Food and Agriculture Organization of the United Nations

CIHEAM

The Current Global Situation and Challenges of Red Palm Weevil Management Programs

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Rome, Italy, 29-31 March, 2017

- ✓ Global spread of RPW
- ✓ Host range, biology, ecology, symptoms and damage
- ✓ Socio-economic and environmental impact
- ✓ Current management practices
- ✓ Challenges and current gaps
- ✓ Lessons learned

Rhynchophorus Distribution

There are ~10 species in *Rhynchophorus*

R. cruentatus

R. ferrugineus expansion since 1966

Invaded Range
of *R.ferrugineus*

R. ferrugineus

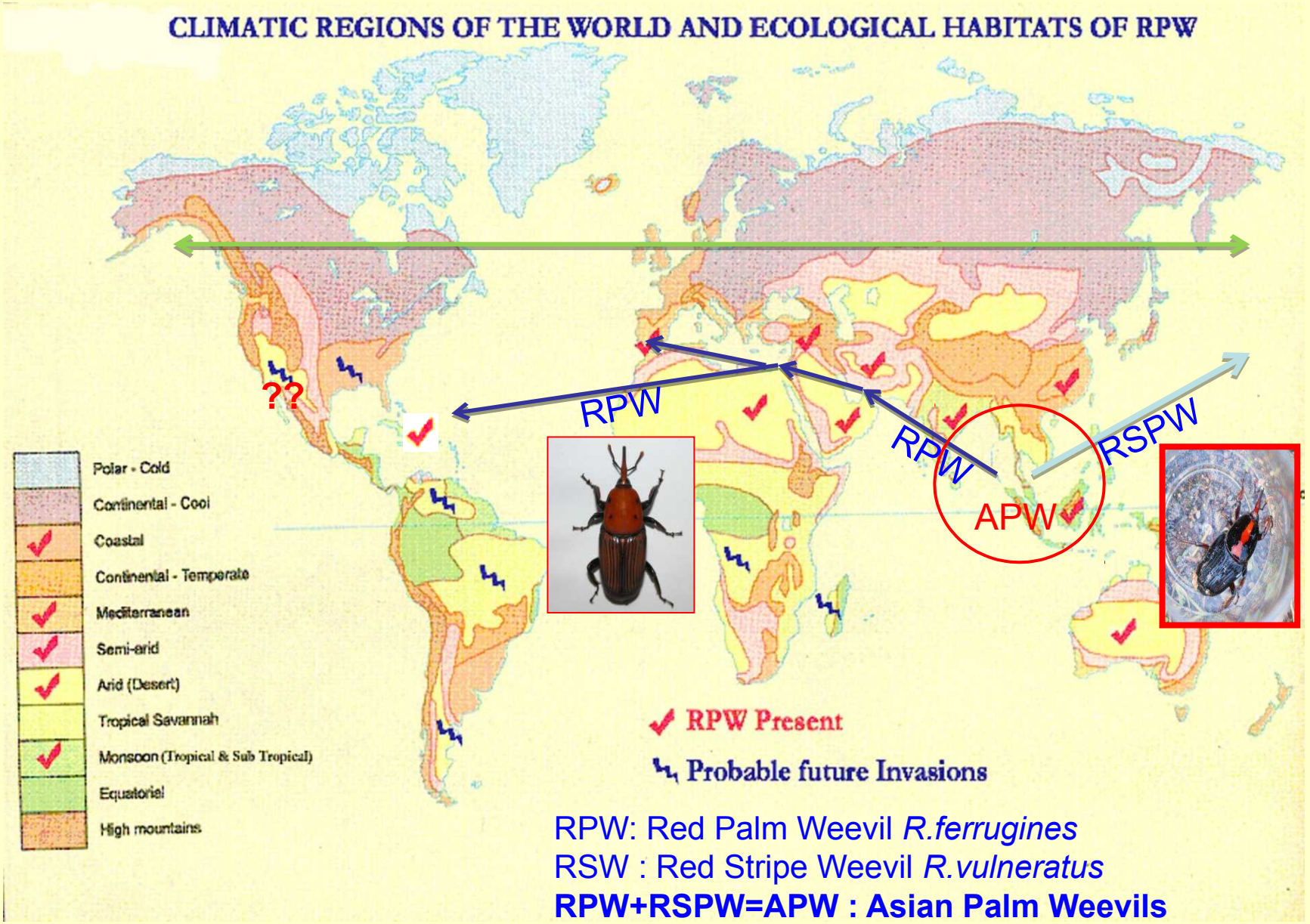
R. palmarum

R. phoenicis

R. quadrangulus

R. bilineatus

This slide is modified from Robin Giblin-Davis, Univ. FL, Fort Lauderdale



The California Report of 2010 is RSPW (*R. vulneratus*) and not RPW

Geographical distribution of RPW

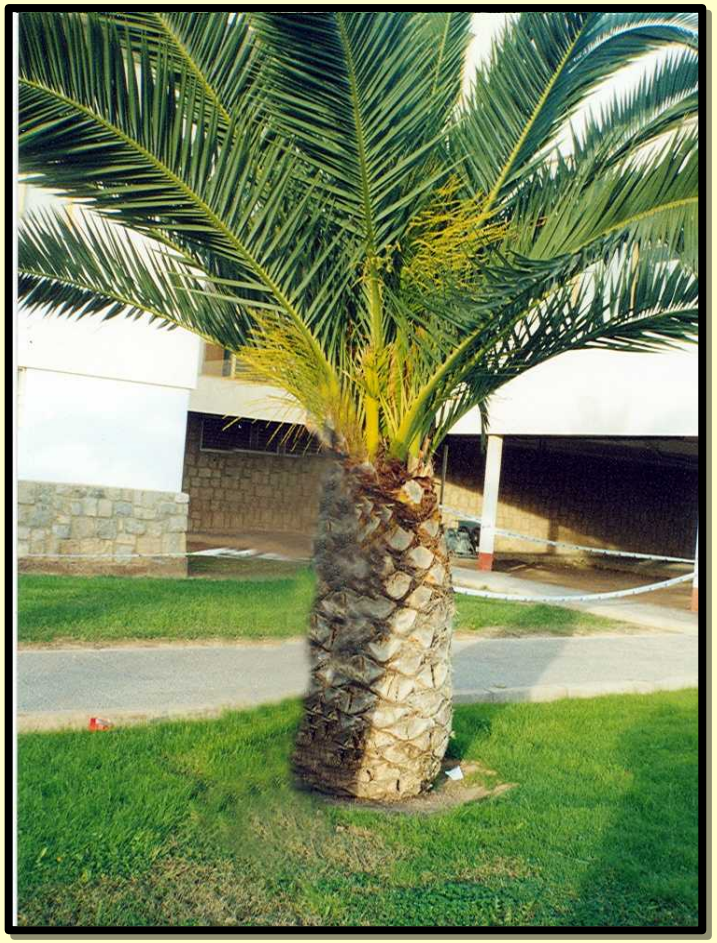
Asia			*Africa*	*Europe*	*Americas*
India*	Thailand	**UAE (1985)**	**Egypt** (1992)**	Spain** (1995)	Curacao Islands (Caribbean-2009)
Pakistan*	Cambodia	Qatar	Morocco**	Turkey**	**USA , 2010 ???**
Sri Lanka	Vietnam	Saudi Arabia	Libya** (2009)	Italy**	
Myanmar	China*	Kuwait	Tunisia 2011	Greece**	
	Taiwan	Oman	Mauritania 2015	France**	
	Philippines	Bahrain		Portugal**	
	Malaysia	Israel		Cyprus**	
	Indonesia	Palestine		Malta**	
	Timor	Jordan		Georgia(2009)	
	Papua New Guinea	Iran		Croatia (2011)	
	Solomon Is./Australia	Iraq ? (1918) **Iraq 2015**			
		Lebanon (2010)			
		Yemen 2013			

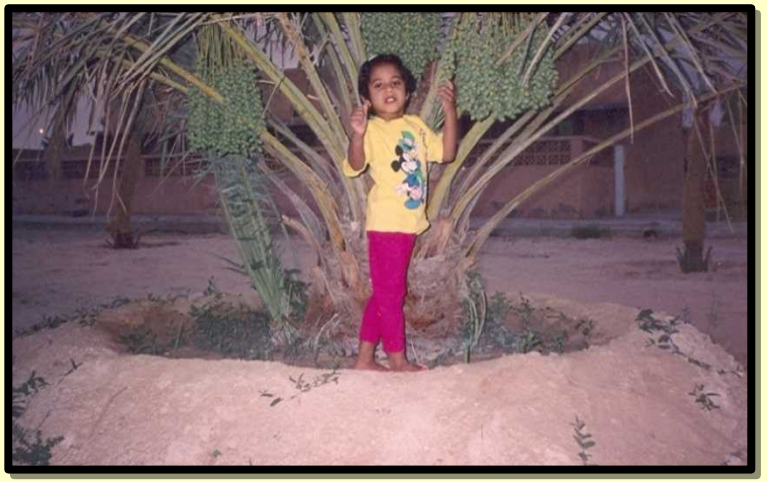
* Grow coconut & date palm ** *P. canariensis*

Host range of *R. ferrugineus* (1956 to 2013) : 4 to 40 palm species

Sr. No.	Host Palm Species	Reference
1	*Cocos nucifera*, *Phoenix dactylifera*, *Metroxylon sagu* and *Corypha umberaculifera*	Nirula, 1956
2	*Cocos nucifera*, *Areca catechu*, *Arenga pinnata*, *Caryota* sp. *Coelococcus* sp., *Corypha* sp., *Elaeis guineensis*, *Livistona* sp., *Metroxylon sagu*, *Nypa* sp., *Oncosperma* sp. and *Phoenix* sp.	Lever, 1969
3	*Areca catechu*, *Arenga pinnata*, *Borassus flabellifer*, *Caryota maxima*, *Caryota cumingii*, *Cocos nucifera*, *Corypha gebanga*, *Corypha umberaculifera*, *Corypha elata*, *Elaeis guineensis*, *Metroxylon sagu*, *Oreodoxa regia*, *Phoenix canariensis*, *Phoenix dactylifera*, *Phoenix sylvestris*, *Sabal umbraculifera*, and *Washingtonia* sp. *Chamaerops humilis and Howea forsteriana (syn. Kentia forsteriana)*	Esteban-Duran *et al.*, 1998 (OJEU, 2008; EPPO, 2009).
4.	40 palm species world wide (Report from Portugal) http://www.savealgarvepalms.com/en/weevil-facts/host-palm-trees	Anonymous, 2013

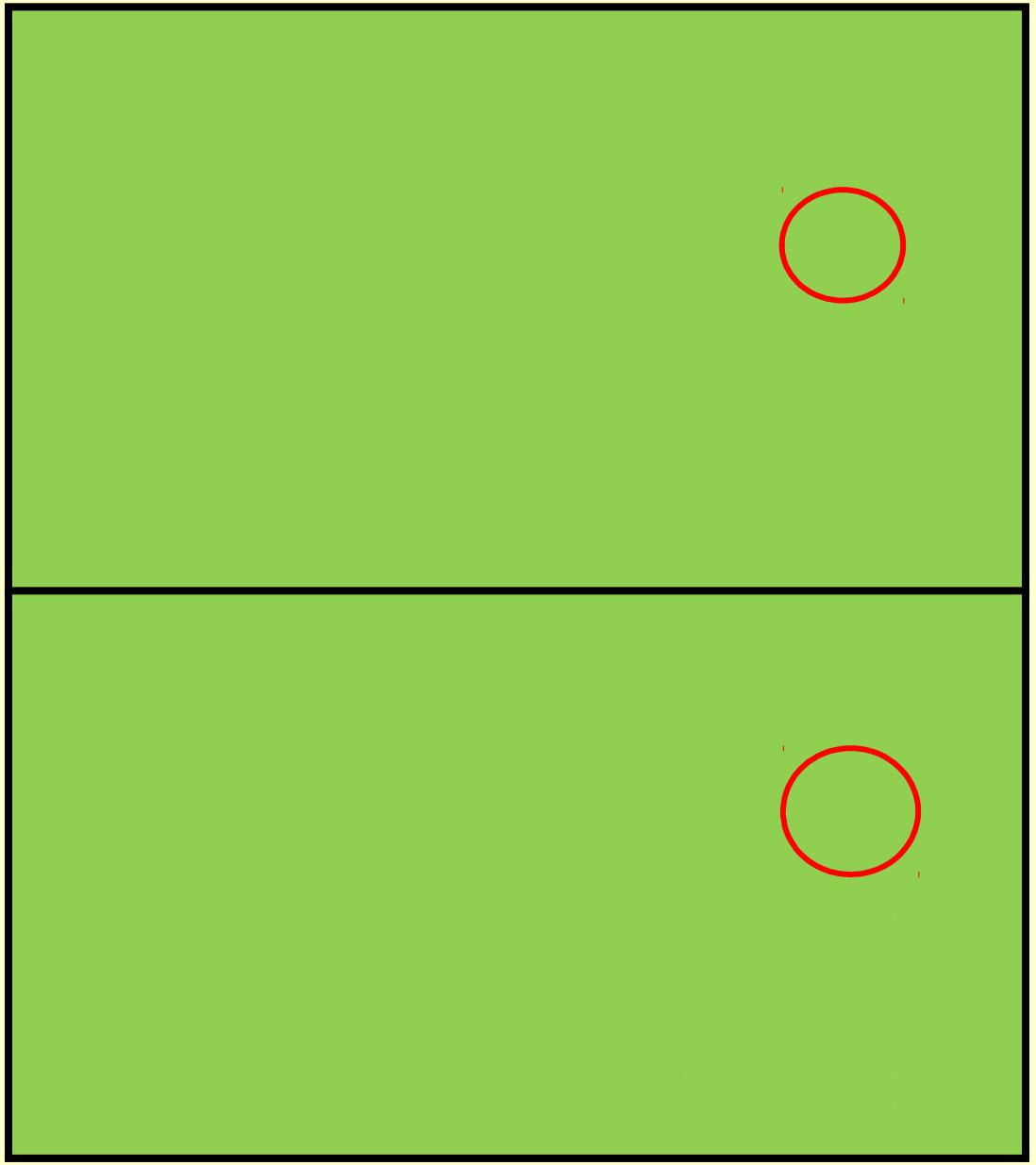
Most Preferred Hosts –*Phoenix canariensis*, *P.dactylifera* and *Cocus nucifera*





Large Stretches of Monocultures of Young Palms

Increase in Area under Date Palm [1992-2012]



GCC Countries

45.36 % increase in area under date palm during the last two decades : 15 million palms

Maghreb Region

47.27 % increase in area under date palm during the last two decades : 12 million palms

Source : FAOstat / Wakas et al., 2015

Check Escape of RPW Through Planting Material

Lack of Quarantine Protocols

Unregulated Palm Nursery Industry

Weak Enforcement

EU Rules to Regulate the Palm Trade : Official Inspections of Immobilized Areas (2007/365/CE)

-Delimitation of survey and demarcated areas

-Three monthly official inspections

- Annual crop declaration

-Application of phytosanitary treatments

-Registration of planting material movement

-Use of plant passport to monitor trade of palms

Socio-economic and Environmental Impact

- RPW has a significant socio-economic impact on the date palm production sector and livelihoods of farmers in affected areas
- Impacts food security and rural community livelihood in date palm oases
- Poses a threat to Heritage/Historic Palms and Plantations of the World (Siwa-Egypt, Al-Ahsa-Saudi Arabia, Elche-Spain,Tangier-Morocco)

Direct losses :

- ✓ Value of the destroyed palms and the loss in yield
- ✓ High cost of management programs
- ✓ Expenses incurred on the removal and disposal of infested palms

Indirect costs are also substantial :

- ✓ Restricted movement of trees, especially their offshoots, resulting in drastic cuts in trade
- ✓ Curtails expansion of new plantations
- ✓ Adverse impact on the environment and landscape as result of chemical treatments and removal of the infested palms, respectively

- Removal of severely infested palms in the GCC countries has been estimated to range from 1.74 to 8.69 million USD at 1 and 5% infestation, respectively

- In Valencia, Spain between 2004 and 2009, around 20,000 palms, mostly *P. canariensis*, were killed by RPW, where losses were estimated to be 16 million Euro.

Extensive Damage to the Urban Landscape

Source: Agrinvest SRL, Italy

Behavior & Bio-ecology of RPW

Behavior of RPW : Not Well Understood

Why is This Weevil Here?
-On Freshly Ploughed Barren Land

Life Cycle of RPW

(Adult)
Partially Hidden/Cryptic

Adult RPW lives for 2-3 months. Females lay 250-350 eggs

Eggs hatch in 3-6 days

Larvae live for 1to 2months and feed on the palm tissue causing extensive tissue damage

Pupal stage lasts for 15-30 days

(Egg-Larva-Pupa)
Hidden/Cryptic

Temperature Thresholds for RPW

Character	Number in days
No. of eggs/ female	58-531 Concealed
Incubation period	1-6
Larva: Larval period	25 – 105 (3-17 instars) Concealed
Pupal period	11-45 Concealed
Adult	50-90 Concealed/Exposed
Egg-Adult	45-139

Lower Temperature Thresholds

Oviposition : 15.45 ^{0} C
Hatching : 13.95 ^{0} C (Dembilio et al., 2012)

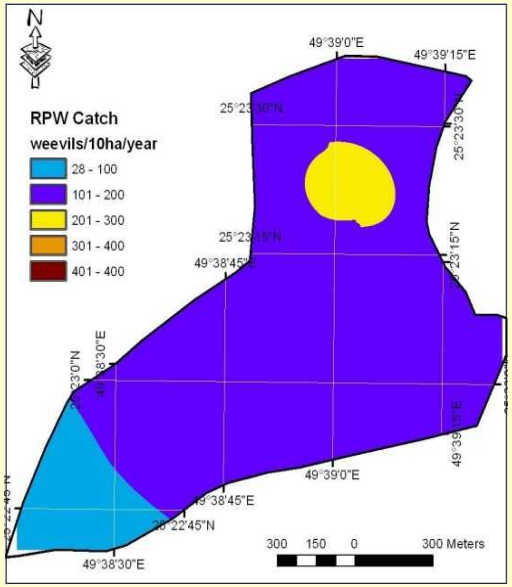
< 1 generation a year in areas with mean annual temperature below 15 ^{0} C.

>2 generations where mean annual temperature is above 19 ^{0} C (Dembilio et al., 2010)

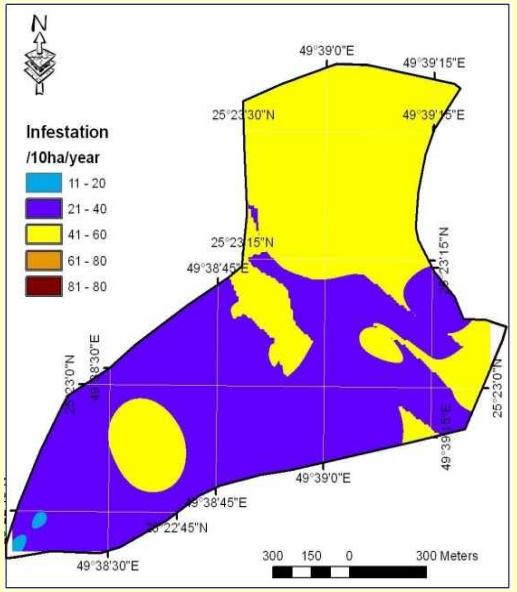
Minimum lethal temperature

10 ^{0} C for eggs
15 ^{0} C for larvae
0 ^{0} C for pupae
(Martin and Cabello, 2005, Cabello, 2006)

GIS Based Spatial Spread of RPW [Al-Soodha (126ha) KSA- 2008]



Weevil Captures

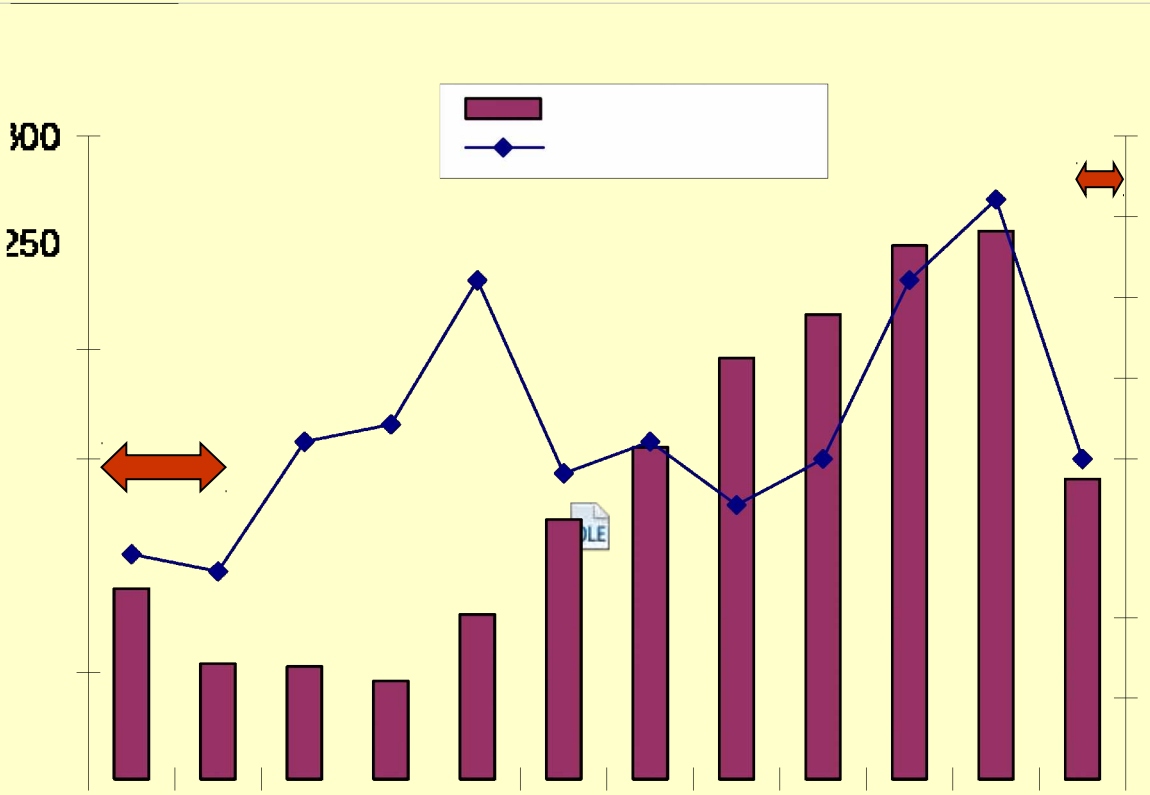


Infestation

Implications:

1.Infestations in clusters

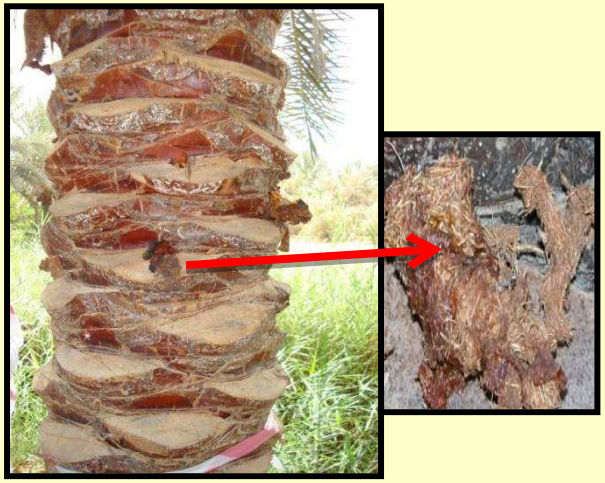
2.Field trials(Trapping trials): Prone to error due to ‘spot effect’



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, 65pp.

Damage-Detection-IPM

Symptoms of Damage Due to RPW

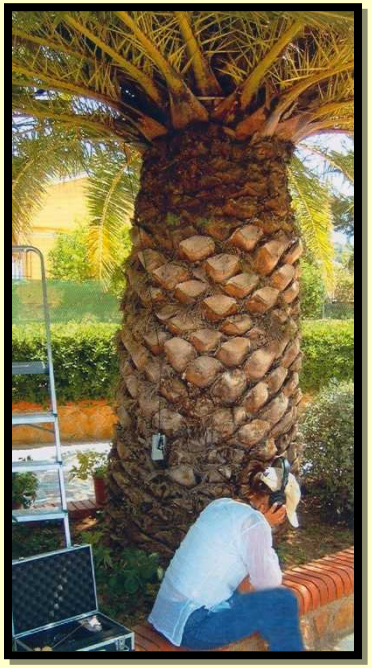


Detecting RPW Infested Palms

Current Practice
- Visual
- Pest Collection (Trapping)

Experimental
- Detecting Chemical Signatures
- Acoustic Detection
- Infrared Cameras
- Thermal imaging

Detecting RPW Infested Palms



Sound Detection Devices

Sniffer Dogs

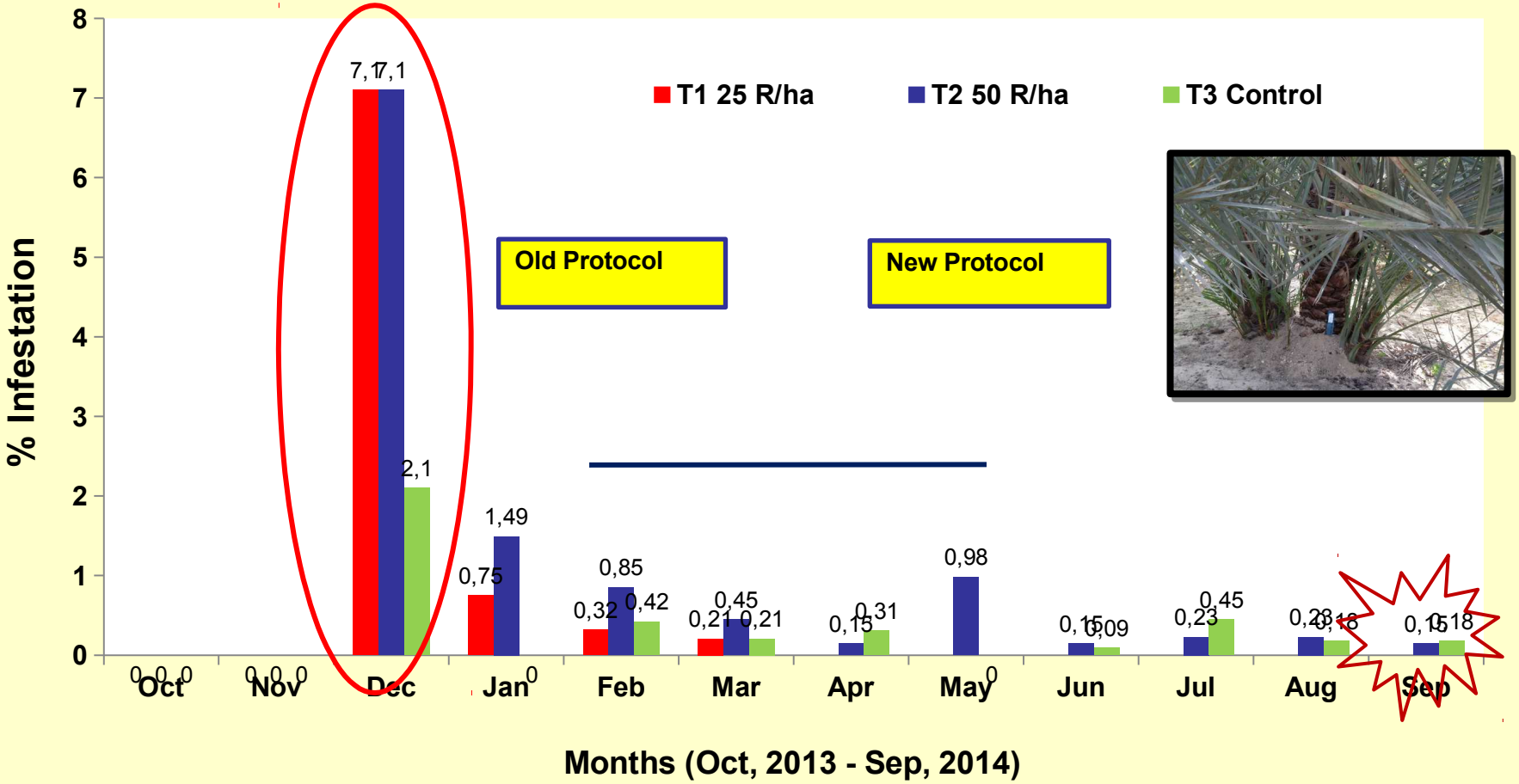
Sensor Based Detection

Visual Inspection of Palms to Detect RPW Infestation

Screw Driver Probe

Photos by : Moisés Fajardo Bello
Coordinador GMR Canarias

Impact of Periodic Visual Inspection of Palms [30 ha Date Plantation]



Regular Visual Inspections : Key to the Control of RPW

Predisposing Factors for RPW Attack

Neglected Gardens

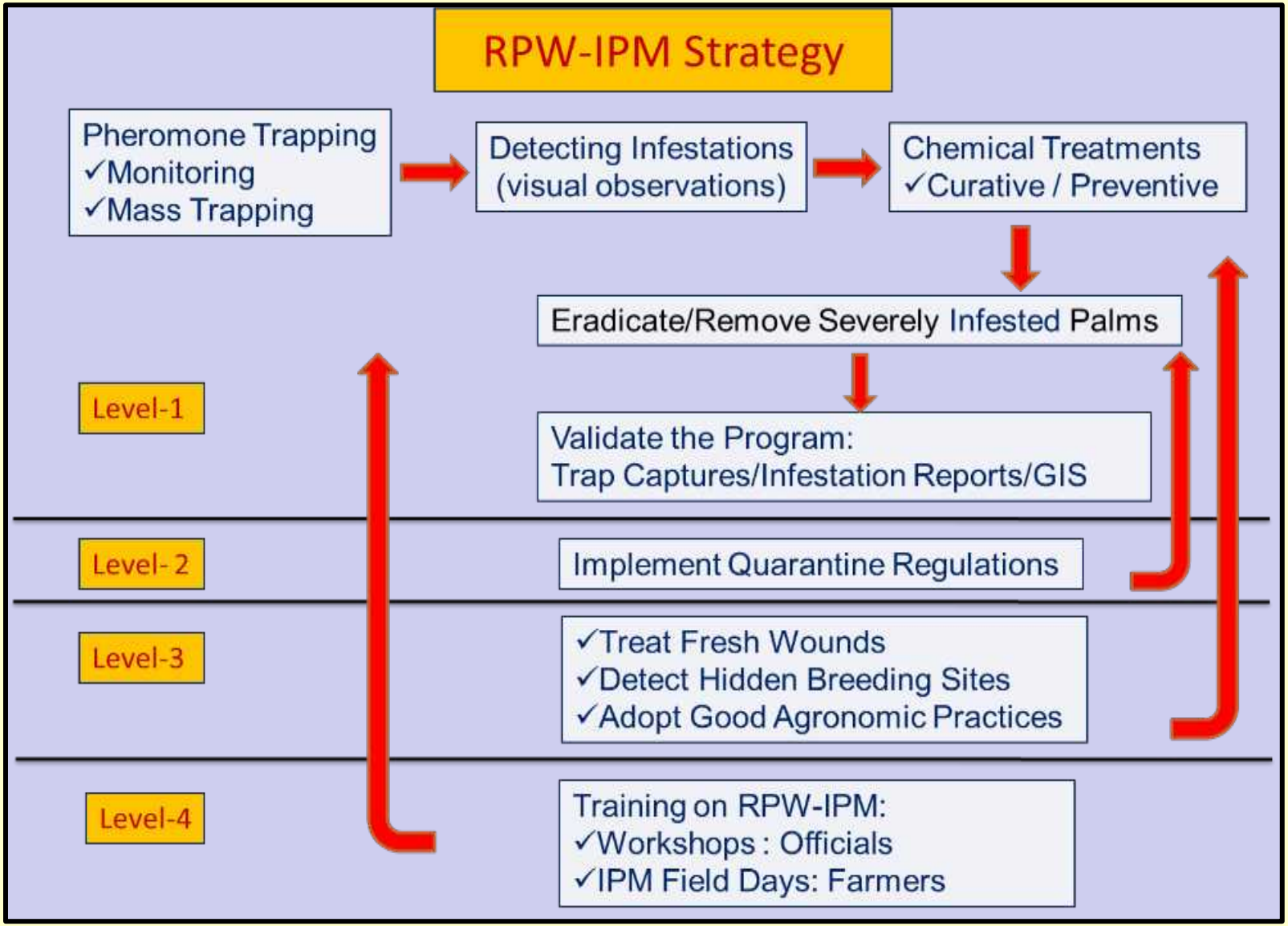
- - - Wounds on the Palm - - -

Breeding site – Cut Palm

Closed Garden

In-groove Humidity*

Abraham et al., 1998 ; Aldryhim et al., 2003*


RPW-IPM Strategy
Pheromone Trapping
✓Monitoring
✓Mass Trapping
Detecting Infestations
(visual observations)
Chemical Treatments
✓Curative / Preventive
Eradicate/Remove Severely Infested Palms
Level-1
Validate the Program:
Trap Captures/Infestation Reports/GIS
Level- 2
Implement Quarantine Regulations
Level-3
✓Treat Fresh Wounds
✓Detect Hidden Breeding Sites
✓Adopt Good Agronomic Practices
Level-4
Training on RPW-IPM:
✓Workshops : Officials
✓IPM Field Days: Farmers

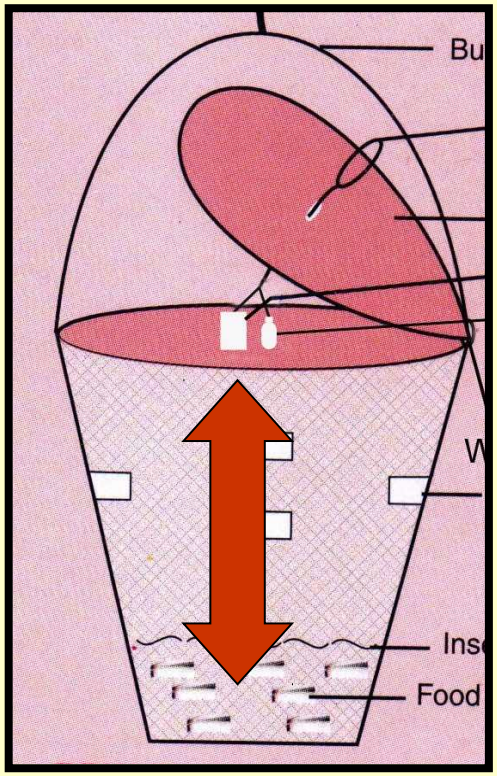
Semiochemicals

Semiochemicals are well-known management tools especially for cryptic species (Soroker et al., 2015)

- **RPW Pheromone** : 4S, 5S nonanol & 4S, 5S nonanone
- **Host Attractants** : ethyl acetate , ethyl alcohol, ethyl propionate, pentan-1-ol , 2-methoxy-4-vinylphenol & gamma-nonanoic lactone
- **RPW Repellents** : methyl salicilate , α-pinene, 1-octen-3-ol & geraniol

(Soroker et al., 2015)

Adopt the Best Protocols to Enhance Trapping Efficiency

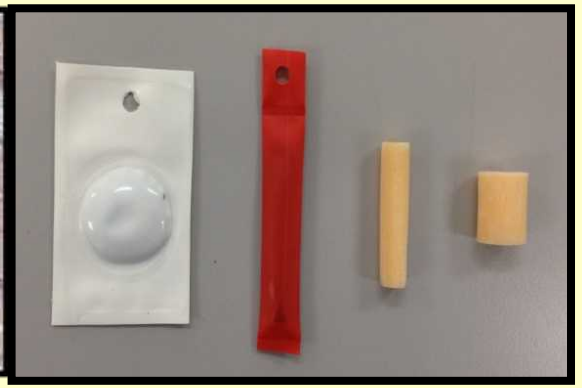


✓ **BAIT LURE SYNERGY**

✗ **PALM LURE SYNERGY**

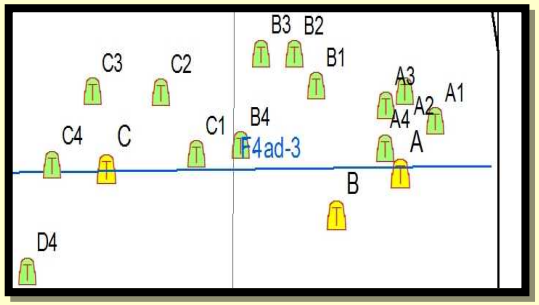
Pheromone Trapping : Overview

Trap Design and Lures

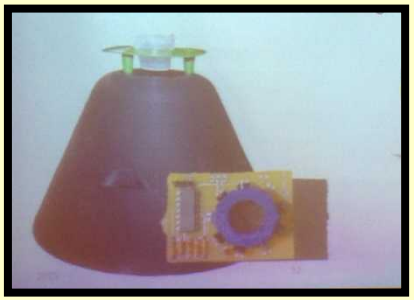


Food Baits and Kairomones

Trap Density and Smart Traps



Trap & Bait Free Trapping



- ✓ Develop mobile application for data collection and transmission
- ✓ Develop a GIS data base

Will trapping alone do ?
The North African Experience

Libya

- Trap captures increased from 10 weevils / trap / month during May ,2009 to over 100 weevils / trap / month during February, 2010

Morocco

- Trap captures within 2-5 weevils / trap / month (2009-10) Morocco

Maps : http://www.lonleyplanet.com

Chemical Control

Preventive Chemical Treatments

Low Pressure High Volume Sprays

Targeted Preventive Sprays
-After Offshoot & Frond Removal

- ✓ Plantations
- ✓ Nurseries
- ✓ Ornamental/Avenue Palms

Curative treatment of RPW infested palms

Mechanical Sanitation

Palm Injectors ?

Insecticide Residues Due to Both Preventive & Curative Chemical Treatments

Removal of Severely Infested Palms

Removal

Shred / pulverize

Burn ??

Lessons From the Canary Island

- ✓ Remove/Eradicate Within 24h of Detection
- ✓ Follow Strict Quarantine Protocols
- ✓ Adopt Phytosanitory Treatments

Current Protocol is Costly and Not Sustainable

Agronomic Practices Influence RPW Attack

Poor Field Sanitation

Frond and Offshoot Management

Irrigation Method & Palm Density

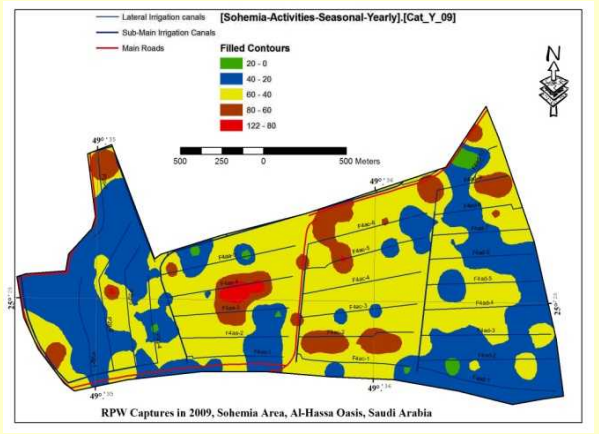
Host Plant Resistance Not Exploited : Does RNAi Hold the Key?

Periodic Monitoring & Evaluation of the RPW-IPM Strategy

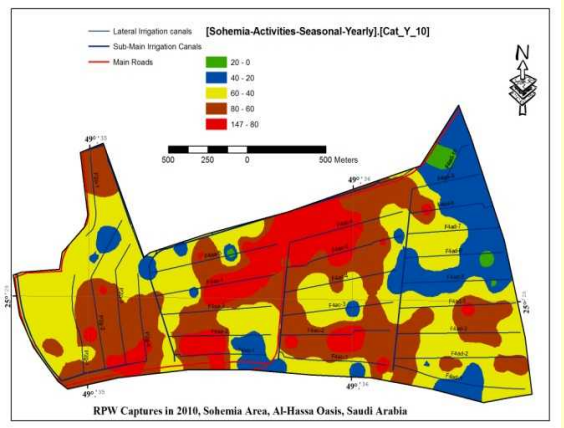
Canary Island RPW Control Program :
Effective use of Mobile Applications /GIS for Instant Communication
[Data Collection, Transmission, Interpretation & Decision Making]

Photo by : Moisés Fajardo Bello
Coordinador GMR Canarias

Al-Suhemia, Saudi Arabia
2009 / 2010



RPW Captures in 2009, Sohemia Area, Al-Hassa Oasis, Saudi Arabia



RPW Captures in 2010, Sohemia Area, Al-Hassa Oasis, Saudi Arabia

What About Biological Control

Potential Biocontrol Agents	Scientific Name
Insects (Wasp, Earwig)	*Scolia erratica , Sarcophaga fuscicauda, Chelisoches moris*
Bacteria	*Pseudomonas aeruginosa, Bacillus* sp., *Serratia* sp. *B. sphaericus, B. mgaterium, B. laterosporus,* and *B. thuringinsis,*
Fungus	*Beauveria bassiana, Metarhizium anisoplieae*
Virus	Cytoplasmic Polyhedrosis Virus (CPV),
Yeast	------
Entomo-Pathogenic Nematodes (EPN)	*Heterorbhabditis* spp., *Steinernema abbasi, Heterorbhabditis indicus, Teratorhabditis palmarum, Steinerema* sp., *H. indica,* and *Rhabditis* sp.
Birds (Indian tree pie bird and Crow pheasant bird)	*Dendrocitta vagabunda parvula*

Under field conditions, imidacloprid and *S. carpocapsae*, either alone or in combination were not significantly different from each other, with efficacies ranging from 73 to 95 % (Dembilio et al., 2010). *Beauveria bassiana* solid formulation with high RPW pathogenicity and persistence, could be applied as a preventive as well as curative treatment for RPW control (Gűerri-Agulló et al., 2011).

RPW Control : Challenges and Lessons Learned

Over all improvement in the IPM Strategy:

- ✓ Providing financial and human resources
- ✓ Better understanding of the behavior (Bio-ecology) of RPW
- ✓ Early detection of infested palms
- ✓ Deliver and sustain biological control agents in the field
- ✓ Test ,develop and deploy service-less trapping options
- ✓ Develop phytosanitary protocols and implement quarantine laws
- ✓ User friendly mobile applications for GIS assisted data management and decision making
- ✓ Focus on applied research
- ✓ Facilitate farmer participation in the control program
- ✓ Involve all stakeholders including the private sector, universities and research institutions, professional associations including producers' organizations
- ✓ Build capacities and strengthen the extension network
- ✓ Experience sharing through local, regional and international cooperation

Is There Hope ?

Yes There Is

- ✓ **Eradication of RPW in the Canary Islands, Spain (May 2016)**
- ✓ **Control of RPW in Mauritania**

THANK YOU

Acknowledgements

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- ✓ King Faisal University, Kingdom of Saudi Arabia
- ✓ Indian Council of Agricultural Research