DE GRUYTER
OPEN

Hellenic Plant Protection Journal **10:** 46-50, 2017
DOI 10.1515/hppj-2017-0005

SHORT COMMUNICATION

Can high pest pressure of the red palm weevil *Rhynchophorus ferrugineus* beat the defense of *Phoenix theophrasti?*

O. Melita, V. Gkounti, D. Kontodimas, D. Papachristos and F. Karamaouna*

Summary The Cretan date palm, *Phoenix theophrasti,* is a less susceptible and suitable host for the red palm weevil compared to the Canary palm, *P. canariensis*, even at high pest pressure. Nevertheless, *P. theophrasti* is not invulnerable to the red palm weevil, hence under continuous and high pest pressure young offshoots/palms can be deadly infested. The slow development of the insect in the Cretan date palm should probably allow a larger 'window of time' for an effective plant protection management against the pest.

Additional keywords: Cretan palm, pest density, suitability, susceptibility

Introduction

The red palm weevil *Rhynchophorus ferrugineus* (Olivier) was recorded for the first time in Greece in November 2005 in the island of Crete (Kontodimas *et al*., 2007). Since then, the pest was established all over the country, causing severe damage to ornamental palm trees occurring in urban and natural landscape areas. The widely distributed Canary palm, *Phoenix canariensis* Chabaud (Arecaceae), was proved to be highly susceptible, while other ornamental species have shown different types of resistance (Dembilio *et al*., 2009; Cangelosi *et al.,* 2016). The Cretan date palm, *Phoenix theophrasti* Greuter (Arecaceae), which occurs naturally in Crete and some Aegean islands, is threatened by the presence of the pest. However, incidents of infestation of *P. theophrasti* are not numerous, leading to the assumption that a level of resistance of the Cretan date palm to the weevil might exist. Dembilio *et al.* (2011) report that healthy 4 years old *P. theophrasti* palms were not infested by adult females after 9 days exposure in a population density of 3 adult females per plant and that a gummy secretion observed in infested palms indicates the existence of antibiosis in this species. Kontodimas *et al*. (2006) reported that development of *R. ferrugineus* adults and their emergence was possible at *P. theophrasti* seedlings after exposure to 6 females/palm (simultaneous presence of 6 males) in laboratory conditions 26°C and 16:8 L:D. The current study aimed at assessing the susceptibility of young plants (corresponding to young offshoots) of *P. theophrasti* to the red palm weevil in response to different population densities in semi-field conditions (compared to the susceptible *P. canariensis),* and their suitability for the development of adult weevils.

Materials and methods

The trials were carried out in semi- field conditions (glasshouse) at Benaki Phytopathological Institute (BPI), Kifissia, Greece. Eight screened metal mesh cages (3 x 1.5 x 2.3 m) were used for different treatments. Assays were performed on 3 years-old potted plants of *P. theophrasti* and *P. canariensis* (the stipe was approx. 15-20 cm high and 15-20 cm wide). *Phoenix canariensis* palms were used as a control susceptible species to the red palm weevil. Five palm trees of each

Benaki Phytopathological Institute, 8 St. Delta str., GR-145 61 Kifissia, Attica, Greece
* Corresponding author: f. karamaouna@bpi.gr

palm species were located in each cage. The palms were exposed to different densities of female weevils, which had been captured in monitoring traps in urban parks of Attica Prefecture. After capture, weevils (male and female) were kept in a rearing Perspex cage (50 x 41 x 50 cm bearing two openings (14 x 28 cm) covered with 2 mm metal mesh for ventilation) under a diet of apples in constant conditions (27 ± 2°C, 60% R.H., 12:12 L:D). A sex ratio of 3:1 (female: male) was sustained to ascertain successful mating. Female individuals were tested for their fertility before the experiment. For this, the females were placed individually in plastic containers (100 cm^3) and were let to lay eggs on a thick slice of apple for 24 hours. Females that laid less than 2 eggs were discarded. After the fertility test, the insects were released in the cages, where they were left to roam freely for 9 days and then were removed. Two experiments were conducted:

i. *P. theophrasti* susceptibility response to pest-density. The palms were exposed to three (3) population densities of female weevils (3, 6 and 12 individuals/palm x 5 palms/cage x 1 cage per species and density) starting at the end of July-beginning of August until middle of September 2013 (21 to 45.7°C the first 20 days after release) to examine the susceptibility of the Cretan palm under different pest pressure compared to the susceptible *P. canariensis*.

ii. *P. theophrasti* suitability at high pest-density. Palms were exposed at the maximum density of those tested in the previous experiment (12 female individuals/palm x 5 palms/cage x 4 cages per species) starting at the beginning of May 2014 (13 to 44°C the first 20 days after release) to examine the suitability of Cretan palms at the age of young offshoots to support the development of the red palm weevil to adulthood.

In the pest-density response experiment, the palms were dissected 4 weeks after the withdrawal of the insects and the successfully hatched larvae were recorded per palm. Percentage successful infestation of the palms [palms bearing live individuals (larvae and pupae) out of total palms exposed] was estimated. The data were subjected to statistical analysis with the Kruskal-Wallis test. Larvae were taken to the laboratory, their head capsule width was recorded and their larval stage was determined according to Dembilio and Jacas (2011). In the suitability experiment, the palm leaves were shortened and the palms were covered individually with a mesh cage and checked daily for adult emergence.

Results and Discussion

The effect of pest density on successful infestation was not found significant (Kruskal-Wallis, H= 2.68; d.f= 1; *p= 0.102),* although an increasing infestation rate (based on oviposition holes and minute larval tunnels without larval development) in higher pest densities was noticed. Successful infestation was significantly less in the *P. theophrasti* palms (0.33 ± 0.27 individuals per palm) compared to that in the *P. canariensis* palms (2.80 ± 1.55 individuals per palm) [(Kruskal-Wallis, H= 4.10; d.f= 1; *p= 0.043* (adjusted for ties)]. Overall pest densities, 13.3% of the exposed *P. theophrasti* palms were successfully infested whereas successful infestation in *P. canariensis* was 33.3%. The number of larvae and pupae per palm ranged from 1 to 4 in *P. theophrasti* and 1 to 24 in *P. canariensis*. In total, 39 larvae developed in *P. canariensis* palms and 5 larvae hatched in *P. theophrasti*, in approximately 4-5 weeks from oviposition. Moreover, the larvae found in *P. theophrasti* did not exceed L7-L8 whereas most of the larvae in *P. canariensis* were L9-L13 [larval stage determination according to Dembilio and Jacas (2011)], indicating that development of the larvae was slower in *P. theophrasti* (Figure 1). A gummy secretion was observed at the oviposition holes and larvae tunnels like in the case of the Dembilio *et al.* (2011) study, the presence and consequent action of which support the assumption for an antibiosis defense mechanism against the pest.

In the high density effect experiment, all *P. canariensis* palms were successfully infested by the red palm weevil while only 25% of *P. theophrasti* palms were infested. In Canary palms, the infestation was evident 6.5-7.5 weeks after oviposition by the weevil (pulpy mass of plant tissue emerging from the basis of leaves and gradual drying and bending of outer leaves) whereas in the Cretan palms the symptoms were seen 13-14 weeks after oviposition (pulpy mass of plant tissue emerging from the palm stem due to larval feeding, Figure 2). A total of 595 adults emerged from 18 palms of *P. canariensis,* 338 individuals of which were females (56.8%) and 257 were males (43.2%). Adult emergence occurred between 10.5 to 15.5 weeks with the majority of them emerging 13 weeks after oviposition. In *P. theophrasti* palms one dead malformed adult, which failed to emerge, and one emerged adult female were recorded 14 months after exposure to the pest, supporting the results by Kontodimas *et al.* (2006) on the development of the red palm weevil in young seedlings of *P. theophrasti* within 4 months at constant 26 °C.

In conclusion, *P. theophrasti* is a less susceptible and suitable host for the red palm weevil compared to *P. canariensis*, even at high pest pressure. The defense of *P. theophrasti* against the pest seems to depend on antibiosis through a gummy secretion of the attacked plants at the oviposition holes and minute larval tunnels (Dembilio *et al.*, 2011). In case of successful infestation, the development of the insect in *P. theophrasti* is very slow in comparison to that in *P. canariensis*, possibly allowing a larger 'window of time' for an effective plant protection management. Nevertheless, our results indicate that although *P. theophrasti* exhibits a high level of resistance to the red palm weevil, it is not invulnerable; under continuous and high pest pressure, young offshoots/palms can be deadly infested. In the wild, infestation of older *P. theophrasti* offshoots by the red palm weevil was reported in Chania-Crete (Conservatory of the Mediterranean Agronomic Institute of Chania) in September 2014 (Prefecture of Chania, C. Fournaraki, personal communication; Kontodimas *et al.*, in press).

The presence of adult individuals has been recorded in the natural habitats of *P. theophrasti* in Crete i.e. the palm forest of Vai and adjacent nurseries (Prefecture of Lasithi, October 2014) and the palm forest of Preveli (Prefecture of Rethymno, November 2014) (F. Karamaouna and O. Melita, personal communication). The present findings should be taken into account for the update of the Action Management Plan towards the most effective protection of the Cretan date palm habitats from the red palm weevil.

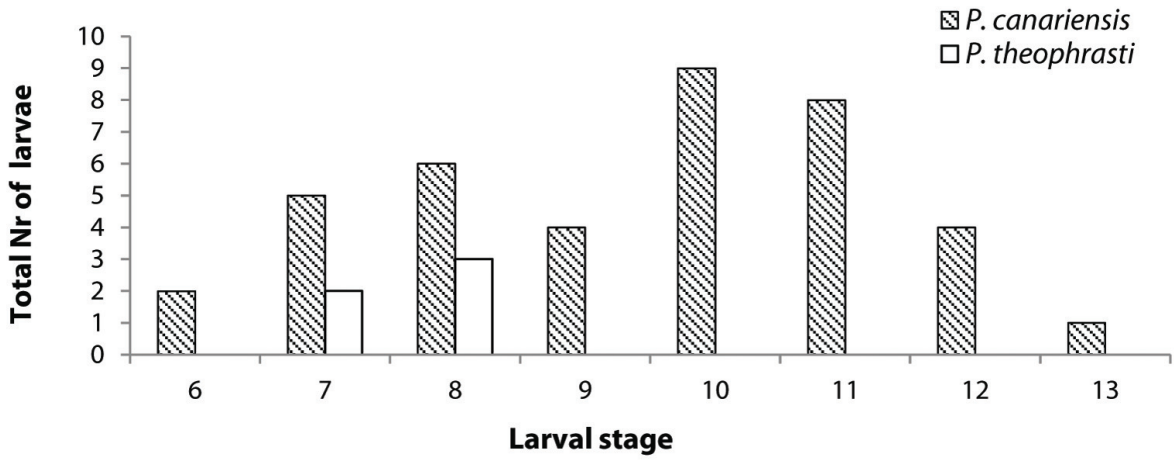

Figure 1. Distribution of larval stages of *Rhynchophorus ferrugineus* in *Phoenix theophrasti* and *Phoenix canariensis* palms in 4 week infested palms (15 plants/species) in semi-field conditions at air temperatures 21 to 45.7°C

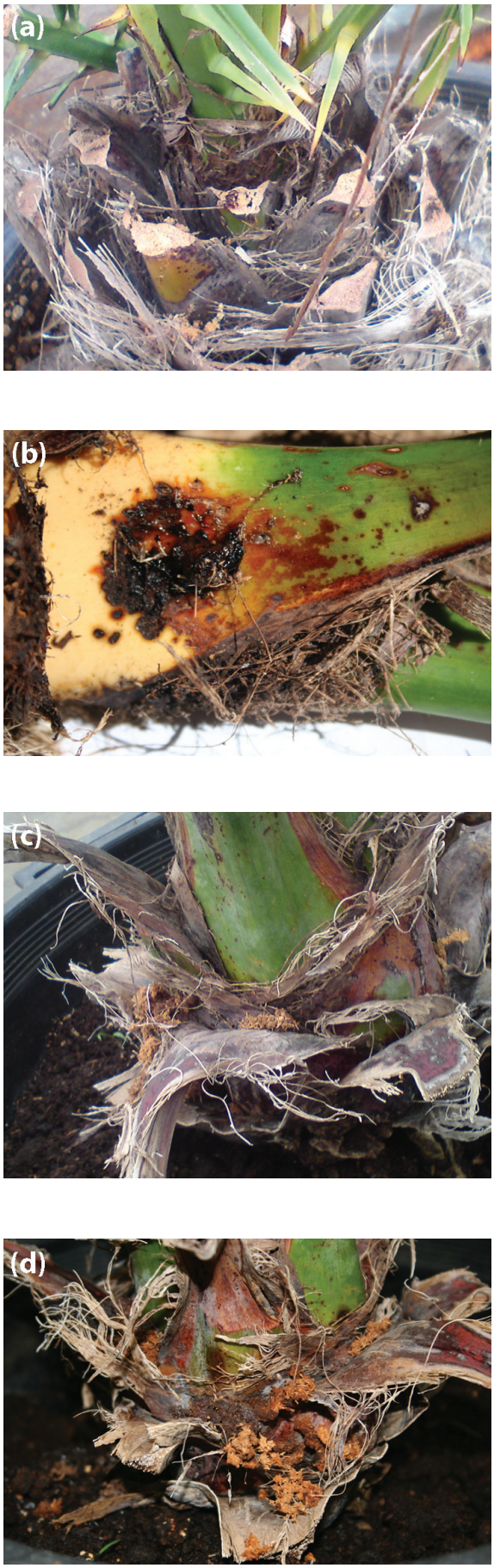

Figure 2. Infestation of *Phoenix theophrasti* by *Rhynchophorus ferrugineus*: gummy secretion on the leaf basis (a) and oviposition holes with gummy secretion (b), 4 weeks after exposure to high pest-density; pulpy mass of plant tissue, approximately 4 weeks after exposure to the pest (c, d) and 14 weeks after exposure to high pest-density (e); malformed adult, which failed to emerge, 14 months after exposure to high pest-density (f).

This research work was conducted in the frame of the FP7 Project PALMPROTECT 'Strategies for the eradication and containment of the invasive pests Rhynchophorus ferrugineus Olivier and Paysandisia archon Burmeister', which is funded by the E.U.

Literature Cited

Dembilio, O. and Jacas, J. 2011. Basic bio-ecological parameters of the invasive red palm weevil, *Rhynchophorus ferrugineus* (Coleoptera: Curculionidae), in *Phoenix canariensis* under Mediterranean climate. *Bulletin of Entomological Research*, 101: 153-63.

Dembilio, O., Karamaouna, F., Kontodimas, D.C., Nomikou, M. and Jacas, J.A. 2011. *Phoenix theophrasti* (Palmae: Coryphoideae) to *Rhynchophorus ferrugineus* (Coleoptera: Curculionidae) and its control using *Steinernema carpocapsae* in a chitosan formulation. *Spanish Journal of Agricultural Research*, 9: 623-626.

Martín, M.M. and Cabello, T. 2006. Manejo de la cría del picudo rojo de la palmera, *Rhynchophorus ferrugineus* (Olivier, 1790) (Coleoptera, Dryophthoridae), en dieta artificial y efectos en su biometría y biología. *Boletín de Sanidad Vegetal de Plagas,* 32: 631–641.

Kontodimas, D.C., Milonas, P., Vassiliou, V., Thymakis, N., and Economou, D. 2006. The occurrence of *Rhynchophorus ferrugineus* in Greece and Cyprus and the risk against the native Greek palm tree *Phoenix theophrasti*. *Entomologia Hellenica*, *16*: 11-15.

Kontodimas D., Soroker, V., Pontikakos, C., Suma, P., Beaudoin-Ollivier, L., Karamaouna, F. and Riolo, P. 2017. Visual Identification and Characterization of *Rhynchophorus ferrugineus* and *Paysandisia archon*. In (eds. V. Soroker and S. Colazza): Handbook of Major Palm Pests Biology and Management. JohnWiley & Sons, Ltd. (in press).

Cangelosi, B., Clematis, F., Curir, P. and Monroy, F. 2016. Susceptibility and possible resistance mechanisms in the palm species *Phoenix dactylifera, Chamaerops humilis and Washingtonia filifera* against *Rhynchophorus ferrugineus* (Olivier, 1790) (Coleoptera: Curculionidae). *Bulletin of Entomological Research*, *106* (3): 341-346.

Dembilio, Ó., Jacas, J. A., and Llácer, E. 2009. Are the palms *Washingtonia filifera* and *Chamaerops humilis* suitable hosts for the red palm weevil, *Rhynchophorus ferrugineus* (Col. Curculionidae)? *Journal of Applied Entomology*, *133* (7): 565-567.

Received: 30 December 2016; Accepted: 20 January 2017

ΣΥΝΤΟΜΗ ΑΝΑΚΟΙΝΩΣΗ

Μπορεί η υψηλή πίεση πληθυσμού του ρυγχοφόρου των φοινικοειδών, *Rhynchophorus ferrugineus,* να υπερνικήσει την άμυνα του φοίνικα του Θεόφραστου *Phoenix theophrasti*;

Ο. Μελιτά, Β. Γκουντή, Δ. Κοντοδήμας, Δ. Παπαχρήστος και Φ. Καραμαούνα

Περίληψη Ο φοίνικας του Θεόφραστου, *Phoenix theophrasti,* έχει μικρότερη ευαισθησία και είναι λιγότερο κατάλληλος ξενιστής για το ρυγχοφόρο των φοινικοειδών σε σύγκριση με τον Κανάριο φοίνικα, *P. canariensis*, ακόμα και σε μεγάλη πίεση πληθυσμού. Εντούτοις ο φοίνικας του Θεόφραστου δεν είναι απρόσβλητος στο ρυγχοφόρο, επομένως κάτω από συνθήκες συνεχούς και υψηλής πίεσης πληθυσμού είναι δυνατή η προσβολή και νέκρωση νεαρών παραφυάδων/φυτών του. Η αργή ανάπτυξη του εντόμου στο φοίνικα του Θεόφραστου πιθανώς να επιτρέπει ένα μεγαλύτερο «παράθυρο» δράσης για την αποτελεσματική αντιμετώπισή του.

Hellenic Plant Protection Journal **10:** 46-50, 2017