CONTROL via Mass Trapping.

RPW capture per area increases with trap density.
Adding More Traps/Point Sources Per Hectare

4.18 RPW/ha

1 Trap zone of attraction RPW

1 Trap/ha
Adding More Traps/Point Sources Per Hectare

1 Trap zone of attraction RPW

4.18 RPW/ha

1 ha

2 Traps/ha

6.6 RPW/ha
Adding More Traps/Point Sources Per Hectare

1 Trap zone of attraction RPW

4.18 RPW/ha

1 ha

4 Traps/ha

12.25 RPW/ha
Adding More Traps/Point Sources Per Hectare

4.18 RPW/ha

10 Traps/ha

1 ha

1 Trap zone of attraction RPW

13.17/ha

Left in the field!!!

17.35 RPW/ha

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High Trap Density = High RPW Capture

Pheromone Trapping Density: Al-Hassa, 2009

Traps/ha
1t/ha 4.15
2t/ha 6.6
4t/ha 12.25
7t/ha 13.4
10t/ha 17.35

Catch/ha/week
5 10 15 20

It is hard work to maintain then traps/ha viable during the entire field season.

This what we have now. There are gaps that are operationally impossible to eliminate because of trap servicing.

This our goal so every incoming beetle FIRST connects with one of our point source of pheromone.

High Trap Density = High RPW Capture
CONTROL OF RPW

RPW Control should be simpler.
Current Trapping RPW - Ferrugineol

- Trap
- Water
- Insecticide
- Pheromone Bait
- Dates/Sugar Cane
ELIMINATE THE TRAP:
HOOK RPW
ATTRACT & KILL
Current Trapping RPW - Ferrugineol

- Trap
- Water
- Insecticide
- Pheromone Bait
- Dates/Sugar Cane

Hook RPW

Pheromone & Insecticide
Simple, very simple.

HOOK RPW dollop
• Aggregation pheromone draws RPW to the Hook RPW dollop

• Contact with the dollop transfers lethal doses of the insecticide to the RPW
Hook RPW: Attract and Kill

Pheromone + Cypermethrin

HOOOOK RPW
(Pheromone & Cypermethrin)

- dead
- paralised
- not active
- active

Time post treatment (hours)

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Hook RPW – Killing

Aged HOOK RPW--Kill Power: RPW Females (%)

- HOOK RPW Still KILLS 100% of Weevils After 6 months In the field!
- Kills 100% RPW in less than 1 hour
Hook RPW – Attraction

There is >25% of the Active Ingredients still in the tank!

Pheromone in Point Source
Aged in Al Hassa Trial for 3.5 mo

Remaining
Released
High Trap Density = High RPW Capture

This what we have now.
There are some gaps, operational is impossible.
Because of the trap servicing.

ISCA's HOOK RPW makes high density point source operationally and economically feasible to deploy areawide.

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HOOK RPW Field Results

HOOK RPW dollop
Field Trial
Hook RPW vs Mass Trapping

Hook RPW: 250 points/ha
Mass Trap: 2 points/ha
HOOK RPW APPLICATION

- 90% on trees
- 10% on trays
- 250 A&K Points/ha
Hook RPW vs Mass Trapping
Population Density

Trap Monitoring Per Treatment

(9 November, 2015 To 8 February, 2016)

Trap shutdown

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Hook RPW vs Mass Trap
Weevils Killed

Al Qassim: Weevils Killed Per Week
Hook RPW vs Conventional Control

Legend

Weevil Killed by Hook RPW/week  Weevil Killed by Conventional Control/week
The substantially higher density of pheromone point sources with Hook RPW allows for broader control and a dramatic increase in RPW removal.
Hook RPW vs Mass Trapping

The substantially higher density of pheromone point sources with Hook RPW allows for broader control and a dramatic increase in RPW removal.

219/ha
Left in the field!!!
Hook RPW: Attract and Kill For High RPW Populations

HOOK RPW
- One application lasts >3-4 months
- Huge RPW killing effect >6 months
- Could eliminate need for:
  - Crews to clean infected trees
  - Preventive insecticide sprays
- Can **eradicate** RPW from treated area
Hook RPW: Attract and Kill For High RPW Populations

NO GAP in Protection:

- **Geographical**
  - High density point source (250 points/ha)
- **Temporal**
  - Reapply every three to four months

Operationally feasible to deploy areawide

Economically feasible

- **250 points/ha** (high RPW density)
  - $75/ha/4 months ($18.75/ha/month)
- **70 points/ha** (low RPW density)
  - $21/ha/4 months ($5.20/ha/month)
2. Control >> Eradication

HOOK RPW

HOOK RPW

BEETLE REPEL
3. Maintenance

BEETLE REPEL
Maintaining Treated Palms Clean: Beetle Repel

Maintaining Fields Clean: Beetle Repel

Beetle Repel dollop
## Beetle Repel

Installation date: 07/08/2016

### Captures of *Rhynchophorus* (Period of 07/15/2016 to 08/26/2016)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>R1</th>
<th>R2</th>
<th>R3</th>
<th>R4</th>
<th>R5</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 (Pheromone)</td>
<td>5</td>
<td>2</td>
<td>0</td>
<td>6</td>
<td>17</td>
<td>6a</td>
</tr>
<tr>
<td>T2 (Pheromone + SPLAT® Repellent)</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0.6b</td>
</tr>
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Averages followed by the same letters are not significantly different by the Tukey's test (p<0.05).

### Captures of *Rhynchophorus* (Period of 09/02/2016 to 09/09/2016)

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<tbody>
<tr>
<td>T1 (Pheromone)</td>
<td>12</td>
<td>13</td>
<td>18</td>
<td>23</td>
<td>34</td>
<td>20a</td>
</tr>
<tr>
<td>T2 (Pheromone + SPLAT® Repellent)</td>
<td>1</td>
<td>2</td>
<td>0</td>
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1. Monitor

Local:

ISCA ABS SMART TRAPS

Areawide:

DATE-GIS

2. Control

Attract & Kill:

HOOK RPW

Repellency:

BEETLE REPEL

3. Maintaining RPW Free

Repellency:

BEETLE REPEL
Extra Slides
The Future of RPW Control: From Management to Eradication. The red palm weevil (RPW), Rhynchophorus ferrugineus, has caused significant losses to the date palm (Phoenix dactylifera L) industry throughout the Middle East since its introduction into this region in the 1980s. For the past three decades, mass trapping has represented the standard for RPW control yet the problem persists. Pheromone bucket traps are difficult to maintain, compliance with the necessary trap maintenance schedule is low, and the number of traps that can be deployed within a given field is limited. In an effort to provide the Gulf region with more effective control products, ISCA has developed three innovative technologies for the management of RPW in the Gulf region; HOOK RPW, SPLAT RPW Repel and the ISCA Smart Trap. Hook RPW is a long lasting formulation that attracts and kills RPW without the need for a trap. SPLAT RPW Repel is a highly effective repellent formulation that stops RPW from attacking palm trees and that creates barriers to their movement and introduction. The ISCA Smart Trap is a highly sensitive, accurate electronic trap capable of instantaneously transmitting captured data to the Internet for immediate analysis. Adoption of these technologies will provide the Gulf region with far more effective RPW control and pave the way to making eradication possible.