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Les recherches menées sur les divers moyens de lutte du CRP

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Institut National Agronomique de Tunisie

المكافحة المتكاملة لأهم افات النخيل في تونس
Lutte intégrée contre les *bioagresseurs* du palmier dattier en Tunisie

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Espèces autochtones: Suppression= Diminution du niveau au dessous du seuil de tolérance

1- دودة الخروب= دودة التمر Ectomyelois ceratoniae

2-اكاروس النخيل Oligonychus afrasiaticus

3-الحشرة القشرية البيضاء Parlatoria blanchardi

4- حفارات ساق النخيل Oryctes sp.

Espèce de quarantaine: Eradication……

5- -سوسة النخيل الحمراء Rhynchophorus ferrugienus

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Charançon rouge du palmier: espèce de quarantaine

Red Palm Weevil

سوسة النخيل الحمراء

آفة حجرية: الاستئصال

Eradication dans le grand Tunis

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سوسة النخيل الحمراء

Rhychophorus ferrugineus

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Methods of Control

1-Plant Quarantine

2-Detection

3- Cultural Control

4- Trapping

5- Chemical Control

Biological Control

Mechanical Control

6-Traityement Arrachage et broyage des pieds atteints S3 et S4

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Methods of Control

1- Plant Quarantine

The cause of the high rate of spread of this pest is human intervention, by transporting infested young or adult date palm trees and offshoots from contaminated to uninfected areas.

Strict quarantine at international and national levels should be applied.

2- Detection

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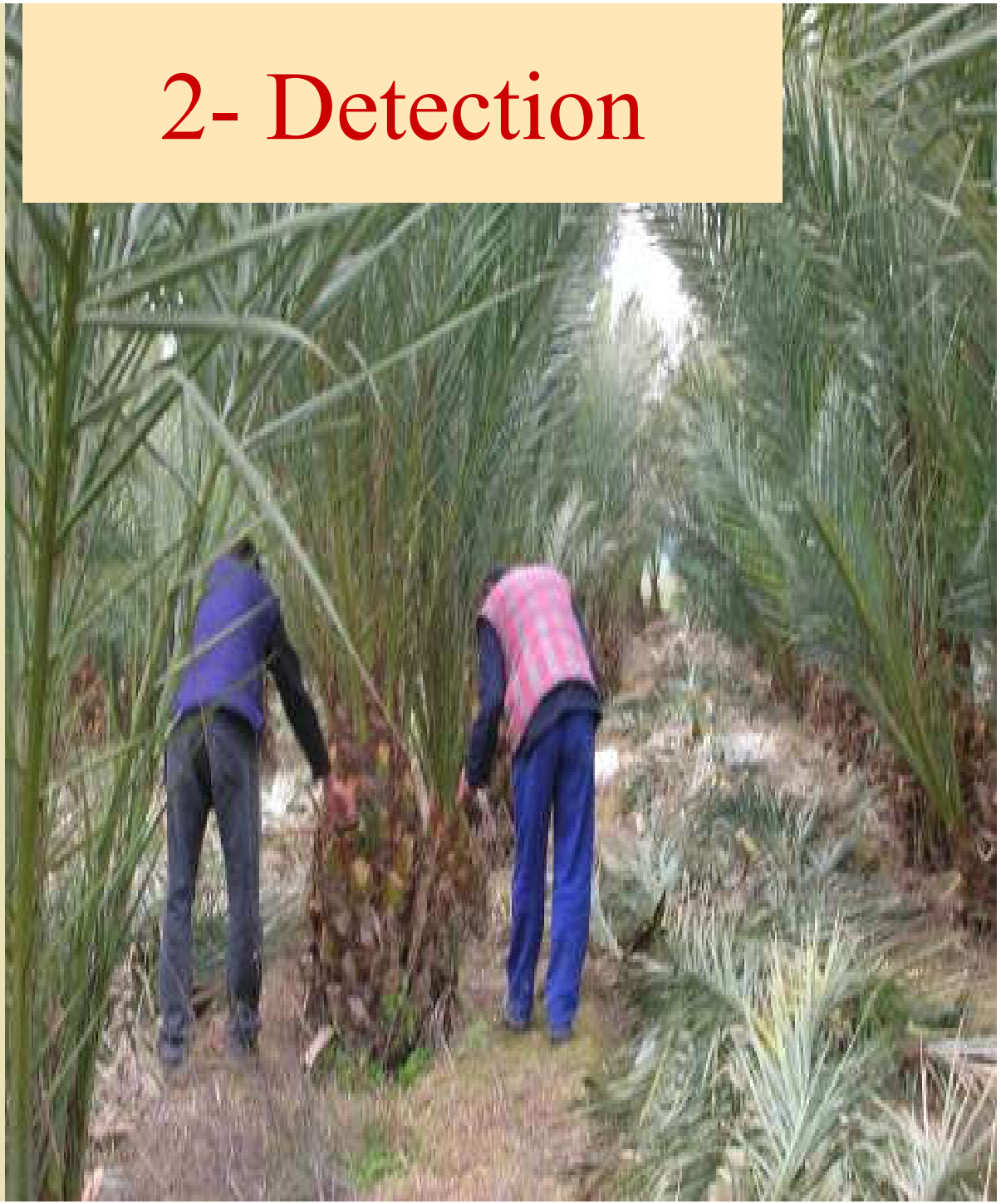
Detection of infested palms constitutes an essential activity and a very difficult task.

To control and eradicate the red palm weevil it is fundamental to detect the infested trees before they constitute new focus of dispersion of the pest.



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Trained dogs assistance

In the regions where the infestation is important, using of trained dogs for detection can be an efficient technique.

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Détecteur du CRP

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Mass and monitoring trapping constitutes an essential part of an IPM of the RPW.

The trap design, location and management have a dramatic importance on the efficiency of the trapping system.

If all these parameters together are not well applied, the trapping can be inefficient and worse, counter

Monitoring: 1 trap/ha

Mass trapping: Heavy infestation 3- 8traps/ha

Localisation des pièges

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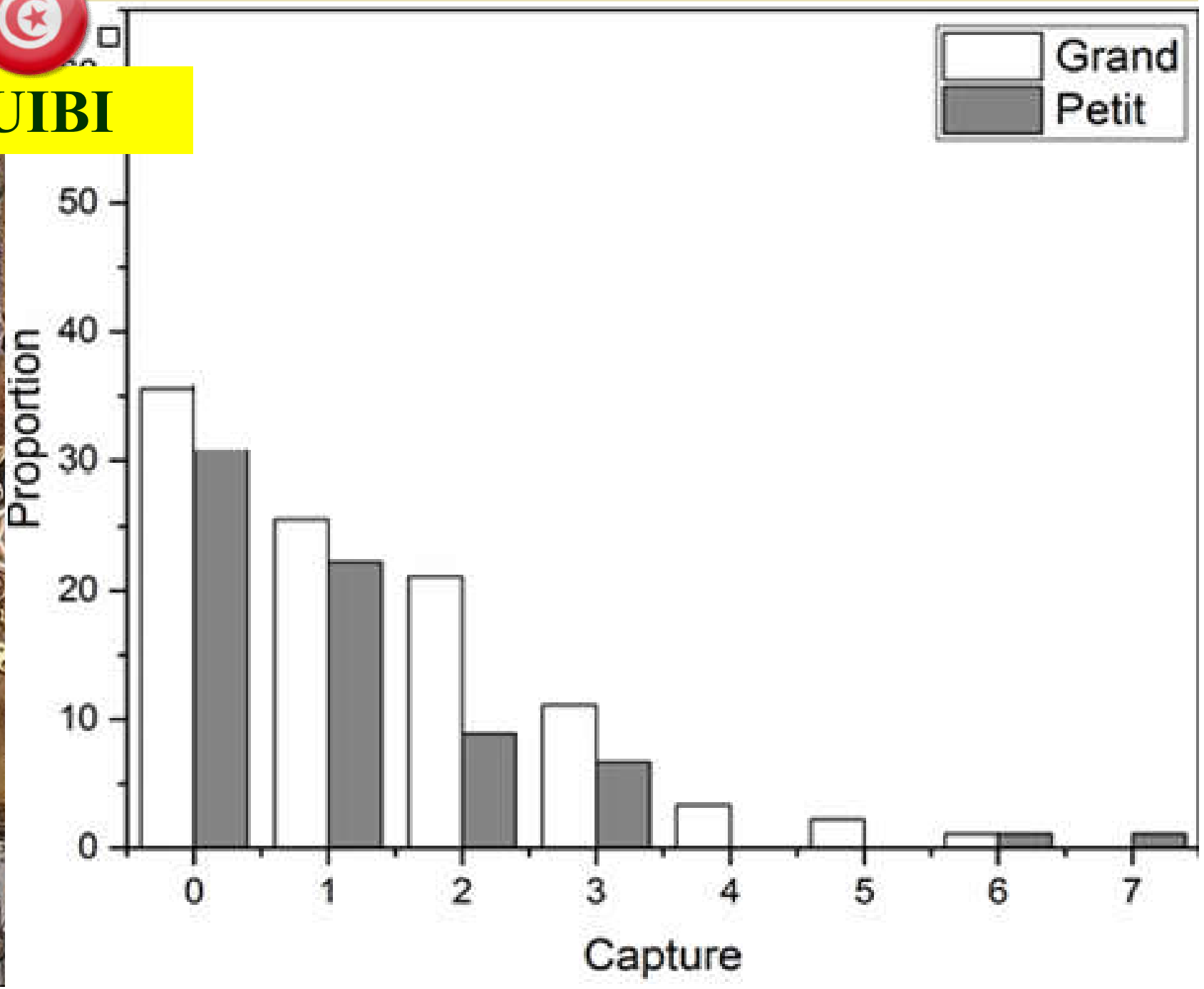

Piégeage de masse

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2 , 4, 6 ,8 et 10 pièges par Ha et capsule ISCA

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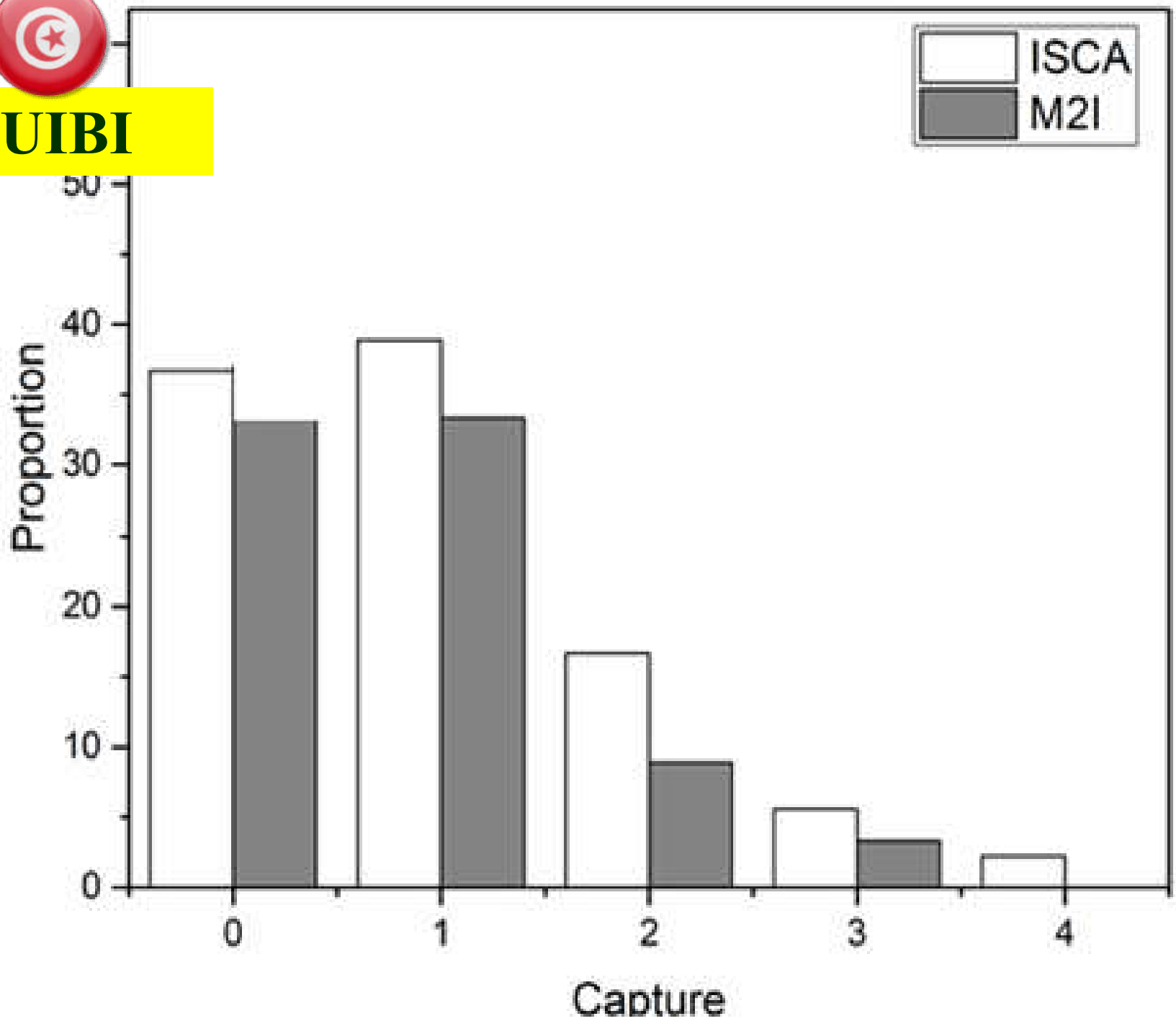

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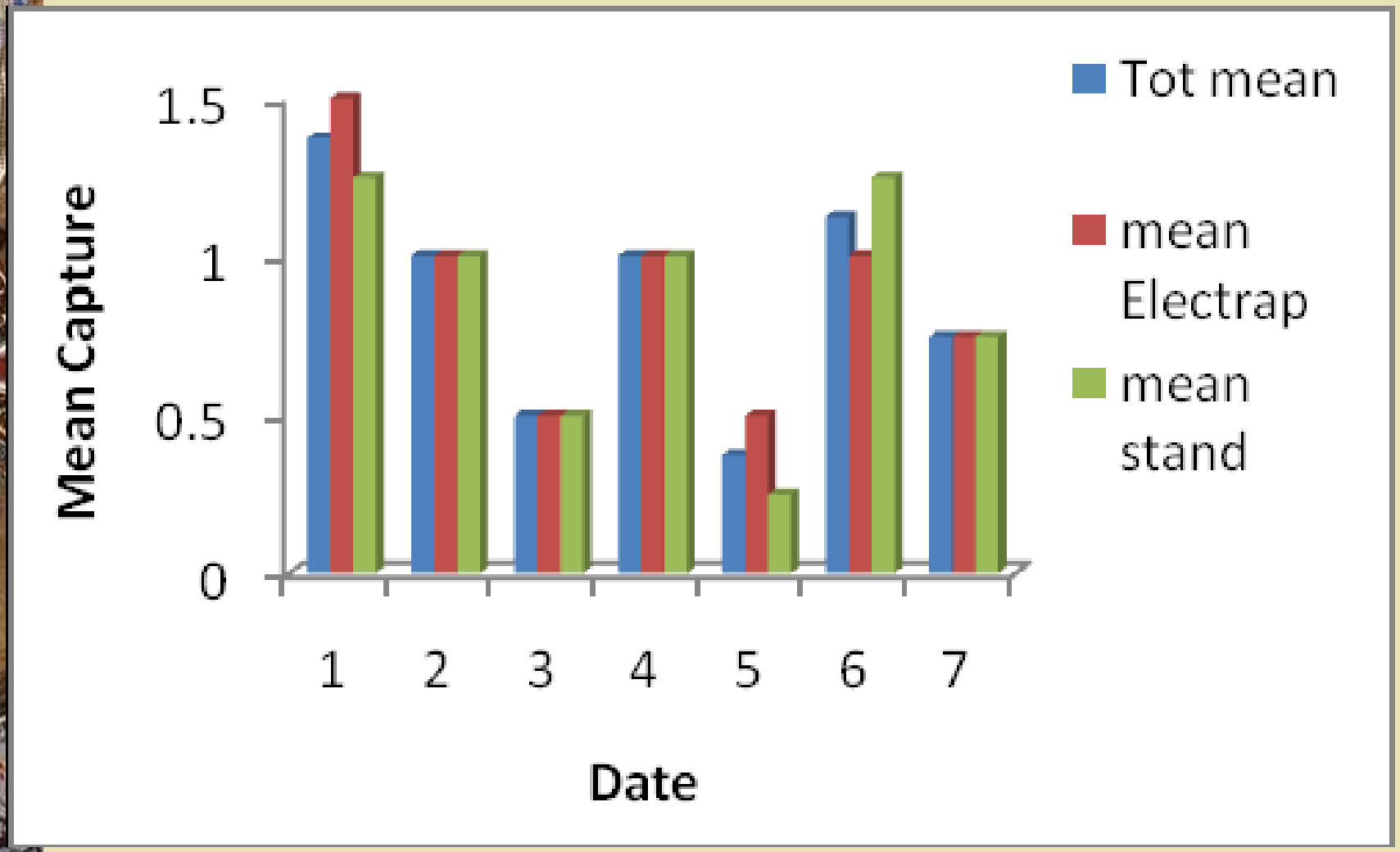
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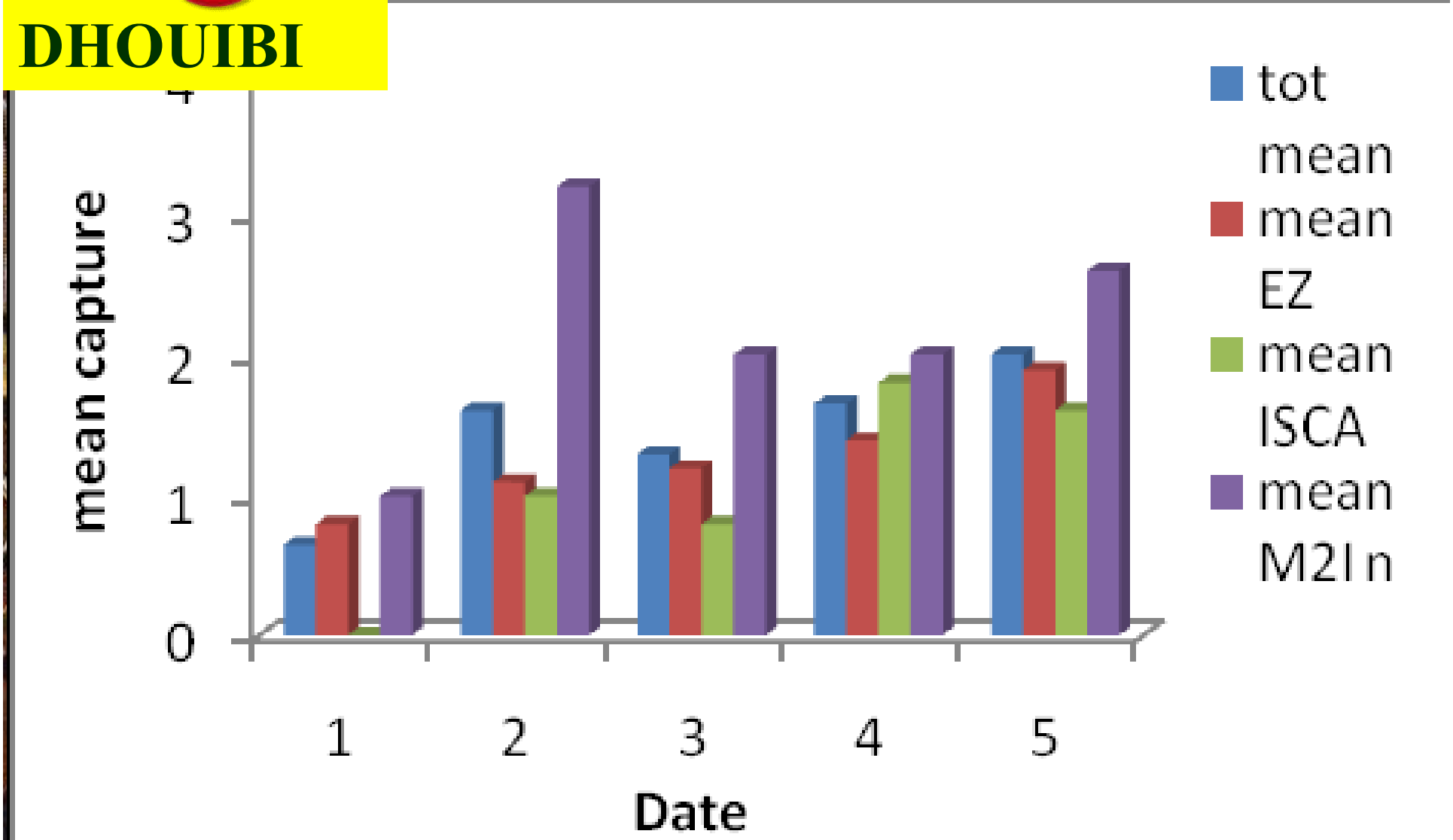
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Arysta
LifeScience
Natural Plant Protection SAS
35 Avenue Léon Blum -64000 PAU - FRANCE
Tel: 33 5 59.60.92.92- Fax: 33 5 59.60.92.99
ARY-0711b-01
Experimental sample
For Research and Development Purposes Only
Not for Sale
MG – Spores of Beauveria bassiana strain NPP1118005 – 5.10E8 cfu/g DM
EUH401 To avoid risks to human health and the environment, comply with the instructions for use.
Contains Beauveria bassiana, may have the potential to produce sensitizing reactions
P233 : Keep container tightly closed
P234 : Keep only in original container
P280 : Wear protective gloves
P402+411 : Store in a dry place, at temperature not exceeding 30°C
Qty: 1kg - Batch n°: 2467/GC55 - Manufacturing date: 14/03/16
Storage conditions: store at 4°C in fridge.

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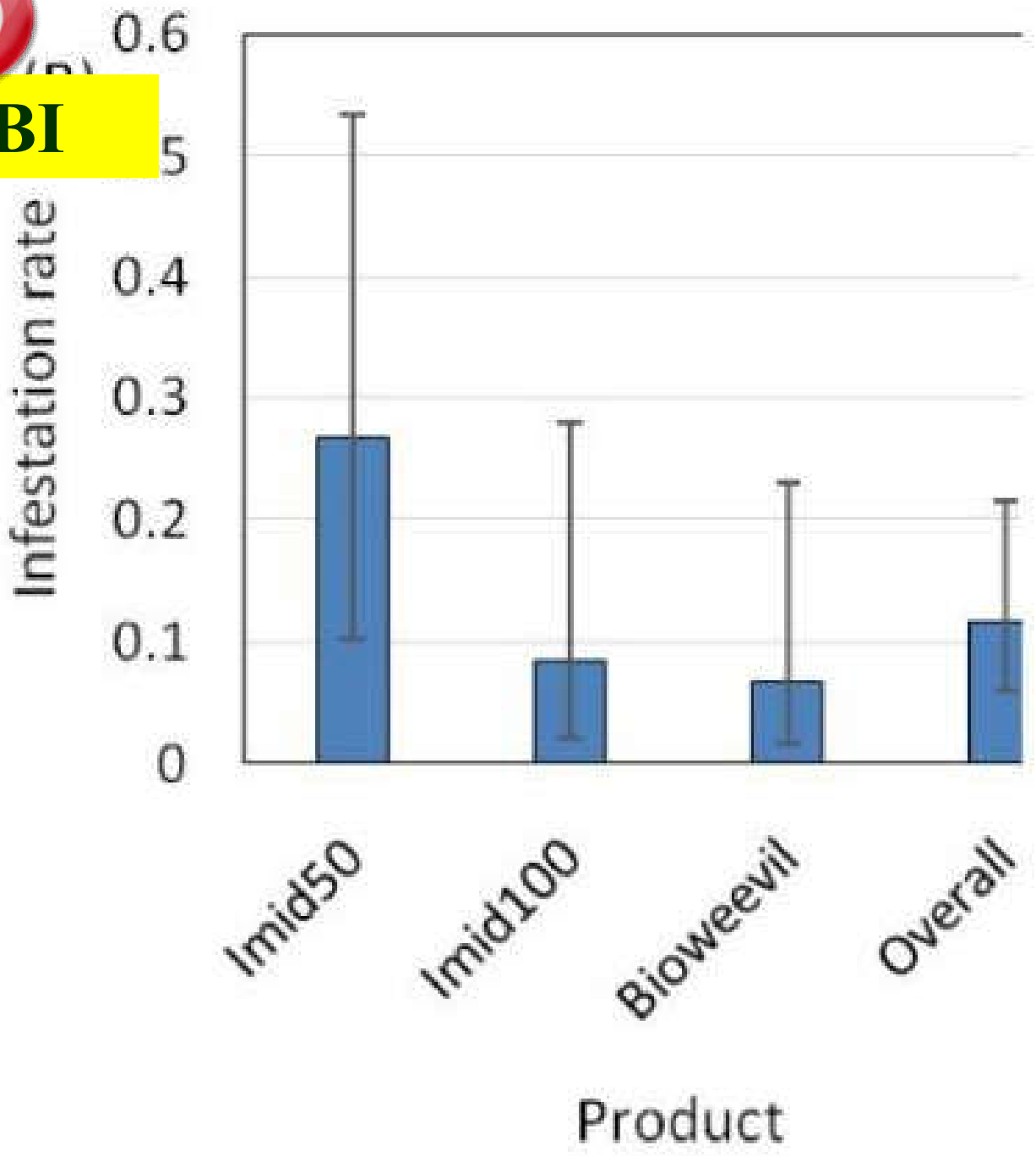
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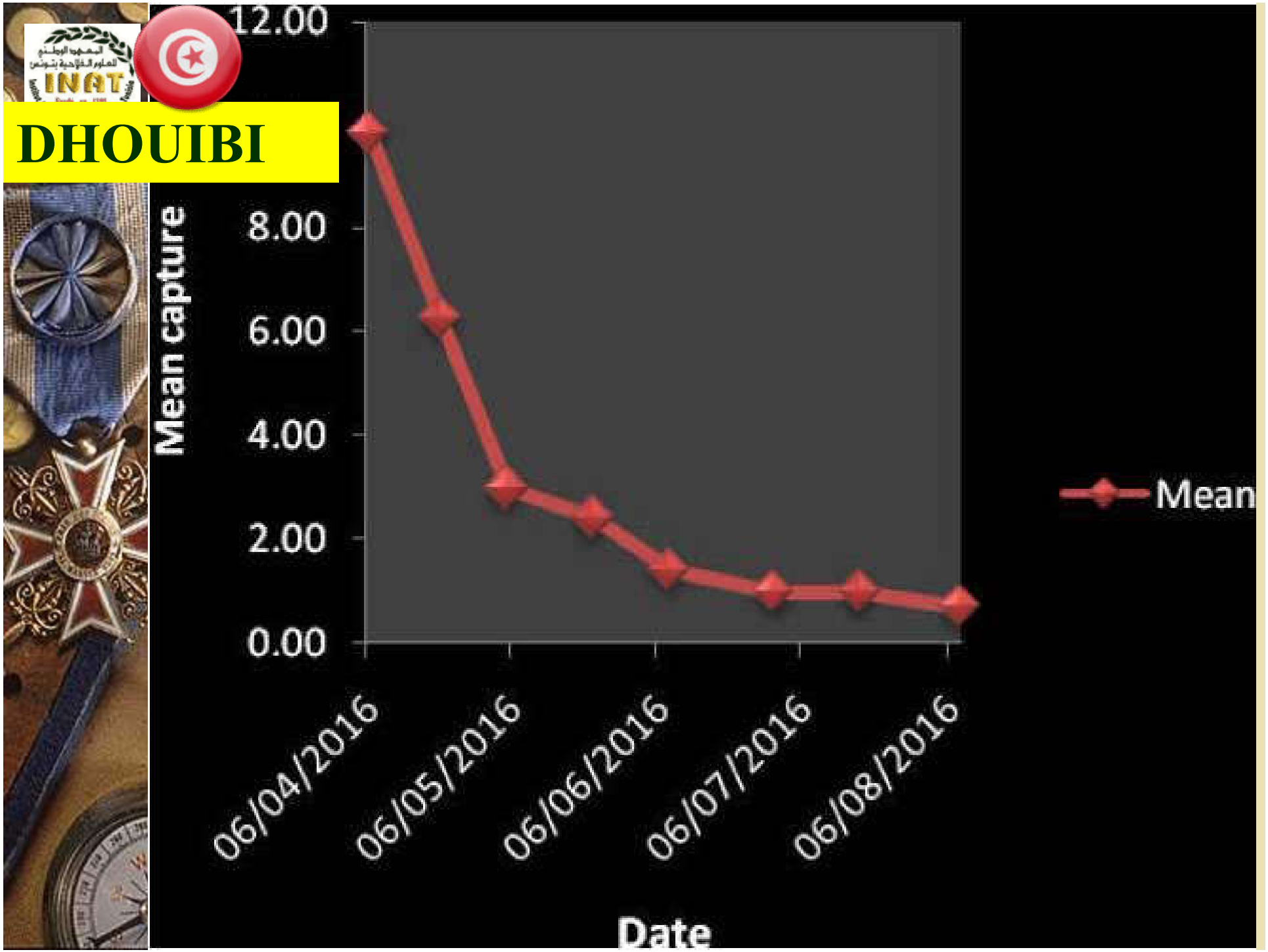
Imid50
Imid100
Bioweevil
Overall
Product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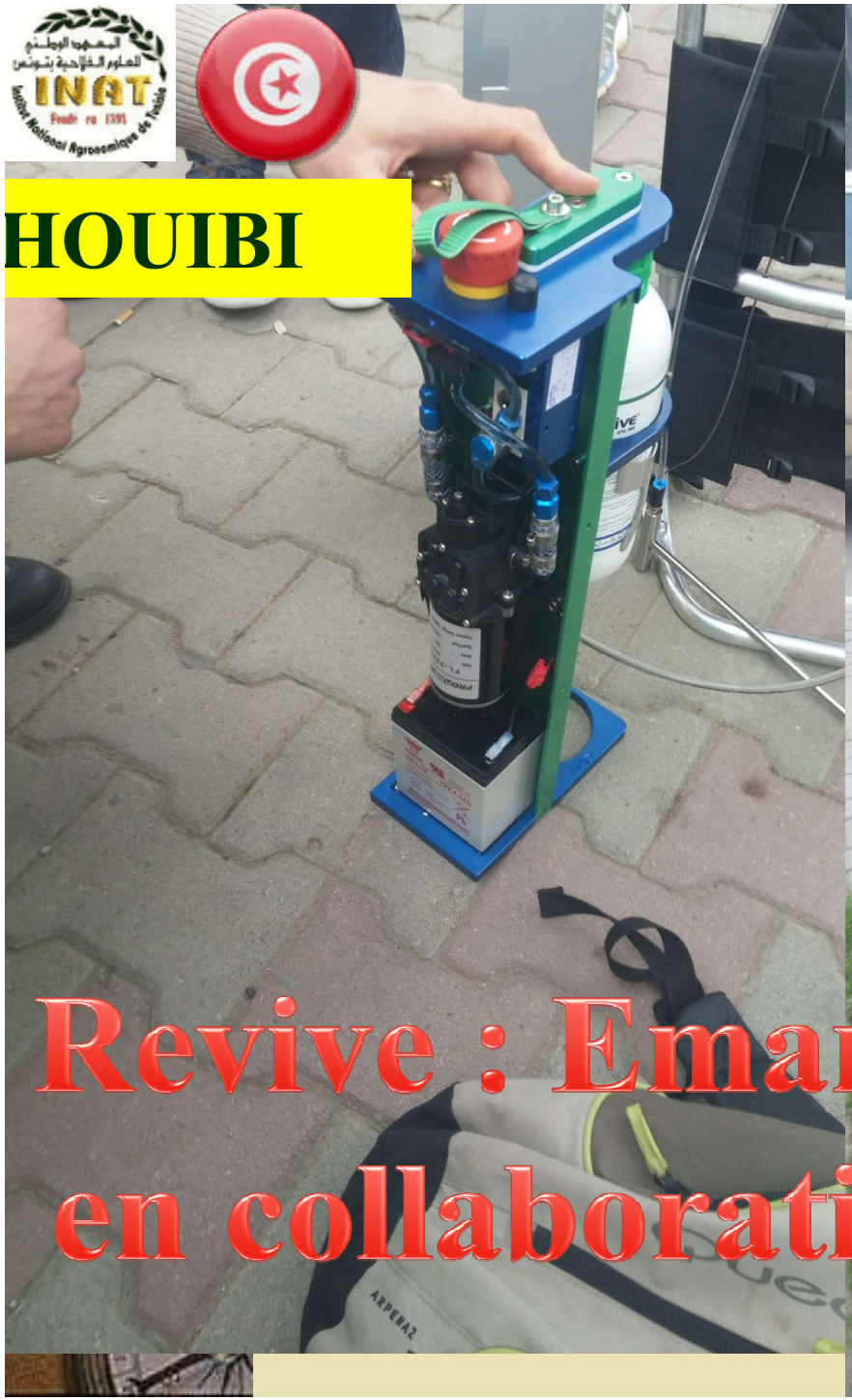

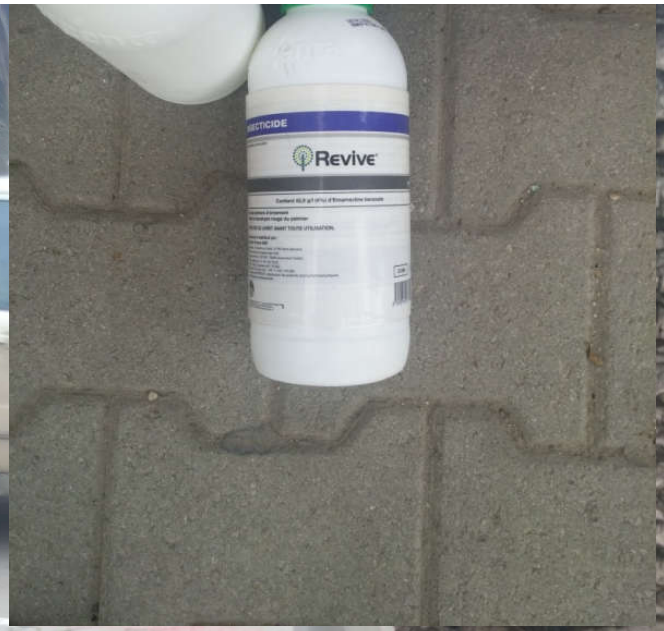

Revive : Emamectine benzoate en collaboration avec syngenta

Essai revive: emamectine benzoate

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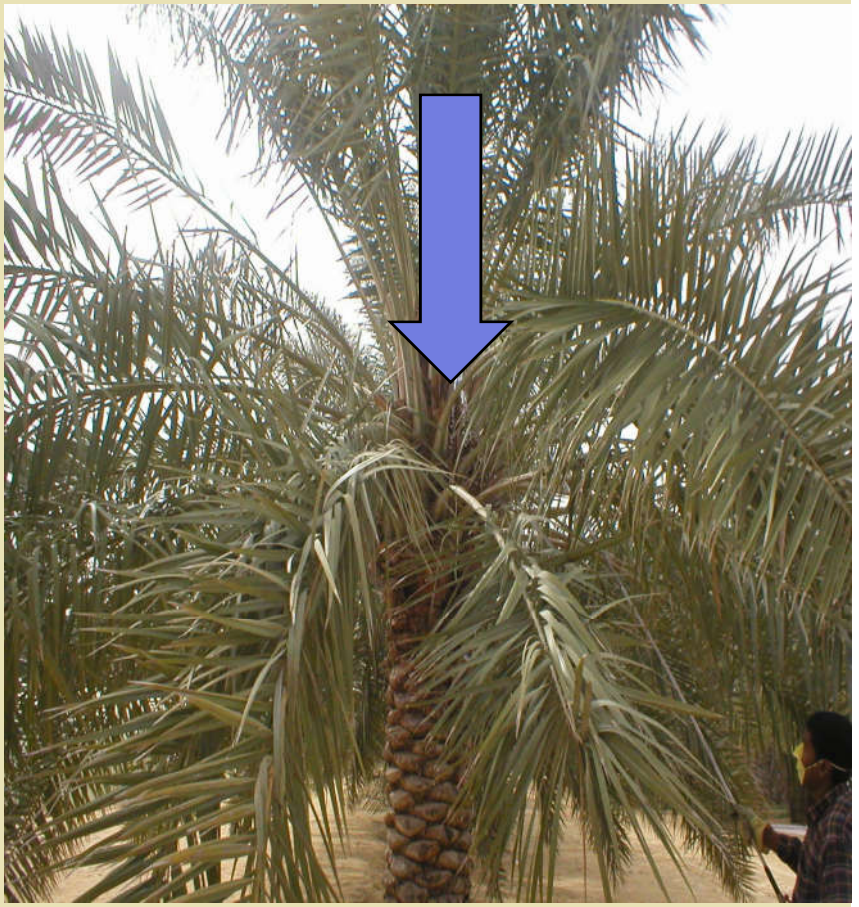
Traitement foliaire: pulvérisation de la bouillie sur le palmier

الرش (المبيدات)



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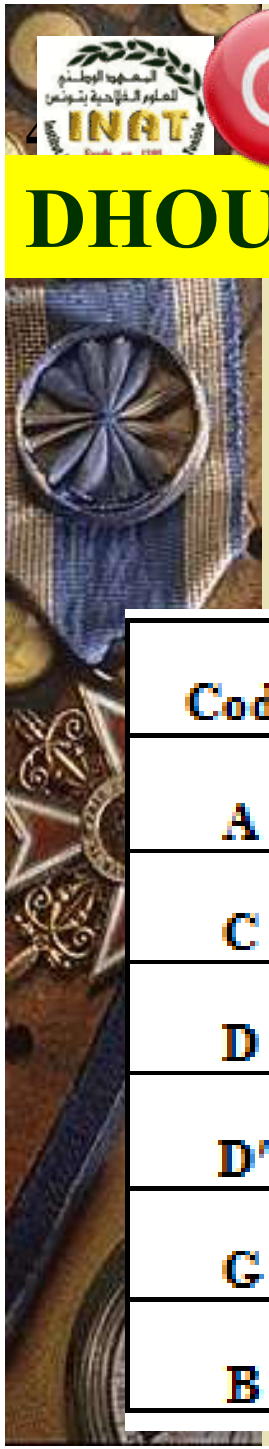
Beaucoup de produits systémiques ont été testés par endothérapie à l'état pur de 50 à 80 cc/palmier



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e/Palm	Preparated solution	Active substance	
	25 g/L	Thiametoxam	Synara
	66,66g/L	400 cc Dimethoate	Biomat
	33,33g/L	400 cc Imidaclopride200	Confidor

Code	Product	Active substance	Dose 1	Dose 2
A	GF-3052	Spinetoram+sulfoxaflor	5g	10g
C	synara	Thiametoxam	7,5g	10g
D	Proclain	Emamectine benzoate	5g	10g
D'	Pro-Act	Emamectine benzoate	80 ml	100 ml
G	Confidor	Imidaclopride	10ml	12ml
B	GF-3441	XDE-607	5g	10g


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emplacement des tubes en plastique et des
en cuivre par des embouts plastiques

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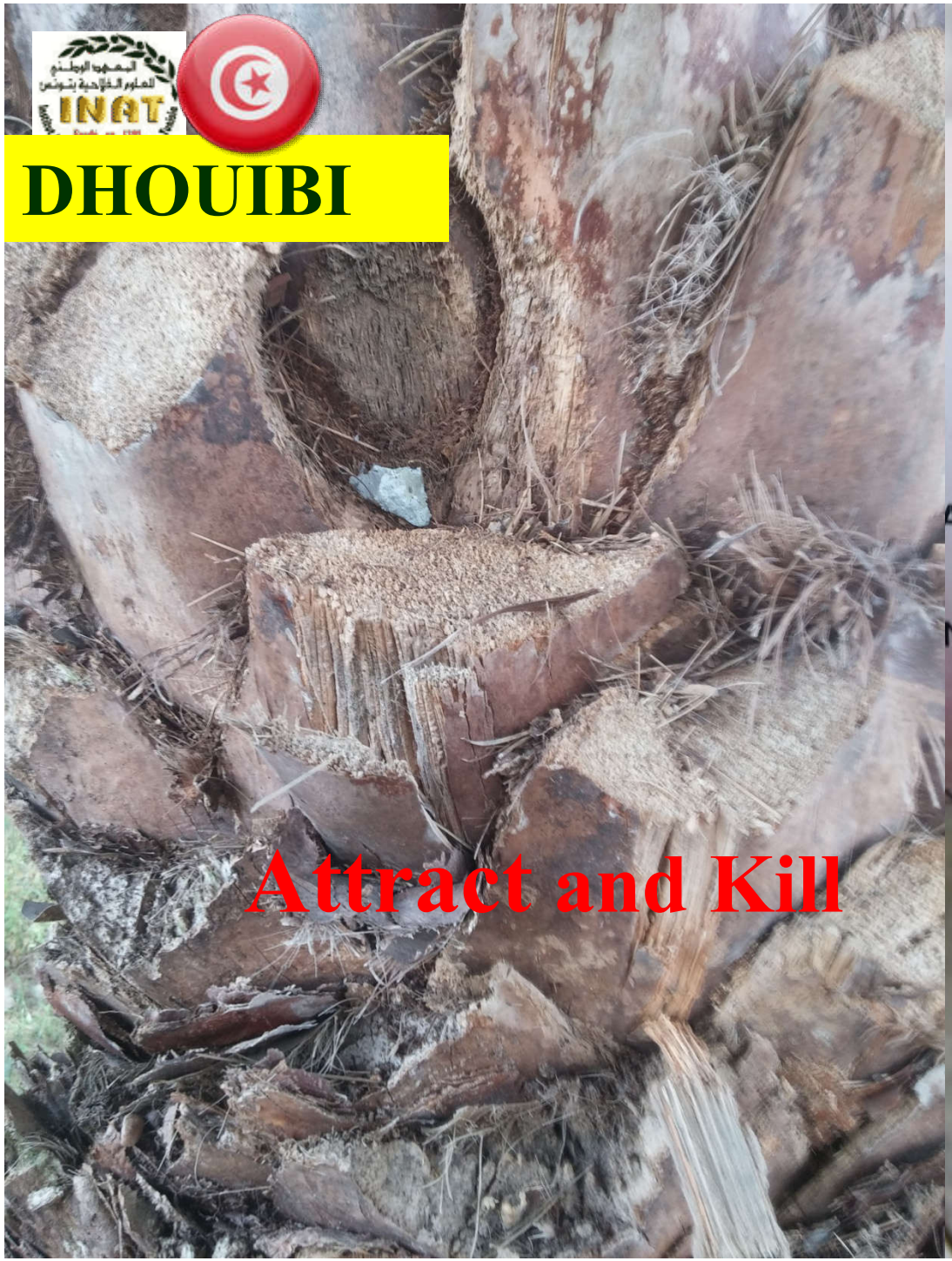
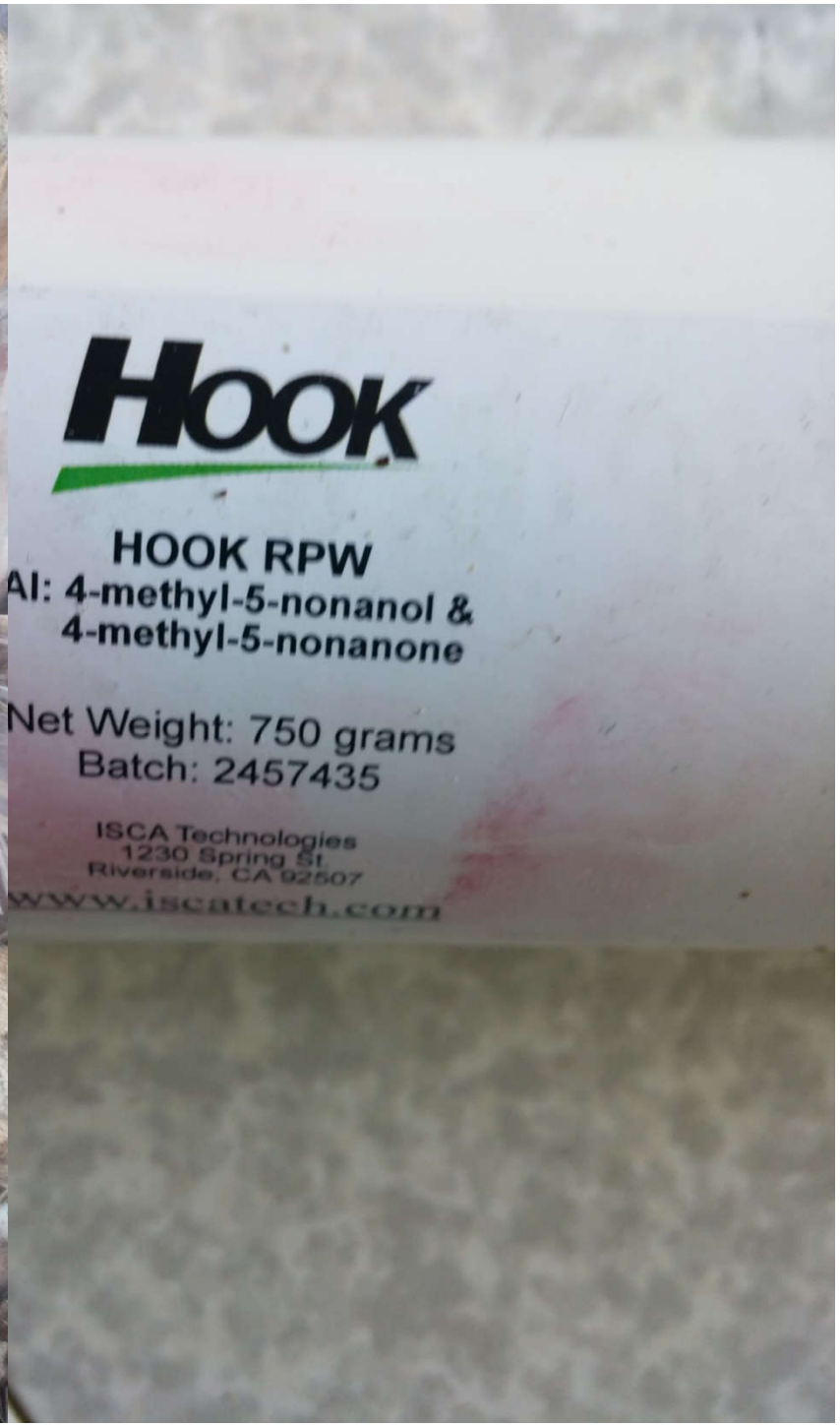


Attract and Kill



Application de l’attract and kill

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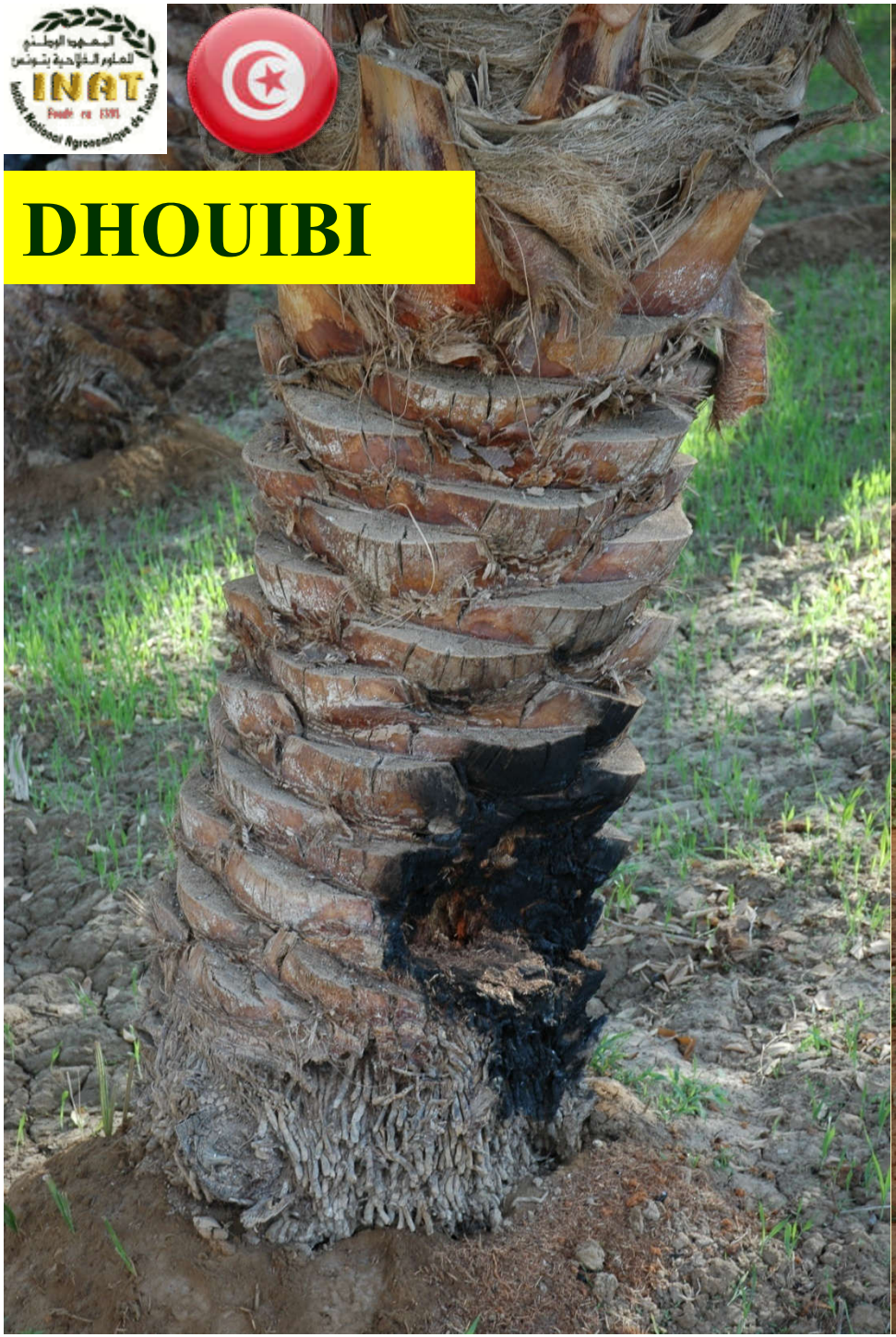

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Broyeur: Après assainissemen

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Enterrement des palmiers infestés

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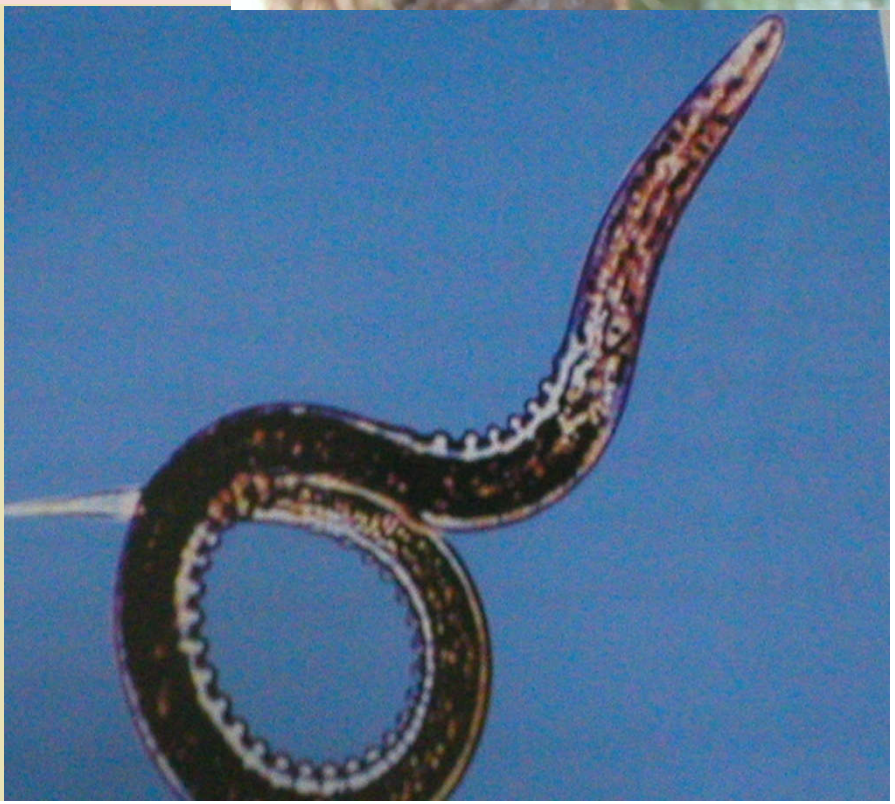
المكافحة الحيوية

الفطر Beauveria bassiana

- النيماتود

- أكاروس



Incinération des palmiers infestés

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Effect of Color Trap, Density and Pheromone Capsule Types on the Trapping Efficacy for the Red Palm Weevil (*Rhynchophorus ferrugineus*)

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Abstract **– The Red palm weevil (RPW), Rhynchophorus ferrugineus (Curculionidae: Coleoptera) is an indigenous species from South East Asia which has recently become one of the most dangerous pests of palms around the globe. Monitoring and mass trapping of weevils with synthetic male aggregation pheromone and food baited traps has been an important component of Integrated Pest Management (IPM) program against RPW. The aim of this study is to evaluate the effect of 3 parameters (trap color, trap density and type of pheromone) on trap effectiveness in catching Rhynchophorus ferrugineus. Food-baited pheromone traps were installed in the infested sites of Tunisia. Three trap colors were tested (black, white and yellow). Tested densities ranged from 1 to 8 and we compared two types of aggregation pheromone capsules (M21 and Atlas Agro). The highest weevil catch was achieved in the black traps. Moreover, these experiments showed that more traps per hectare are necessary to capture more adults in little time. Hence, our studies provide information for optimizing trap density using black traps combined with M21 capsule of pheromone for mass trapping program.**

Keywords **– RPW, Trap, Color, Density, Pheromone, Effectiveness.**

I. Introduction

The red palm weevil, Rhynchophorus ferrugineus (Olivier) (Coleoptera: Curculionidae) (RPW) is currently considered as the most damaging invasive palm pest worldwide ([1]-[2]-[3]-[4]).

Rhynchophorus ferrugineus is native to southern Asia as described during the late nineteenth century on coconut palm. By the mid-1980's, the range of attack had spread through the Middle East and then it reached northern Africa by 1992 following a more quick spreading pattern. The rest of the Mediterranean countries were totally infested by 1994, eventually to report the pest attack in North America in 2009 [5]. The pest is reported to attack more than 20 species of palms worldwide. The latest report of an RPW invasion occurred in late 2011 in Tunisia where it was found infesting Phoenix canariensis. On this last species the weevil's infestation occurs on the top of the tree. Such an attack pattern is due to the massive pest presence throughout the whole year, the severe damage occurring within infested trees and the late onset of the symptoms' expression make their detection difficult. Four stages were defined, revealing the outcome of the attack on the leaves and the crown of P. canariensis. Stage 0 defined as an asymptotic palm (Figure 1), Stage 1 is caracterised by Some chewing symptoms in inner leaves (Figure 2), Second Stage is marked by Extensive chewing symptoms of "V" shape (Figure 3), Asymmetric inner leaf growth is clear in Stage 3 of an attack and on the last stage all the crown leaves collapsed into an "umbrella" shape (figure 5).

As the eggs of RPW are deposited inside concealed places of the stem, larvae (figure 6) hatch and start destructing reaching generally the apical growth area.

Fig. 1. Asymptotic palm

Fig. 2. Chewing symptoms in inner leaves

Fig. 3. Extensive chewing symptoms of shape

Quelques références sur le charançon rouge du palmier en Tunisie

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Red Palm Weevil (*Rhynchophorus ferrugineus*) Chemical Treatments Applied on Ornamental Palms in Tunisia: Results of Extensive Experiments

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Email: dhouibi.med@inat.agrinet.tn

Abstract **– The red palm weevil (RPW), Rhynchophorus ferrugineus Oliv, (RPW) (Curculionidae: Coleoptera), is an economically important, tissue - chewing pest of date palm in many parts of the world. The invasion of Red palm weevil (Rhynchophorus ferrugineus) to Tunisian ornamental palms was detected in 2011. It has begun a real threat to date palms Phoenix dactylifera. Chemical control becomes an essential mean to recover infested palm trees. In this study, we evaluated several chemical products: Spinetoram + sulfoxaflor, Imidacloprid, Thiamethoxam, XDE-607 and Emamectin benzoate against RPW at different localities in Tunis. Palms were selected randomly based on visual symptoms. Three methods of chemical delivery were used: powdering, irrigation and injection. This study revealed that the use of Imidacloprid 5% (Suxon mini) by irrigation with the dose of 500 g/Palm give better results in protecting the palm. Emamectine benzoate shows significant efficacy using the product: Pro-act while applying a dose of 100 ml/palm.**

Keywords: **– Red Palm Weevil, Ornamental Palm Trees, Imidacloprid, Emamectin Benzoate, Thiamethoxam, Spinetoram, spinetoram + sulfoxaflor, Endotherapy.**

I. Introduction

The red palm weevil (RPW), Rhynchophorus ferrugineus Olivier (Coleoptera: Curculionidae), is one of the most severe pests of various palm species, including ornamental palms ([1]; [2]; [3]; [4]).

RPW is originally from South Asia where it is a major pest of coconut. In the Mediterranean basin RPW has become a key pest of P. canariensis which is extremely sensitive to its attack [4].

By the mid-1980's, multiple introductions of R. ferrugineus to the Middle East from Pakistan and India have occurred and the Asian palmweevil (APW) is now a serious pest of date palms, in the Arab Gulf States.

The rest of the Mediterranean countries were totally infested by 1994, eventually to report the pest attack in North America in 2009 [5].

The RPW reportedly attacks over 26 species of palm belonging to 16 genera globally in several regions of the world.

In the Mediterranean basin it has moved to Africa and Europe, mainly due to the movement of infested planting material. As concerns Italy, RPW severely damages overall Phoenix (P.) canariensis. Since then it has quickly spread in almost all areas where P. Canariensis was present, resulting in rapid death of thousands of plants [4].

The latest report of an RPW invasion occurred in late 2011 in Tunisia where it was found infesting Phoenix canariensis [3]. As the eggs of RPW are deposited inside concealed places of the stem, The creamy white color larvae (grubs) are the most destructive stage. These legless larvae feed on the succulent plant tissues that create feeding galleries and move towards the center of the infested palms. Such feeding pattern disrupts the vascular system of the infested palm resulting toppling, collapse and death of the infested palm under severe attack. A very typical sign of infestation is the distorted growing point at the top of the palm. The growth at the top of the canopy can become deformed and offset. This distortion is a very common symptom and is more easily seen than other symptoms of infestation.

A 0–4 scale has been developed to characterize the stages of RPW infestation ,where 0 represents an infested date palm showing no stages of the pest or damage symptoms, while 4 indicates a RPW-infested date palm that has toppled [6].

This scale has been adopted in our study to evaluate the palm trees 'infestation stages.

Life cycle is than wholly sealed within the stem upon emergence of the adults from the cocoon which fly out and infest new palms or remain in the same palm and cause re-infestations at a new site [7].

The existing methods of RPW management largely rely on the integrated pest management IPM strategies, which include: phyto sanitation, use of conventional insecticide, pheromone traps and bio-control agents. The chemical control method against RPW, include regular surveillance as the first necessary step for a swift detection, spraying and injecting of synthetic insecticides into infected palms [8].

Preventive and curative methods were often based on chemical pesticides, until an extended alternative has been introduced involving the use of natural enemies ([7]; [8]) including nematodes, bacteria, and fungi have shown variable results in terms of larval and adult mortality.

Even though highly effective pesticides exist. There are many problems related both to the delivery of the product to the target (tunneling larvae within the palm) and also regarding the ecotoxicological profi le of these chemicals . New environment friendly products are urgently needed, and alternative application methods (such as trunk injection) or uptake mechanisms (such as systemic products) have already been demonstrated ([9], [10]).

Imidacloprid [1-(6-chloro-3-pyridylmethyl)-2 nitroimino-imidazolidine] possess both systemic and contact mode of action and is compatible with different application methods for example foliar application, seed treatment [11], soil drench and stem application in different crops and trees [10]. Imidacloprid causes

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Comparison of the Efficacy of Bioshell (Essential Oils) and Entomopathogenic fungi (*Beauveria bassiana*) with Imidacloprid against the Red Palm Weevil Rhynchophorus ferrugineus (Coleoptera: Curculionidae)

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Abstract **– The red palm weevil (RPW, *Rhynchophorus ferrugineus* (Olivier) (Coleoptera: Curculionidae) is one of the most severe pests of various palm. Entomopathogenic fungi and biological pesticides are being put forward as biological control agents in Integrated Pest Management (IPM) to control RPW. The aim of this study is to evaluate the efficacy of two biological products (the entomopathogenic fungi: *Beauveria bassiana*) and the biological insecticide (Bioshell) derived from essential oils against red palm weevil compared to the confidor (Imidacloprid) as a reference product. In various study sites, the treatment of the palms trees was carried out by the three products to be tested. To verify the effectiveness of each product, the evolution of infestation of treated palms was checked. Controlling the number of infested palms, the results obtained in this study show no significant difference between palms treated with biological products and those treated with Imidacloprid. These studies can prove the effectiveness of biological control against red palm weevil. Moreover, the use of biological products should be included in the integrated pest management against RPW.**

Keywords **– RPW, Entomopathogenic fungi, *Beauveria bassiana*, Essential Oils, Bioshell (Biowecvil), Imidacloprid, Effectiveness.**

I. Introduction

The red palm weevil, *Rhynchophorus ferrugineus* (Olivier) (Coleoptera: Curculionidae) (RPW) is an economically important pest of palm trees in the different growing area in the world ([1]; [2]; [3]; [4]).

RPW is originally from South Asia where it is a major pest of coconut. In the Mediterranean basin RPW has become a key pest of *P. canariensis* which is extremely sensitive to its attack [5].

By the mid-1980's, multiple introductions of *R.ferrugineus* to the Middle East from Pakistan and India have occurred and the Asian palm weevil (APW) is now a serious pest of date palms, in the Arab Gulf States.

The rest of the Mediterranean countries were totally infested by 1994, eventually to report the pest attack in North America in 2009 [5].

The RPW reportedly attacks over 26 species of palm belonging to 16 genera globally in several regions of the world.

The latest report of an RPW invasion occurred in late 2011 in Tunisia where it was found infesting Phoenix canariensis.

Infested palms are hard to detect since the larvae feed on the internal tissues of the palm. Under careful observation, surveyors may be able to detect infested plants with holes in the crown or trunk. Additionally, distorted or "clipped" fronds may be seen. Leaves may droop because of loss of support by bored axils and a collapsed canopy [6] a very typical sign of infestation is the distorted growing point at the top of the palm.The growth at the top of the canopy can become deformed and offset. This distortion is a very common symptom and is more easily seen than other symptoms of infestation.

As the eggs of RPW are deposited inside concealed places of the stem, larvae hatch and start destructing reaching generally the apical growth area.

Life cycle is than wholly sealed within the stem upon emergence of the adults from the cocoon which fly out and infest new palms or remain in the same palm and cause re-infestations at a new site [7].

The existing methods of RPW management largely rely on the IPM strategies, which include: phytosanitation, use of conventional insecticide, pheromone traps, attract and kill technology and bio-control agents.

The chemical control method against RPW, include spraying and injecting of synthetic insecticides into infected palms [8].

Neonicotinoids, comparatively new group of synthetic insecticides, agonists the nicotinic acetylcholine receptors (nAChR).

Imidacloprid [1-(6-chloro- 3-pyridylmethyl)-2-nitroimino-imidazolidine] possess both systemicand contact mode of action and is compatible with different application methods for example foliar application, seed treatment [9], soil drenchand stem application in different crops and trees [10].

Imidacloprid causes irreversible blockage of post synaptic nicotinergic acetylcholine receptor of the central nervous system [11].

In laboratory and semi-field conditions, imidacloprid SL formulation successfully controlled RPW [12].

Preventive and curative methods were often based on chemical pesticides, until an extended alternative has been introduced involving the use of biological products and natural enemies ([13]; [14]).

For the sake of date palms, we have to take into consideration the accumulation of insecticides in the fruit. Amongst the variety of natural products available, essential oils (EOs) are being investigated since a decade

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Effect of Trap Size and Pheromone Capsule Types on the Trapping Efficacy for the Red Palm Weevil (*Rhynchophorus Ferrugineus*)

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Abstract **– The Red palm weevil (RPW), *Rhynchophorus ferrugineus* (Curculionidae: Coleoptera) is an indigenous species from South East Asia which has recently become one of the most dangerous pests of palms around the globe. Monitoring and mass trapping of weevils with synthetic male aggregation pheromone and food baited traps has been an important component of Integrated Pest Management (IPM) program against RPW. The aim of this study is to evaluate the effect of 2 parameters (trap model and size, and capsule type) on trap effectiveness in catching Rhynchophorus ferrugineus. Food-baited pheromone traps were installed in the infested sites of Tunisia. Three different traps were tested (large (10 l) and small 2l) and electrap. Second, we compared four types of aggregation pheromone capsules: M2I classic capsule, M2I new formula, Rhyncho plus (EZ) and ISCA). There was no significant difference between Electrap and the large bucket. However this latter seemed more performing than the small trap. Moreover, our studies provide information for optimizing trap density using black large traps combined with M2I classic capsule of pheromone for mass trapping program. For M2Inew capsule seems to be better at the beginning, after 3 weeks ISCA is better and remains more.**

Keywords **– Rpw, Trap, Size, ISCA, Rhyncho plus and M2I Pheromones, Effectiveness, Mass Trapping.**

I. Introduction

The red palm weevil, Rhynchophorus ferrugineus (RPW) (Olivier) (Coleoptera: Curculionidae) is an economically important pest of palm trees in the different growing area in the world ([1]; [2]; [3]; [4]).

RPW is originally from South Asia where it is a major pest of coconut. In the Mediterranean basin RPW has become a key pest of P. canariensis which is extremely sensitive to its attack [5].

By the mid-1980's, multiple introductions of R. ferrugineus to the Middle East from Pakistan and India have occurred and the Asian palm weevil is now a serious pest of date palms, in the Arab Gulf States.

The rest of the Mediterranean countries were totally infested by 1994, eventually to report the pest attack in North America in 2009 [6].

The RPW reportedly attacks over 26 species of palm belonging to 16 genera globally in several regions of the world.

The latest report of an RPW invasion occurred in late 2011 in Tunisia where it was found infesting Phoenix canariensis.

Infested palms are hard to detect since the larvae feed on the internal tissues of the palm. Under careful observation, surveyors may be able to detect infested plants with holes in the crown or trunk. Additionally, distorted or "clipped" fronds may be seen, leaves may droop because of loss of support by bored axils and a collapsed canopy [7]. A very typical sign of infestation is the distorted growing point at the top of the palm. The growth at the top of the canopy can become deformed and offset. This distortion is a very common symptom and is more easily seen than other symptoms of infestation.

As the eggs of RPW are deposited inside concealed places of the stem, larvae hatch and start destructing reaching generally the apical growth area [8].

Life cycle is than wholly sealed within the stem upon emergence of the adults from the cocoon which fly out and infest new palms or remain in the same palm and cause re-infestations at a new site [9].

An integrated pest management (IPM) program has been chosen as the most effective system recently developed in the countries concerned by the infestation.

Regular surveillance is the first necessary step for a swift detection even though palms in the early stages of attack are difficult to detect but can be cured with insecticide (stem injection). Palms in the later stages of attack often host several overlapping generations of the pest with a more severe tissue damage and have to be eradicated [2].

Preventive and curative methods were often based on chemical pesticides, until an extended alternative has been introduced involving the use of natural enemies ([7]; [8]). The male aggregation pheromone of R. ferrugineus was identified as 4-methyl-5-nonanol and 4-methyl-5-nonanone by Hallett et al. (1993) and soon commercial formulations were available for monitoring or mass trapping. The pheromone components 4-methyl-5-nonanol and 4-methyl-5-nonanone in the ratio of 9:1 was found to be effective for attracting both male and female adults of RPW [10] Pheromone trapping of adult palm weevils was used to capture and kill the insect to reduce the insect populations in the field ([1]; [11]). The aggregation pheromones have high potential in the management of palm weevils especially the R. ferrugineus as it attracts both males and females ([9]; [11]; [12]; [13]). The trapping methods are also advantageous as they are efficient in attracting a much higher percentage of females in comparison to males and this kind of pheromone based system helps in further reducing progenies ([13]; [14]; [15]). Moreover, for the success of IPM it is necessary to know the optimum number of traps for a specific unit area.

Studies showed that more traps per hectare are necessa-ry to capture more adults in little time. Using from 4 to 8

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Effect of Color Trap, Density and Pheromone Capsule Types on the Trapping Efficacy for the Red Palm Weevil (*Rhynchophorus ferrugineus)*

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Essais
Produits M2I

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Site Rades 19
semaines /40piéges

total=	%	
103	31.88	Total Seau avec eau
100	30.96	Total M2i avec eau
53	16.4	Totalseau sans eau
67	20.74	TotalM2i sans eau
323		Total des adultes

Adulte/P/S

0.425

sidence Ambassade de France Tunis 20 semaines/40 piéges

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Total	%	
23	25.27	Total Seau avec eau
31	34.06	Total M2i avec eau
14	15.38	Total seau sans eau
23	25.27	Total M2i sans eau
91		Total des adultes capturés

Adulte/P/S 0.114

INAT 21 semaines 40 piéges

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total	%	
98	16.20%	TotalPiègeM2I0,5%
123	20.43%	TotalPiègeM2I 1%
105	17.44%	TotalPiège M2I 2%
39	6.48%	TotalPiège ISCA
66	10.96%	TotalSeau 0,5%
89	14.78%	TotalSeau 1%
48	7.97%	TotalSeau 2%
34	5.68%	TotalSeau ISCA
602		Total adultes

Adultes/P/S

0.7166

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Parc Belvédère

19 semaines / 40 pièges

Total	%	
35	14.65%	TotalPiègeM2I0,5%
47	19.67%	TotalPiègeM2I 1%
25	10.50%	TotalPiège M2I 2%
14	5.86%	TotalPiège ISCA
36	15.06%	TotalSeau 0,5%
45	18.83%	TotalSeau 1%
25	10.50%	TotalSeau 2%
12	5.02%	TotalSeau ISCA
239		Total adultes

adultes/p/s

0.3144

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ukra: **Essai Paraffine 11 Semaines 30 piéges**

	Paraffine	Para+ Eau	Eau	
Total	22	16	11	49
%	45%	32.60%	22.40%	

Adultes/P/S **0.1485**

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Effect of different concentrations of M2I ™ pheromone dispensers and the impact of water in pheromone traps for *Rhynchophorus ferrugineus* (Coleoptera: Curculionidae) management in Tunisia.

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ولكم جزيل الشكر على حسن الاستماع
Merci pour votre attention
Thank you for your attention