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PALM PROTECT, AN EUROPEAN APPLIED RESEARCH ACTION DEVOTED TO PALM BORER PESTS

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SUMMARY

Palm Protect is an EU-funded program (2012-14) entitled: “Strategies for eradication and containment of invasive palm borers, *Rhynchophorus ferrugineus* and *Paysandisia archon*. The project aims at throwing light on aspects of the pest biology in Europe, which are unknown and preclude efficient control, validating new and reliable methods for detection and control, and implementing them into strategies for eradication of the palm borers both at the points of entry in the EU and in the infested areas. The project also aims at providing with an economic analysis to value palm services and management options and to disseminate the findings to the stakeholders. Palm Protect associates 12 research organisations, 1 SME, UK, France, Greece, Italy, Slovenia, Spain, Israel and Egypt. It is based on 6 actions: Management, Biology, Detection, Control, Economics and Dissemination. France contributes by INRA (Versailles et Sophia Antipolis) and CIRAD, which are particularly involved to provide new fundamentals about adult mobility, semiochemicals and parasitoids. The results will make it possible to improve European regulation and its efficacy from a consolidated scientific background in compliance with the standards in force for pest control.

Key words: *Paysandisia archon*, *Rhynchophorus ferrugineus*, biology, detection, control, economic impact.

RESUME
Palm Protect est un programme financé par l'UE (2012-14) intitulé 'Stratégies pour l'éradication et le confinement des ravageurs invasifs des palmiers *P. archon* et *R. ferrugineus'.* Il a pour objectifs d'éclairer les éléments inconnus de la biologie en Europe de ces espèces qui limitent l'efficacité de la lutte, de valider des méthodes et des stratégies fiables et nouvelles pour leur détection, leur gestion et leur éradication tant aux points d'entrée que dans les zones contaminées. Palm Protect diffusera le fruit de ces travaux à tous les acteurs de la filière 'palmiers'. Le programme associe 12 organismes de recherche, une PME, le Royaume-Uni, l'Espagne, la France, la Grèce, l'Italie, la Slovénie, Israël et L'Egypte. Il comprend 6 actions : Coordination, Biologie, Détection et surveillance, Lutte, Economie et Diffusion des acquis. La France contribue par l'INRA (Versailles et Sophia Antipolis) et le CIRAD, et s'implique fortement dans l'acquisition de connaissances nouvelles sur le déplacement des adultes, les médiateurs chimiques et les parasitoïdes. Les résultats serviront de base pour améliorer la réglementation européenne et son efficacité à partir de données scientifiques en application des règles générales en vigueur pour le contrôle des bio-agresseurs.

Mots-clés : *Paysandisia archon*, *Rhynchophorus ferrugineus*, biologie, détection, lutte, impact économique.

INTRODUCTION

Since the discovery of the Red Palm Weevil, *Rhynchophorus ferrugineus Olivier*, in Europe in 1995 palm trees of the Mediterranean basin have heavily paid to this weevil and also to the palm borer moth, *Paysandisia archon* Burmeister, first reported in 2001. Both insects kill palm trees and damage keeps up with increasing.

Palm Protect estimates European losses to be greater than 100 millions Euros and more than 100,000 palm trees since the fortuitous introduction of these pests.

Larvae are borers that feed on the soft growing tissues of the stems and/or of the foliar bases. Resulting damage is generally not detectable before several months after the first eggs have been laid. This feature does not make it possible early detection and has favoured disseminating the pests by transportation of infested plants over the lack of vigilance and regulation, which could have impeded it.

Symptoms of infestation vary with the palm species and the pest. Location of damage requires good expertise and is very labour consuming, in particular for tall palm trees that require examining the foliage at the top of the plant. When symptoms are very pronounced, they generally are quick followed by general decline and death of the palm trees (OEPP, 2008a,b). The confined life of the larvae, the large size and the peculiar anatomy of palm trees (arboreal monocotyledonous plants), and the presence principally in urban areas make control difficult, costly and constrained from both technical and regulatory standpoints.

If palm trees are constitutive elements of south landscapes and make living many professionals, attention paid to palm borers has suffered from the low economical weight directly related to these plants as compared to other plant and crop circuits and to the lack of precise valuing of their landscape, touristic and environmental services .

Efficient methods to detect and control the palms borers and the definition of an adapted regulation need robust data to be established. As such information was lacking or controversial the borer issue has been increasing in size and let stakeholders down-and-out with much delay to provide with unambiguous recommendations.

Important advances have luckily been achieved in the last years: new methods (sanitation pruning, use of enthomopathogenic nematodes, pesticide injection…) have been developed and authorized, which make it possible to save high-value infested palms. In the same time stakeholders have been more mobilized and in a more coordinated. Hope to stop infestation remains despite a dismal situation (Ferry and Gómez, 2008).

The EU launched the European R&D ***Palm Protect*** in 2012 (http://www.palmprotect.eu; list of partners) to translate this hope into reality. The program aims at quickly consolidating the latest advances, clearing up controversial points, and supporting the evaluation of additional possibilities to provide unambiguous recommendations across the European Union by relying on collective expertise.

Palm Protect objectives are to develop reliable methods that can be used by plant protection organizations, inspection services, producers and buyers of palm trees for the early detection, eradication, control and containment of the palm borers. Methods will be developed for implementation to the palm trees at the origin, points of entry, in transit and on-sites.

These objectives will be achieved through 4 main areas of work on ***biology*** to better understand and measure the features in order to better assess the risk to facilitate decision making and optimize the monitoring and control procedures; **detection and monitoring** to develop early detection and monitoring technologies and protocols of reference; **control** to propose new methods and protocols to eliminate and contain these pests; and finally, **dissemination** of information to share the results with all stakeholders of the 'Palm tree' sector both within and outside the EU.

PALM PROTECT MAIN ACTIONS

BIOLOGY

The fight against invasive pests often stumbles over a lack of knowledge of their biology, related to host changes and adaptations to the environment. ***Palm Protect*** aims at

illuminating yet misunderstood points on these adaptive aspects, particularly relating to the relationship to the palm trees and congeners, and multiplication and travel capacities in the Mediterranean zone.

Palm Borer own dispersal capacity

Actual distances flown by the insects, including females fertilized, will be established, as well as the conditions needed for these travels y different methods (*e.g.* miniaturised radio transmitters). Therefore the risk associated with each species from an infested palm will be evaluated with a better precision, which will help optimizing the size of the monitoring perimeters and the distribution of pheromone traps.

Review about host palm range and life cycle Under European conditions

From a collective expertise covering the major affected countries and works in progress, ***Palm Protect*** will produce several documents (scientific and practical) that will establish the crosschecked data on the biology of stem borers in Europe for a diagnosis and accurate prediction of risk on the main palm species by country using refined insect development models (Dembilio *et al.*, 2012). Our current work shows the remarkable capacity of adult weevils to survive, move and keep their reproductive potential between 10 and 20°C, and also the generalized risk to all species of palm trees due to both borers since there are more frequent attacks observed on palms initially given as rarely infested (*e.g. Washingtonia* spp.) since 2010 and also more frequent co-infestations.

New semiochemicals and methodology suited to the pest behaviours

The use of sexual (pheromones) or food attractants or coloured traps offer powerful possibilities of monitoring or control against pests that are effective and respectful of the environment and human health. These criteria are especially important regarding the management of palm borers that are mostly found in cities and ***Palm Protects*** aims at improving existing tools and discovering new ones to strengthen the efficiency of behaviour-controlled-based methods.

Red Palm Weevil: ***Palm Protect*** aims at improving pheromone-based trapping by proposing new attractants and repellents to make it possible to develop a push-pull strategy. Pheromone-based trapping is essential to detect infestation spots and to eliminate adults in mass (Oehlschlager, 2007). The pheromone is synergistic with injured palm odour. To maintain traps at an optimal efficiency, natural plant bait that is emitting the synergistic odour must be renewed once to twice monthly. Such an operation is costly, especially in labour, and it is often to realize with an appropriate frequency, what reduces trapping efficiency. ***Palm Protect*** relies on specialists to work out an artificial palm odour that should be as easy to use as synthetic pheromone and therefore lower trapping costs with an increased efficiency. The partners have also characterised repellent candidates (Guarino *et al.*, 2012).

Castniid borer moth: The development of a trapping system for this moth guides our action. No pheromone is available for it, which has sophisticated diurnal behaviour. Recent work indicates that females do not possess the usual moth pheromone gland (Sarto i Monteys *et al.*, 2012). ***Palm Protect*** studied the existence of other pheromones that could serve as an attractant watch and analyses the insect visual capabilities to assess the potential of visual lures like what to could be developed against various pests of veterinary or agriculture importance (tsetse flies, pollen beetle...).

To identify parasitoids of Castniid borer moth in Europe

Palm Protect focuses effort on searching parasitoids that parasitize eggs under natural conditions (based on the observation of perforated eggs in Europe that suggest the existence of parasitism) and on selecting lab strains available for use in the EU that are able to adapt to the eggs of this insect for efficient parasitisation.

DETECTION AND MONITORING

The detection of the palm borers essentially relies on visual search of symptoms that have to be effectively recognized. Such an expertise requires a careful training. It is very laborious because its effectiveness is based on a plant-to-plant review repeated in time and requests access to the foliage for the tall palm specimens. Its major pitfalls are the time between initial infection and expression of visible symptoms, the existence of asymptomatic infested plants and the time required for the review of each palm tree. In this context ***Palm Protect*** aims to: i- set quantitative and standardized protocols for visual detection for each pest and host palm species; ii- complete the work in progress to improve the sensitivity and early detection using non-visual methods carrier of hope; iii- to develop a field real time decision-making tool that makes it easier geo-referencing of both palm diagnosis and follow-up of the operations implemented for palm borer management.

Detection using dogs

The detection of illegal, dangerous or rare hidden materials (*e.g.* truffle), which have a scent signature is carried out very efficiently by specialized dogs. This method that has proven its potential to the weevil is the subject of a new action in Europe (Nakash *et al.*, 2000).

Acoustic detection

Various systems were evaluated against RPW since 2000 (Soroker *et al.*, 2004). ***Palm Protect*** will respond to the challenge of the automated analysis of the sound signal that discriminates the sounds generated by the larvae of the weevil of other sounds that the human ear cannot do. This approach, can be considered for gains in sensitivity and early detection very important for diagnostics in the nursery.

Semiochemical-based trapping

The practice of trapping is general but there are multiple local variations on the choice and the frequency of renewal of the baits, or traps sometimes in contradiction with the principles which guarantee maximum sensitivity (Rochat *et al.*, 2013.). Deployment strategies remain very empirical in urban environment under the constraint of the private property. From the same tools compared in several countries with the same protocols ***Palm Protect*** will establish protocols and recommendations for efficiency and optimized economic profitability of traps including the results of the biology section (new bait and improved traps; *e.g.* Alfaro *et al.*, 2011).

Expert system for real-time geo-referenced diagnosis and follow-up of RPW

The strategies implemented to manage the palm borers up to now resulted in contrasted results, with success or failure, which all demonstrate how an accurate and fast geographic monitoring of the infestation fronts is critical to optimize decision making. Field staff are in need of a simple and effective tool that helps them in their visual diagnosis, which instantly backups observations, provides decision support and makes it possible to similarly record all operations of monitoring and control for a continuous centralization of the data relevant to infestation management and necessary for coordinated decision. ***Palm Protect*** will optimize and implement a pilot expert system that meets these criteria from combined mobile, GIS and web technologies on test areas. This system is suitable for managing scattered palm trees in a complex way in urban environments or nurseries (Pontikakos *et al.*, 2013).

CONTROL

Life principally confined of the palm borers, often at several metres from the ground and in urban areas, complicates the effective application of insecticides and the cost of treatments. Two challenges come together: follow the regulatory constraints (ecotoxicological safety) while reaching the targets. Better reach the eggs and larvae in the palm trees will achieve the

regulatory goal of eradication and safety and save still more effectively high-value palm trees, with a clear and immediate benefit for landscapes and persons. ***Palm Protect*** articulates its activity for an integrated and optimized approach that is combining all the existing or new possibilities with focus on options that minimize the risk of spread of synthetic insecticides in the environment (use of biological control agents and validation of methods to optimize the application of systemic insecticides agents with strong capacity of distribution and persistence in the palm trees). This component combines various trials, especially field ones, and the know-how of both public and private teams.
The main points developed in this section are:

A critical review about available control means

A comprehensive paper about the situation focused on the advances in Europe and worldwide retrospect to combat palm borers will be published in 2013 (Jacas and Dembilio, 2013; Dembilio and Jacas, 2013 Jacas *et al.,* submitted).

Field trials to validate protocols for effective use of insecticides

They will be carried out and evaluated for both preventive and curative effects in particular for the two most problematical situations: the areas of quarantine at ports of entry in the EU and the nurseries in order to ensure the circulation of healthy palms and the efficient handling of the tall palm trees planted, for which the technical and regulatory constraints and controversies are today the highest. This item includes to evaluate and optimize systematically different parameters related to the endotherapy, mostly to better understand the migration of the active ingredients for increased efficiency, reproducibility and persistence in order to limit the number of injections. ***Palm Protect*** will bring scientific measurements on these aspects in order to support regulation change in the use permissions / restrictions of practices for combating RPW and/or the borer moth.

Tests of new control agents especially biological ones against RPW

Additional bioassays of bioagents will be performed with same objectives of defining protocols as with synthetic insecticides. The external application of biological agents inherently limits efficiency on immature stages confined in living tissues of plants because the agents cannot reach the targets by an active transport through the vessels or the parenchyma and are essentially restricted to migration in the open water in contact with the plant (inner or surface capillarity *e.g.* for nematodes). ***Palm Protect*** will evaluate various agents and strains (strains of fungi of virulence strong and likely to migrate into the palms, insecticidal proteins...) for which active transportation is expected.

Define protocols for developing combined integrated approaches.

There is no sufficient hindsight and references about combining attractants, repellents and pathogens and disposing of infested palm waste safely in an effective strategy to regulate RPW populations under Mediterranean conditions. Several means will be improved from the project outcomes, which will be combined within various strategies: mass trapping, attract-&-Infect, push-pull... ***Palm Protect*** will provide collective expertise to define procedures for implementation, evaluate impact and redact documents to bridge this gap in support of regulatory and plant protection services and operators.

VALUING PALM SERVICES, MARKET AND OPTIONS FOR PALM BORER MANAGEMENT

It has dramatically appeared that there is no review about the economy of palm trees in the UE particularly to estimate the global value associated with the various palm environmental and patrimonial services. ***Palm Protect*** will therefore describe and estimate the value of ornamental / amenity palms around the Euro-Mediterranean region from an ecosystem services perspective, identify and describe the potential socio-economic impacts of the palm borer pests using appropriate risk assessment and economic methods. This will make it possible to estimate costs of implementing alternative pest management options that emerge from the other working sections of ***Palm Protect***, especially devoted to monitoring and control methods and strategies.

CONCLUSION

Finally ***Palm Protect*** is designed to inform about its actions (Rochat, 2012) and disseminate as widely as possible the results of its work and conclusions, reaching the plant protection agencies and services plants and all players in the sector "Palm trees" inside and outside the EU. Dissemination will be carried out as the progress of program, during seminars internal or open to the specialist audience in partner countries and in the form of a package of documents aimed at different audiences published in scientific journals, technical or posted on the Web site of program (http://www.palmprotect.eu). A 6-month meeting was held in Tel-Aviv by the end of 2012 and the next mid-term project will be held in Montpellier France in mid-2013. Various on-going aspects are presented in the frame of the current AFFP meeting in Nice.

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