**Kassem Tofailli**
Founder, AgriMed Solutions, Ltd.
kassem@agrimedsolutions.com

# The Early Detection of Red Palm Weevil A New Method

## Abstract

The Red Palm Weevil (Rhynchophorus Ferrugineus), or RPW, is considered one of the most dangerous pests facing palm trees in over 35 countries (including the GCC, Mediterranean, East Asia and part of Europe). Many attempts have been made to deal with this deadly pest, often referred to as the "palm cancer". As of yet, however, no viable method to detect the pest in its various forms has been developed.

This document gives an overview of the current detection methods and introduces a totally new technique for the early detection of the RPW. The method is based on a combination of medical, computer, and electronic technologies. Because the larva is the most dangerous phase of the pest due to the direct damage it inflicts on the infected tree, this document concentrates on this phase of the life cycle. Several graphics and photos

are exhibited showing results of the tests that were performed in the course of developing this method. The paper also suggests new quarantine protocols that could help improve the efficiency and effectiveness of post-infection strategies. And finally the paper suggests possible directions for future research and product development.

Keywords: palm tree, red palm weevil, pest control, early detection, electronics in agriculture

## Introduction

Of all the pests and insects that attack palm trees, Red Palm Weevil (Rhynchophorus Ferrugineus) is arguably the most virulent. The most comprehensive RPW website publishes quarterly data on the infestation rates of this deadly pest, and the numbers are growing exponentially. Affected countries (about 40 by now) include members of the GCC and others in the Mediterranean, East Asian, and Southern European regions.

Finding an efficient solution to the RPW problem will not only save a "blessed" tree, but would also help farmers and governments reverse the mounting financial losses that have resulted. Although there are no specific studies on the economic impact of this problem, estimates place annual losses in multi-billion dollar ranges. The direct costs include the value of the destroyed trees and their potential date crop, the cost of trapping and other quarantine methods, and the huge budgets allocated to the various chemical treatments. The indirect costs are also substantial. The most significant of these is the restricted movement of trees, especially their offshoots. These restrictions result in drastic cuts in trading not only among countries but also between different regions of the same country.

## TESTING PROCESS

**Photo 1:** Selected offshoot plants wrapped and transported to the test location: Italy

**Photo 2:** Plants were trimmed and removed from pots in preparation for the test

The "Palm cancer", as the RPW is often termed, has been the subject of intensive research in recent years. Most studies conclude that effective treatment is unlikely to be achieved in the absence of effective early detection. The term "early detection" essentially refers to the detection of infection while at the larva stage. The life cycle of the RPW starts with an adult female laying approximately two hundred eggs on new growth, either at the base of young leaves or in open lesions on the plant. Each egg hatches into a white legless larva. The larva will feed on the soft fibers and terminal buds, tunneling through the internal tissue of the tree, often excavating holes in the trunk. Scientists agree that it is this burrowing of the larva into the palm heart that causes the most mortality. By the time the larva pupates, the damage that has already been inflicted is so serious that it eventually kills the host.

In addition to the long dormancy period, another problem complicating treatment is the rapid spread rate. Scientists believe that the main cause of the high spread rate is human intervention. The transportation of infested young or adult date palm trees and offshoots from infected to uninfected areas is the main culprit here.

Currently, there is a wide belief among policymakers, researchers, and farmers that early detection would help save thousands (if not millions) of healthy trees through the use of simple measures to quarantine the infected trees and protect the uninfected trees and offshoots. Potentially, then, early detection could help win the war against the RPW. In this short paper, we propose a test-proven early detection method that we believe could change the battle field.

The next section reviews some of the main methods currently in use in the war against the RPW pest and their limitations. Our proposed methodology will then be outlined along with a description of the initial testing performed. Conclusions and recommendations are presented in the last section.

## Overview of current methods

Over the years, the standard approach for dealing with the RPW problem has been to exterminate adult pests. This is usually done through chemical treatment (usually involving the injection of various insecticides inside the tree). There are two main problems with the standard approach. The first is that by the time the infection is detected and the treatment begins, the damage is so serious that the tree usually dies anyway. The second problem, also related to late detection, is the spread of the infection beyond the original area due to the transportation of infected trees and offshoots. This late detection of the presence of the weevil has long constituted a serious problem in the fight against the pest, and has led to a flurry of research aimed at early detection. Despite this, no safe techniques for early detection have been devised. A brief survey of the current detection methods follows.

A popular and well established

**Photo 3 :** Plants were trimmed and removed from pots in preparation for the test

**Photo 4 :** Drilling several in different sizes

technique entails the use of traps to determine the presence of RPW within certain perimeters. The major drawback with this method is that at most it only defines a general area where there is an infestation. In this way, it indicates the presence of the pest within that perimeter but could neither identify the specific tree or offshoot that is infected nor the extent of the damage that is already inflicted.

Another method involves the visual observation of infestation symptoms. This method relies on the human eye to detect the weevil. Clues such as chewed fiber rejects at the base of leaves or stems, folding and dying leaves, or smelly secretions are observed as possible clues to the presence of the pest. This method is seriously limited, however, because infested adult palms could live for years without displaying external symptoms.

A method that received substantial attention when first proposed a few years ago involves the injection of a virulent topical nematode worm into infected palm trunks. Once inside the weevil's body, the worm releases a lethal bacterium that causes death within three days. The strategy was only tested successfully in the laboratory, however. In real applications, the technique turned out to be deficient on one important account: the nematode attacks only mature weevils, not larvae. Since the weevils would have inflicted most of their damage by the time they are detected, the technique will not reduce mortality rates unless it is combined with an effective early detection method that allows farmers to inject the worm in trees that are identified to harbor the larvae.

The possibility of using audio detection systems (based on acoustics) has also been explored, but this method has only been tested in a laboratory setting and is still far from being implemented on a wide scale commercial basis.

Finally, and much more recently, there have been trials with trained sniffing dogs to smell the presence of larvae or mature weevils inside a tree truck. While this method may hold some future promise, especially, if the dogs could smell the larvae, mixed results have been reported. A question will probably remain as to how accurate and reliable the results are, and where the exact location of the infestation is.

It is obvious from the above that much progress still needs to be made on early detection and diagnosis. The RPW spends most of its life cycle in a dormant larva state inside the tree trunk. By the time symptoms are manifested and treatment begins, it is already too late. Not only has that particular tree and its offshoots been already infested, but, since mature

**Photo 5 :** Infestation with Larvas (different sizes and location)

**Photo 6 :** Infestation with Larvas (different sizes and location)

weevils travel fast from one tree to another, many of the surrounding trees within a particular perimeter would also be at risk. This leads to a much higher mortality than anticipated. That is why a lot of the contemporary research in this field is now focusing on issues related to detection, specifically early detection. As asserted by J.R. Faleiro in his authoritative review of 100 years of RPW management and treatment experience, the "early detection of Red Palm Weevil infestation in the field is vital for the success of any RPW-IMP programs". According to our own literature review as well as first-hand interviews, this sense of urgency is shared by most researchers and public policymakers in countries where RPW infestation is high.

## Parameters of the proposed technique

The method proposed and explained in this paper focuses on diagnosis. Our goal is to develop a viable system to detect the RPW inside the tree in as many life cycle phases as possible. The method represents a totally new approach based on two simple hypotheses: a) an effective detection technology must provide definitive visual inspection of the pest, and b) detection must occur at the larva stage in order to achieve the desired mortality rate reduction. A technology like that would not only solve the major detection challenge of the weevil problem but would also eliminate most of the wasteful and costly guesswork that has characterized public policy in this domain.

Based on a thorough analysis of the current diagnostic routines, we decided to explore the usefulness of X-ray technology to this special detection problem. Despite the fact that current x-ray systems are mainly designed to identify human and animal tissues, this technology has been used in other applications, including a number of non-destructive tests and procedures. Additionally, there have been several attempts to use x-ray imaging to inspect wood surfaces for different purposes, but never before in pest control.

## Detailed system description and testing

Practically palm trees can be divided into two main categories: a) offshoots

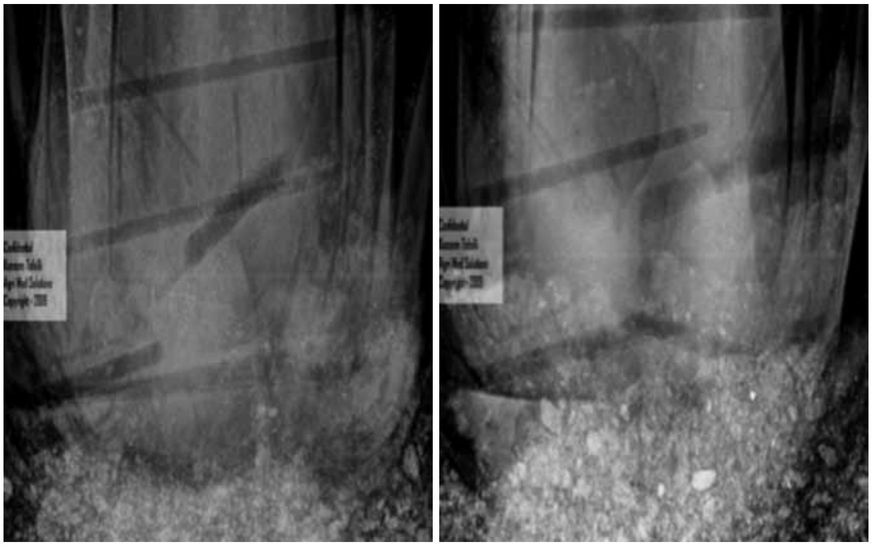

**Photo 7, 8 :** Test showing all tunnels made using different size drills

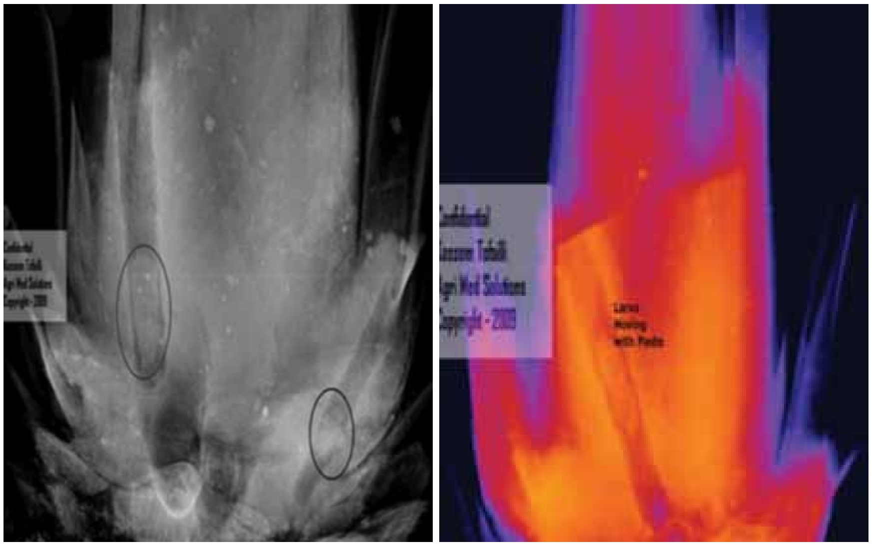

**Photo 9, 10 :** Highlighted Larvas inside the trunk

and unplanted trees, and b) planted trees. Each category requires a different set of mechanical and functional requirements. The system we assembled was mostly designed for unplanted trees with plans in the works to deal with the planted trees in the field.

## The System

A number of factors were involved in defining system hardware and software requirements, such as tree density (which could vary from one plant to another), pest tissue density, system mobility, etc. Once an optimum (representative) configuration was determined, we contracted with a specialized factory to build a customized x-ray system that included several components. System assembly and testing were performed in Italy.

## The Testing Process

As already explained, and because the larva causes the most direct harm to the inner part of the tree, the priority was to detect the larva. Preparations for testing were performed in the following steps. Details about each step are also presented under each photo.

First, we selected 4 offshoots (shown in photo number 1) with trunks 35-40 cm in diameter. These were x-rayed prior to any infection.

Using a drill, we then created several tunnels with different sizes (8, 6, 4, 3 mm) (shown in photos number 2)

Next, we inserted live larvae of different sizes into the trunks at different locations (shown in photo number 3)

Finally, we closed the holes with artificial jelly materials, and prepared the offshoots for another round of x-rays.

## Test Results

Testing was performed using the specially designed radiography system and resulted in clear visual detection of the larvae in the radiographs. Specifically, the different tunnels made inside the tree trunk are clearly visible along with the larvae inside each tunnel (photo number 4). The test showed the larva in different locations (photos 5 and 6). Furthermore, the movements of particular larvae can be traced by comparing different photo pairs (this is shown in photo number 7 and number 8). All the data were collected and stored in different formats which could easily converted for further processing.

## System Benefits

By performing tests such as the ones above at different local and regional testing stations in each country,

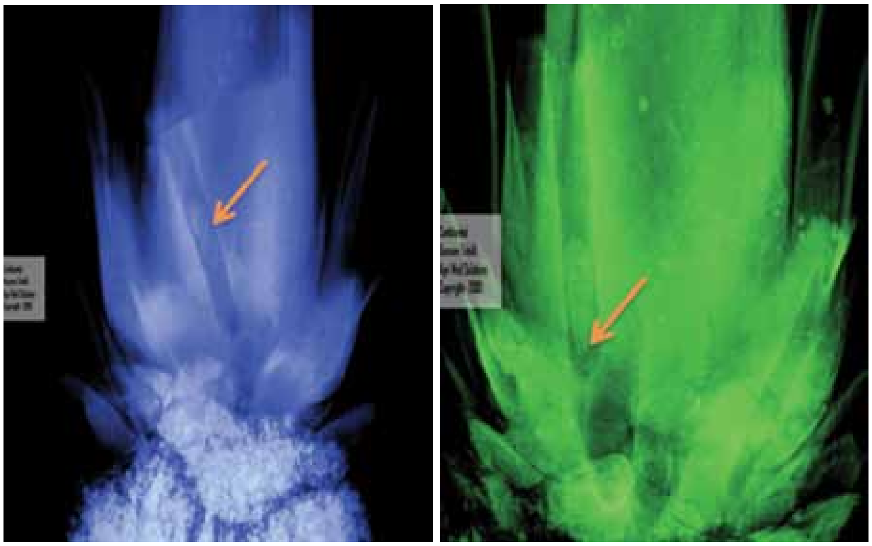

**Photo 11, 12 :** Larva moving iside the trunk

infested offshoots could be identified and removed prior to shipping. It should be mentioned that the results that can be obtained in the field are unlikely to deviate much from those obtained in the lab. Confidence in the reported tests is therefore high.

The most important benefit of this system would be the resumption of offshoot trading among countries. This will allow farmers to recapture the income-earning potential of their offshoots. In recent months, this income had dwindled to negligible amounts in light of tighter regulations and stricter movement controls. The system would also allow the movement of larger unplanted palm trees of different sizes, such as those exported for their aesthetic and landscaping features.

In the future, it is expected that systematic detection would become part of all Integrated Pest Management (IPM) programs. The stationery scanning system which could be located at different borders, airports, seaports and inland locations can ultimately scan any unplanted tree regardless of its size.

Finally, the proposed system can also be used to help scientists better understand the biology of the RPW (system could monitor day-by-day its behavior) and the extent of the damage it causes by monitoring closely its development inside the tree trunk.

## Related System Functions

The purpose of this document is only to introduce this new method and prove its feasibility. However, it must be born in mind that a complete system would probably include a number of other features. For example, a conveyor belt to move the offshoots and trees being tested would be necessary, as well as one to sort the output between uninfected and infected trees. Components that perform the tracking, labeling, and tracing functions must also be considered.

## Conclusions

The results obtained represent a breakthrough which could provide a new opportunity to combat a dangerous pest. The benefits of the system as a detection tool have been exposed. Further development needs to be performed to enhance the success rate of test results. One possible route for that is the use of advanced image enhancement and processing techniques.

It should be noted that this paper was not designed to explain and all system features and functions but to report the successful results obtained and emphasize the importance of implementing this new method in the field in order to help eradicate this pest and ultimately consider is as a new detection standard as part of any effective IPM programs.