BIOLOGY AND MANAGEMENT OF RED PALM WEEVIL IN SAUDI ARABIA

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DATE PALM ORCHARD IN SAUDI ARABIA

Tissue Cultured Plants near Al Kharj

HOST RANGE

***Rhynchophorus ferrugineus* feeds primarily on palms (Arecaeae) and has been recorded on the following plants:**

- Agavaceae: *Agave americana* (century plant).
- Arecaceae: *Areca catechu* (betel nut palm),
- *Arenga saccharifera* (sugar palm),
- *Borassus flabellifer* (toddy palm),
- *Borassus* sp. (palmyra palm),
- *Calamus merrillii* (rattan),
- *Caryota cumingii* (fishtail palm),
- *C. maxima* (giant mountain fishtail palm),
- ***Cocos nucifera* (coconut),**
- *Corypha utan* (= *C. gebanga*, *C. elata*) (gebang palm),
- *C. umbraculifer* (talipot palm),
- *Elaeis guineensis* (oil palm),
- *Livistona decipiens* (ribbon fan palm),
- *L. chinensis* (Chinese fan palm), *L. saribus* (= *Livistona cochinchinensis)* (serdang palm),
- *L. subglobosa,*
- *Metroxylon sagu* (sago palm),
- *Oneosperma horrida,*
- *O. tigillarium* (nibong palm),
- ***Phoenix canariensis*** (Canary Island date palm),
- ***P. dactylifera* (date palm),**
- *P. sylvestris* (Indian date palm),
- *Oreodoxa regia* (royal palm),
- *Sabal umbraculifera* (pygmy date palm),
- *Trachycarpus fortunei* (Chusan palm) and *Washingtonia* sp.
- Poaceae: *Saccharum officinarum* (sugar cane).

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BIOLOGY OF RED PALM WEEVIL

LIFE STAGES OF RPW

DURATION OF LIFE STAGES

- Mated females lay approx 200-300 eggs and occasionally may exceed 500. Eggs hatch in 5-9 days.
- Upon hatching the larvae feed on the host tissues boring inside and molt several times. It takes 70-189 days depending on temperature and humidity.
- Fully grown larvae spin a fibrous cocoon from the host plant tissues and pupate.
- Pupa stage may last 18-25 days under lab conditions.
- Adults on emergence are fully developed and ready to mate except in some cases. Longevity of males/females is variable but usually more than 60 days.

LARVAL INSTARS AND DURATION

Instar	Duration (days)		Instar	Duration (days)
1	6.83±0.44		9	9.67±0.87
2	8.33±0.70		10	12.33±1.82
3	6.67±0.48		11	17.83±1.59
4	5.17±0.28		12	12.33±1.22
5	5.50±0.20		13	13.50±2.17
6	6.00±0.47		14	17.67±2.10
7	9.00±1.49		15	22.00±1.97
8	9.83±0.98		16	24.70±6.08
	Total			167.50±8.38

LABORATORY REARING

Many studies were conducted to mass rear the insect in laboratory. Mostly on sugarcane and/or semi-synthetic diets (Rahalkar et al., 1972; Rahalkar et al., 1985; Rananaware et al 1975, (India); Salama and Abdel-Razek, 2002 (Egypt).Rahalkar *et al*. (1978) reported that an artificial diet containing sugarcane bagasse, coconut cake, yeast, sucrose, essential minerals and vitamins, agar, water and food preservatives maintained 12 generations of the weevil.

In Saudi Arabia also mass rearing technique has been developed (Aldhafer, 1998; Vidyasagar & Aldosari, 2010 (communicated).

Reports available about the healthy and large insects obtained through rearing on palm tissues of dates….

SA researchers have found differences in the development based on the date palm cultivar (Al-Ayedh, 2008).

NUMBER OF ANNUAL GENERATIONS

In Saudi Arabia study was conducted on the number of instars and duration of each generation. It is dependent on the temperature and took approximately 170 days on an average for one cycle (communicated for publication).

It was estimated about two generations in the field based on the laboratory biology and weevil capture rated in the field. (Vidyasagar et al 2000)

In Egypt, El Ezaby (1997) reported that the weevil has three generations per year, the shortest generation (first) of 100.5 days and the longest (third) of 127.8 days. The study also showed that the upper temperature threshold of the egg was 40°C.

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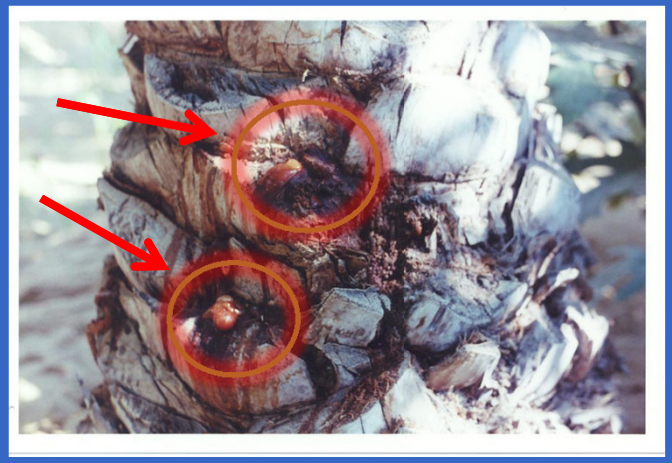
NATURE OF DAMAGE IN DATE PALM



How Coconut, Date and Canary Palms are different !

Description	Date palm	Coconut palm	Canary palm
Morphology of stem	**Rough**	Smooth	Smooth
Propagation	**Offshoots**	Seed	Seed
More infestations	Young	Young	Young & Old
Site of infestations	Bole / crown	Crown/bole	Crown
How Long RPW is known	20 years	100 years	10 years
Transplanting	Any Age	1-2 yrs	Seedlings

RPW DAMAGE IN PALM TREES

Date Palm

Coconut Palm

Canary Island Date Palm

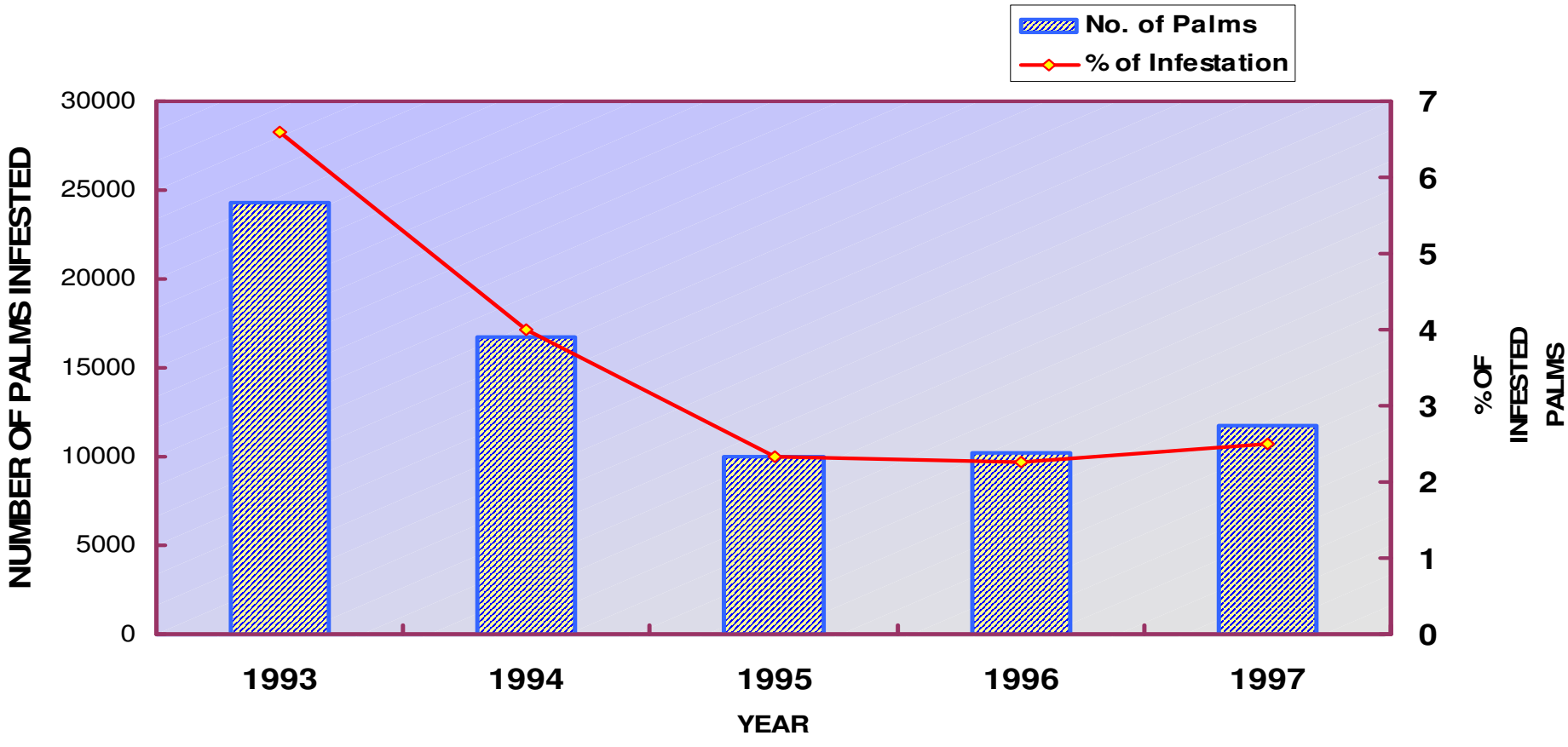
RPW SCENARIO IN SAUDI ARABIA

- ✓ RPW known to farmers since 1990s only.
- ✓ Most of the farm operations are carried out by farm labor.
- ✓ Plant protection operations are organized by Agriculture Ministry and/or farmer himself.
- ✓ More awareness about the damage and hence ready to adopt new methods of control.
- ✓ Access to latest methods for management through extension services.
- ✓ Propagation by offshoots or grownup palms and transported and transplanted in other locations.
- ✓ Plant quarantine laws regarding transport or import of planting material in place.

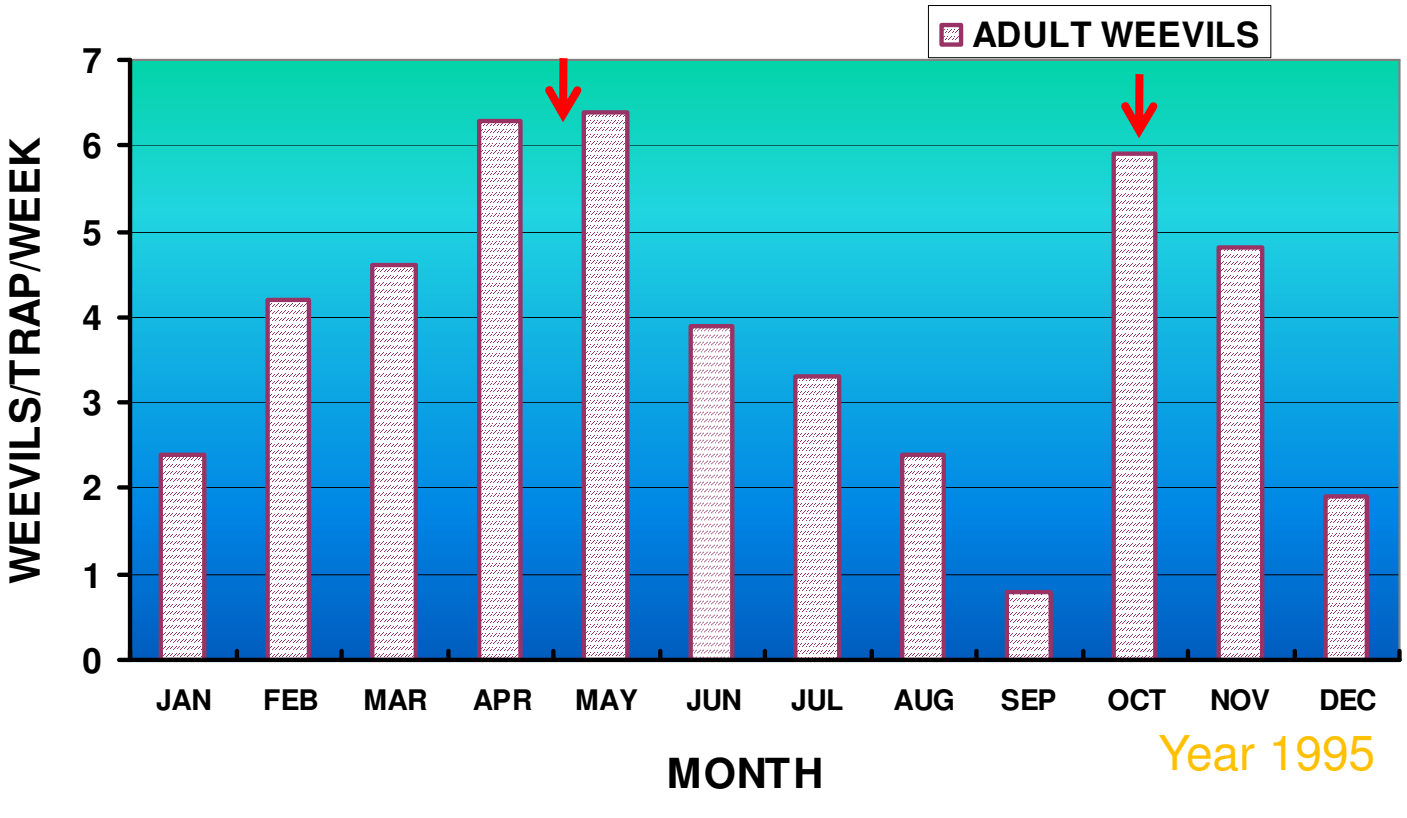
DISTRIBUTION OF RPW IN SAUDI ARABIA

CASE STUDY – SAUDI ARABIA (1993–1998)

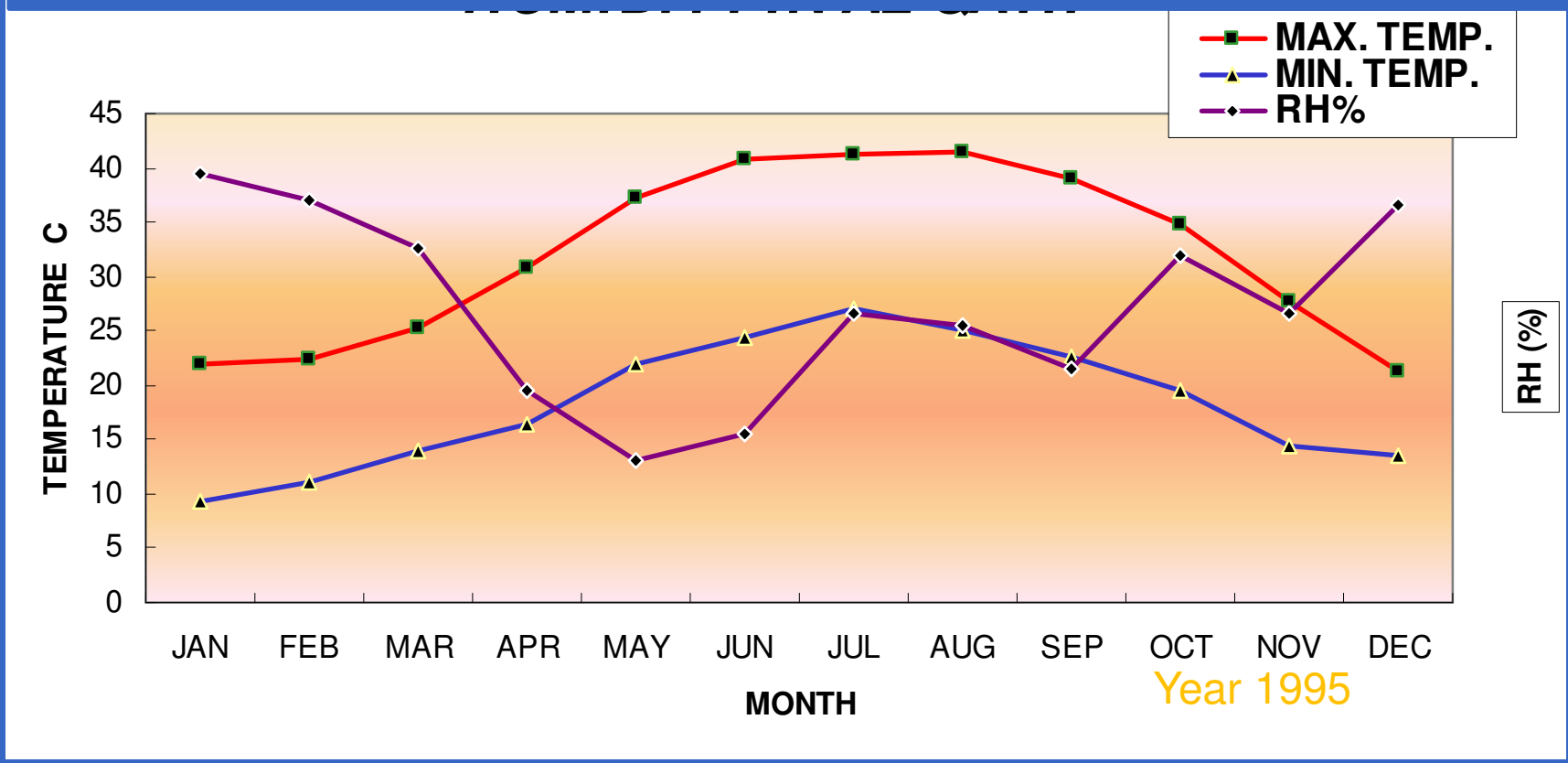
NUMBER AND PERCENTAGE OF INFESTED PALMS FROM 1993-1997



Average Number of Adult Red Palm Weevils Captured in Different Months



AVERAGE MAXIMUM AND MINIMUM TEMPERATURE AND RELATIVE HUMIDITY



PLANT PROTECTION OPERATIONS

S. No.	Description	Year			
		1994	1995	1996	1997
1.	No. of infestations (S.No. 6 - 7)	16694	10041	10241	11693
2.	No. of injections	10003	5287	4865	5091
3.	No. of fumigations	4542	1033	914	899
4.	No. of inject.ion + fumigation		1039	1025	1264
5.	No. of clean + insecticide		1940	2683	3697
6.	Total palms treated (S.No. 2 - 5)	14545	9299	9487	10951
7.	Total palms removed	2149	742	754	742
8.	Old palms removed	2718	2104	1827	770
9.	No. of palms soaked	321805	299386	275135	257385

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MANAGEMENT OF RED PALM WEEVIL IN SAUDI ARABIA

DETECTION METHODS

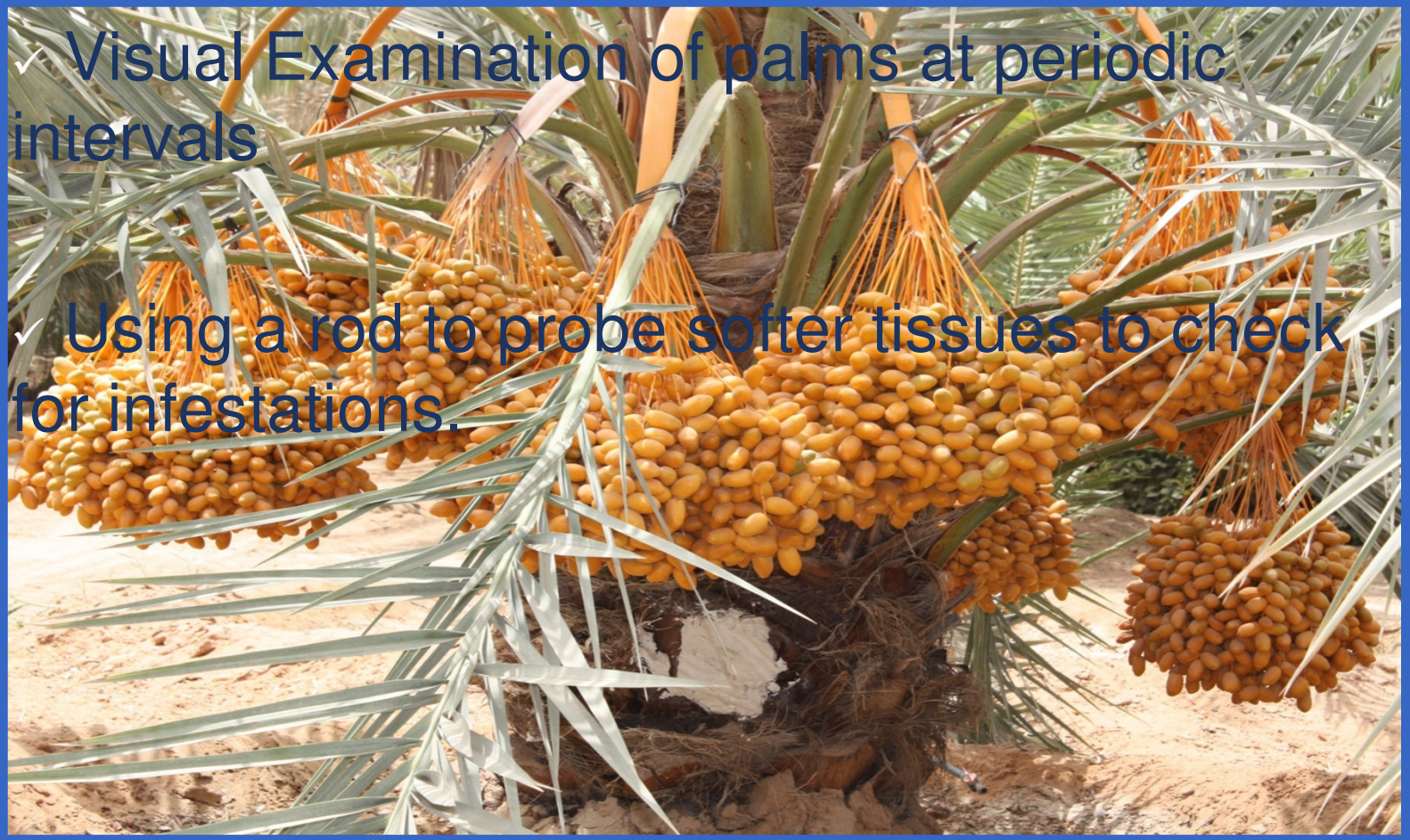
Past

- Inspecting the palms visually for symptoms of damage
- Probing the suspected parts of the palms
- Other methods of detection

Present

Bioacoustic methods for detection

METHODS OF DETECTION



- ✓ Visual Examination of palms at periodic intervals
- ✓ Using a rod to probe softer tissues to check for infestations.

MODERN DETECTION METHODS

A

Laar WD 60 : High end amplifying system with special probe sensor sound activities from 50 Hz up to 250 kHz. Laar TCE 1 detector.
Contact microphone, airsound ultrasound microphone, contact acceleration sensor and a combined contact airsound probe sensor. (Laar Tech Inc, Germany, 2004)

B

- ✓ The SP-1 sensor is magnetically attached to a nail inserted into the soft palm wood.
- ✓ The nail acts as a “waveguide” to conduct the sounds from RPW larvae feeding inside stem.

C

- ❑ Acoustic signals of boring RPW larvae recorded using off-the-shelf recording devices.
- ❑ Discrimination of RPW signals from those emitted by healthy palms is still difficult.
- ❑ The methodology applied was similar to speech recognition techniques, utilizing Vector Quantization or Gaussian Mixture Modeling.

Chemical Control Methods

Spraying method

Conventional spraying of pesticides with high pressure sprayer

CHEMICAL CONTROL METHODS

Soaking methods

Soaking the crowns with long lance at low pressure

STEM INJECTION METHODS

Stem injection methods

- ✓ Mechanical injection manually
- ✓ Electric Drilling and injection
- ✓ High pressure injection with latest equipment

1994-2010
(continued)

STEM INJECTION

Drilling of holes

Administering Insecticide with bottle

CHEMICAL CONTROL TRIALS

(Past)

- **Pesticide was applied to the crown and stem of palms by soaking method.**
- **1. Endosulfan 2. Supracide (0.1%) and 3. Decis (0.01%) recorded the least infestations.**
- **In another trial Endosulfan (0.1%) and Dimethoate (0.1%) proved effective in preventing infestations.**
- **The soil drenching with Confidor 200SL @ 15 ml in 10 L water per palm or soil application of Confidor 5 G granules @ 100 g per palm was also tested.**
- **Application of Confidor 5 G granules @ 100 g per palm has not prevented pest attack.**

Eastern Province, KSA, (1994-1996)

ENDOTHERAPY

(Present)

Unit of high pressure Stem Injection

PESTICIDE RESIDUES

- Recent studies indicated the presence of higher levels of pesticide residues in date fruits indicating a hazardous trend in the date palm cultivation.

- There is a need to take up the residue studies in the date fruits from various sources of Kingdom to ensure safety standards.

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LOG TRAPPING IN SAUDI ARABIA

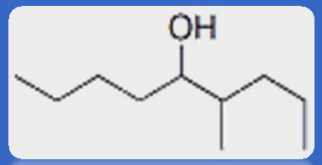
(WITHOUT PHEROMONE)

First traps in 1992

MALE AGGREGATION PHEROMONE

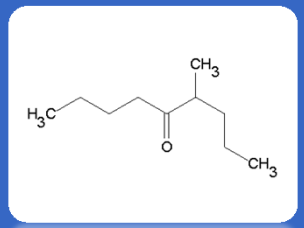
(4S,5S) 4-methyl-5-nonanol

major component $C_{10}H_{22}O$



4-methyl-5-nonanone

$C_{10}H_{20}O$



VARIOUS TRAP DESIGNS

Inverted Trap

French Trap & **Lure**

Serial Funnel Trap of Turkey

PHEROMONE TRAPPING

Monitoring

- Distribution of Saudi pheromone traps
- Monitoring the traps and checking infestations

Mass pheromone trapping

- Attract and kill the insect to reduce population
- Higher density trapping methods
- Servicing of traps regularly
- Adoption of any new methods

SUSTAINING TRAPPING SYSTEMS

- For developing a successful trapping system against a pest, information on the
- Type of trap
- Height of trap
- Kind of food bait and
- Most essentially trap density is needed.
- More information is required to make a strong program.

CHEMICAL ECOLOGY OF THE INSECT – FUTURE TRENDS

Present status	Future research
Aggregation pheromone blends in mass trapping are used (4 methyl 5 nonanol + 4 methyl 5 nonanone) (9:1)	Are there other groups of behavior modifying chemicals in RPW ?
Aggregation pheromone + Kairomone also used	Are there other host volatiles to increase attraction?
Food baiting is a must	Any substitute for Food available ?

BIOLOGICAL CONTROL METHODS

- Efficacy of entomopathogenic nematodes namely *Heterorhabditis bacteriphora*., *Steinernema* spp. and isolates already tested.
- *Beauveria bassiana* and many isolates were tested against RPW.
- Methods for the formulation of these biocontrol agents and application in field has been tested.
- Integration of the most potent biocontrol agents in the management programs may be fully explored.
- From 1997 to 2002 there was a project on Biocontrol of RPW in Saudi Arabia and other Gulf countries.

CULTURAL PRACTICES

Date palm *Phoenix dactylifera* grows in very hot arid zones of the world and palms give out offshoots in the early part ie 5-10 yrs old palms. Irrigation and humidity were shown to have effect on RPW (Aldryhim, Y. and Khalil, A. (2003) and Aldosari (2008).

A palm may continuously produce these offshoots. Farmers use them for new plantations. Propagation by offshoots. So there is transportation involvedLike many palms, quite old and tall trees are transplanted to establish new farms or just landscape, & irrigation my be flood, drip or sprinkler depending upon the type.

USE OF LIGHT TRAPS TO CAPTURE *ORYCTES* SP.

Light traps are used to capture *Oryctes* spp. In many farms of Saudi Arabia.

Reduced populations of *Ocyctes* sp. Reduces mechanical damage to the palm.

Hence access points on the tree for Red Palm Weevil are reduced.

This is a good method for preventing weevil attacks.

PLANT QUARANTINE

- Movement of offshoots within infested area.
- Transport of planting material to other regions within the country.
- Transport from one country to other.
- Serious consideration should be given based on sound scientific principles.
- Emphasis should be to contain the infestation.

REMOVAL OF PALMS - 1

REMOVAL OF PALMS - 2

(Present 2009)

MODERN METHODS

Microwave technologies 1

Red Weevil Buster - Jordan

- High radio-frequency jamming hit the tree.
- Reaches very high temperatures of up to 60 degrees Celsius.
- These high-frequency waves will produce heat inside the tree to kill to all organisms.

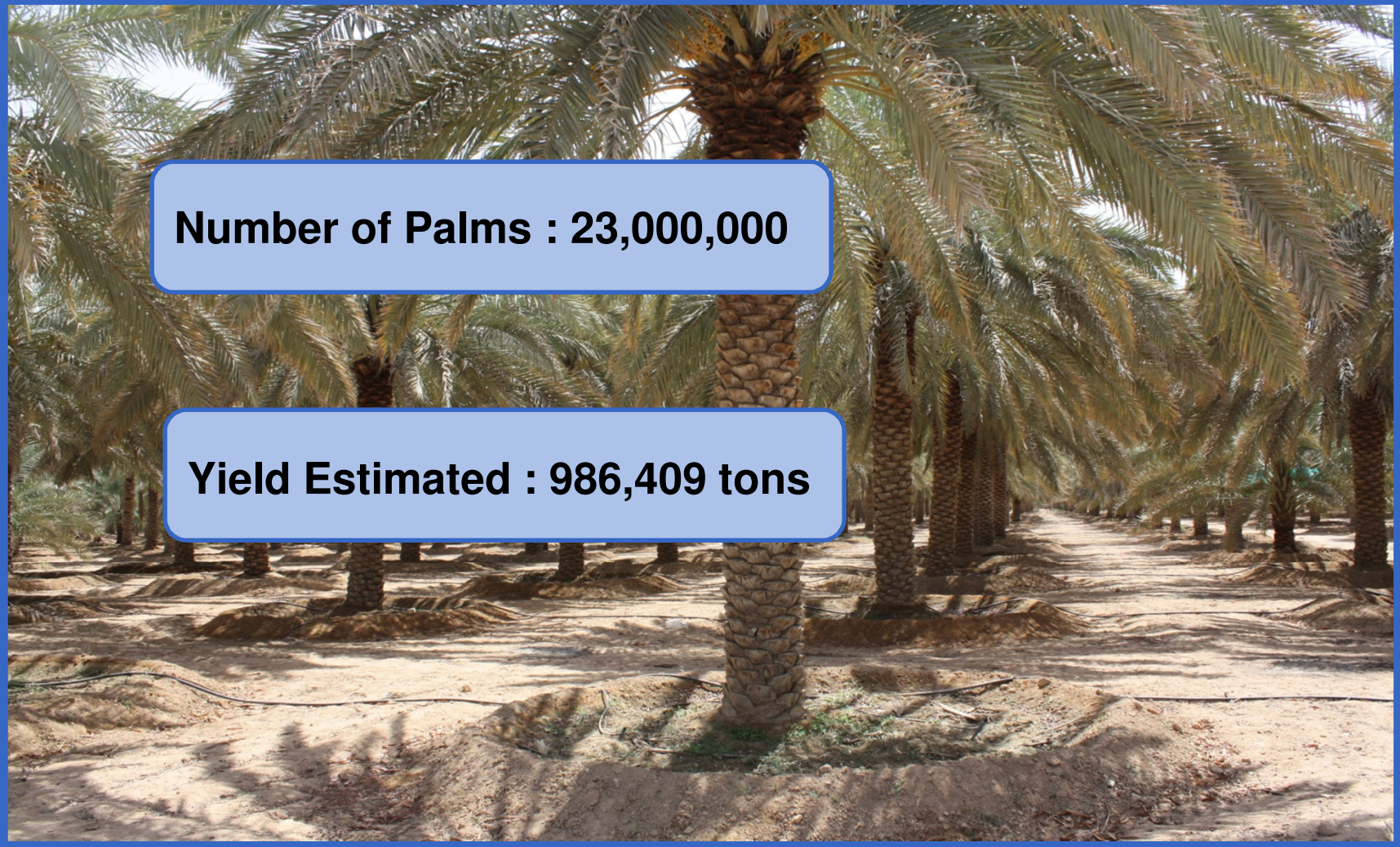
Microwave technologies 2

EcoPalm Ring

BIOTECHNOLOGY RESEARCH

- Research on Red Palm Weevil (RPW) molecular biology and biotechnology
- Development of a diagnostic kit for early detection of RPW.
- DNA fingerprinting of RPW adults from different areas. National and International locations.

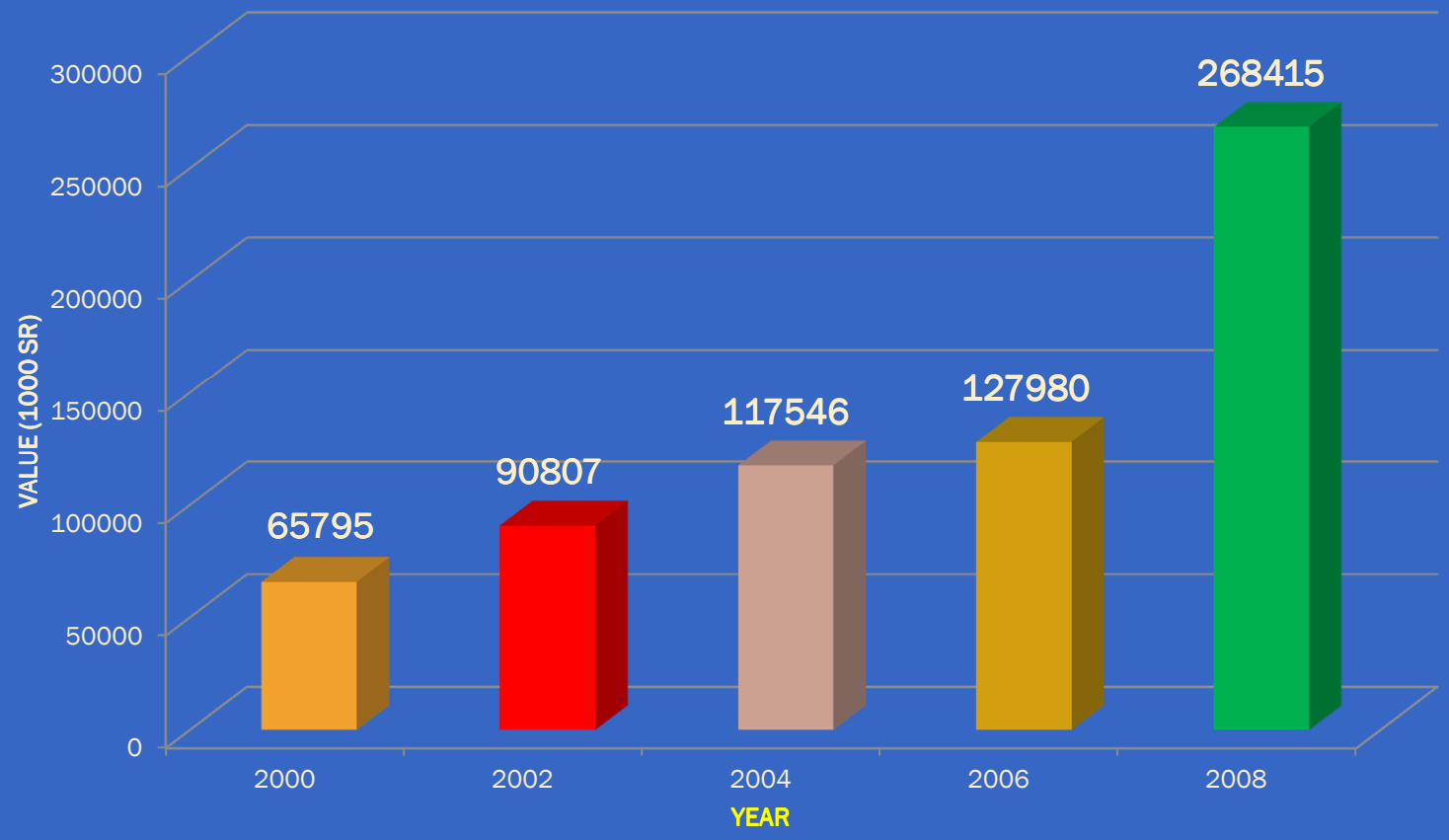
NUMBER OF PALMS AND YIELD IN 2008 KSA



Number of Palms : 23,000,000

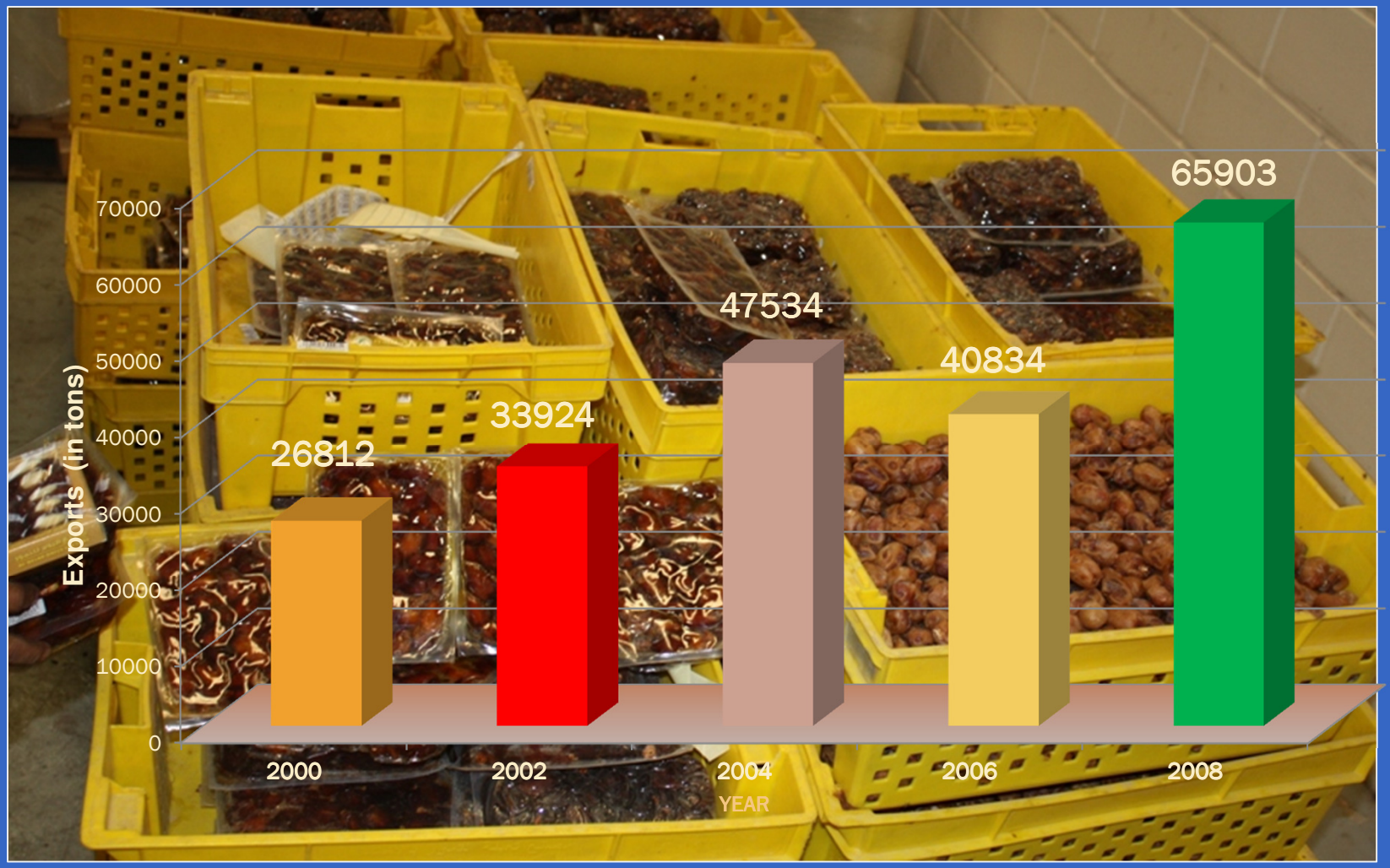
Yield Estimated : 986,409 tons

VALUE OF DATES EXPORTED BY SAUDI ARABIA ('000 SR)



QUANTITY OF DATES EXPORTED BY KINGDOM OF SAUDI ARABIA

(IN TONS)



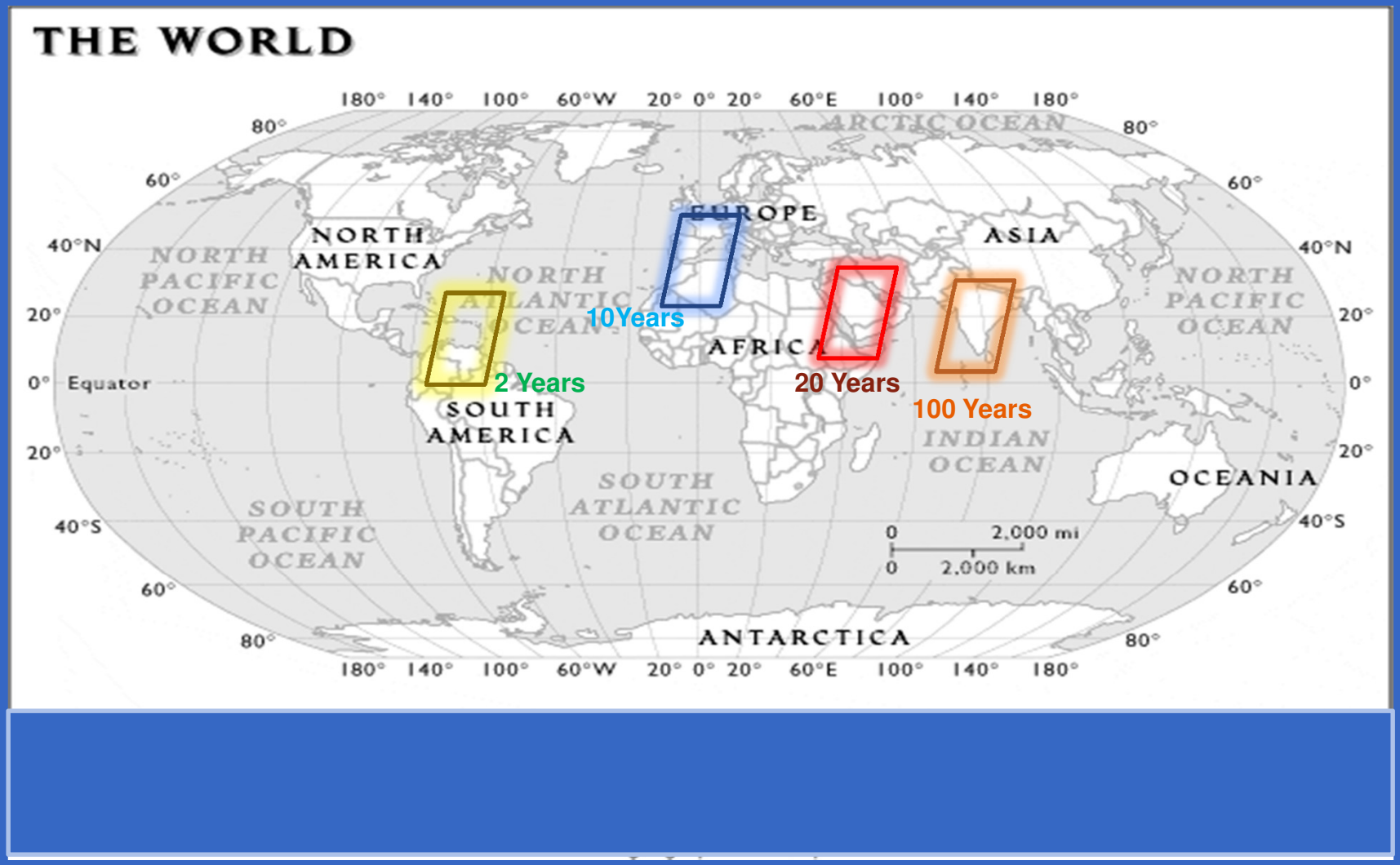
PRODUCTION AND EXPORT OF DATES IN SAUDI ARABIA

(IN TONS) (2008)

CHAIR OF DATE PALM RESEARCH AND COLLABORATIONS

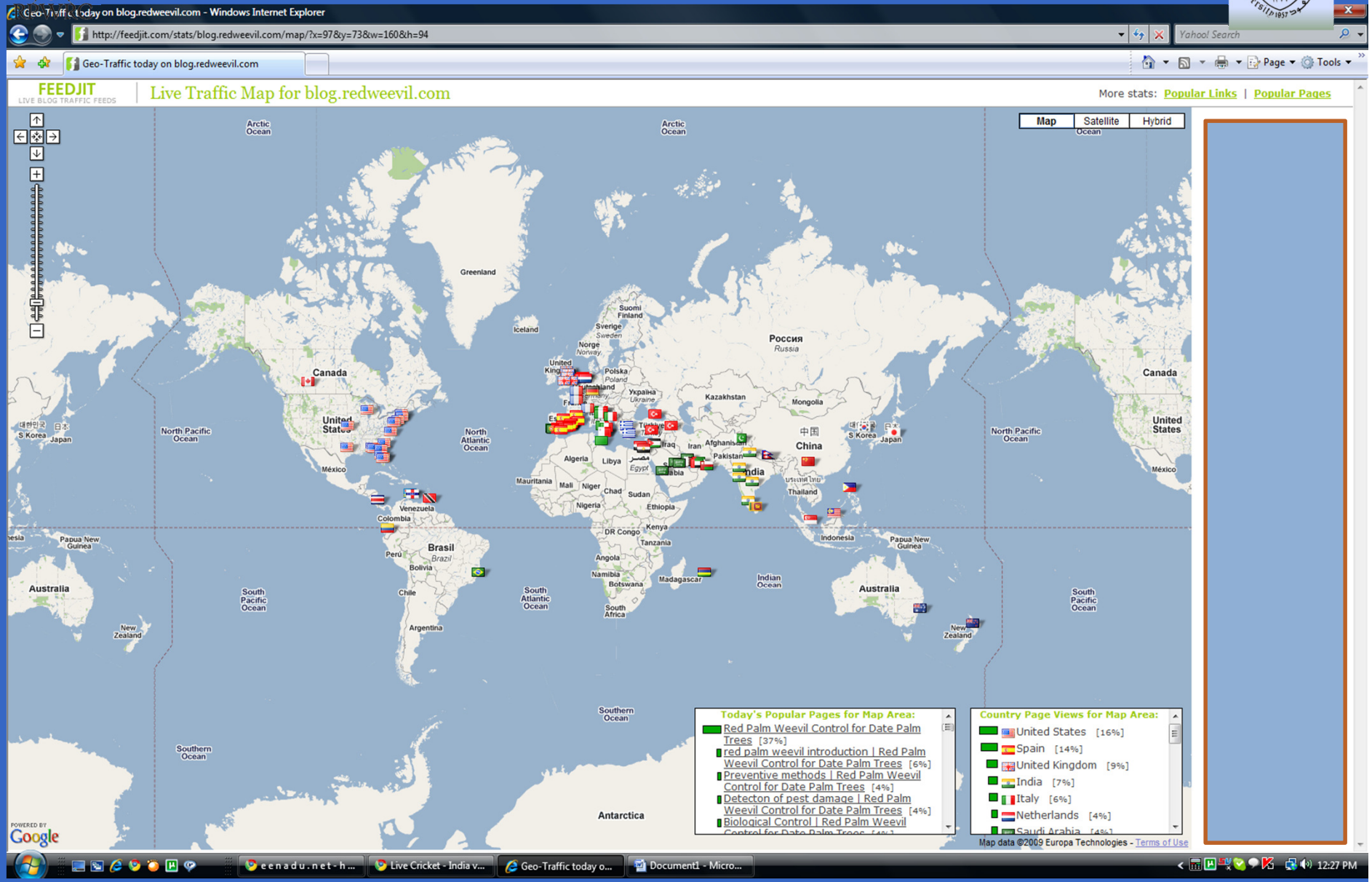
- MoU signed with Biotechnology Research Center of Excellence, King Saud University.
- MoU signed with Date Palm Research Center, Excellence Center, King Faisal University.
- Cooperation with Ministry of Agriculture, Saudi Arabia
- Collaboration with foreign institutes is in the pipeline.
- Open for any future collaboration with institutes working with identical problem for synergies.

WORLDWIDE SPREAD OF RPW



DISTRIBUTION & DISPERSAL

Worldwide Interest in Red Palm Weevil



RED PALM WEEVIL RESEARCH CHAIR WEBSITE

www.rpwrc-ksu.org

WEB PORTAL OF RED PALM WEEVIL

FOLLOWING URLS ARE GLOBAL WEBSITES DISSEMINATING INFORMATION ON RPW

www.rpwrc-ksu.org – Official website of Red Palm Weevil Research Chair of King Saud University with information on Red Palm Weevil, news and others. Now it will deal with all aspects of date palm cultivation under a new name.

www.redweevil.com – the blog on red palm weevil for giving opinion on the management of the pest… open for others to comment.

www.redpalmweevil.com – Started in 1998 the first website to deal with Red Palm Weevil.

CONCLUSIONS

- Making innovations in device development to detect the pest early.
- Validation of new chemical molecules for the control in view of recent restrictions on certain pesticides.
- Developing novel and effective methods for delivery of chemicals.
- More emphasis on improving the trapping systems.
- Advances in chemical ecology of the insect pest.
- Several biocontrol agents have been evaluated over the past and ways should be found to find formulations and dispensing methods.
- Innovation in the research, development, refinement and validation.
- For the sustainability of the RPW management more efforts are required to develop eco-friendly strategies.

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THANK YOU