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Effectiveness of Sustainable Home-Made Mcphail Traps in Mass Capturing of Longicorn Beetle, *Trichoferus griseus* (Fabricius) Adults under the Rain-Fed Conditions of Matrouh Governorate – Egypt

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Abstract

Longicorn beetle, *Trichoferus griseus* (Fabricius, 1792) (Coleoptera, Cerambycidae) is one of the most damaging fig tree pests at the Egyptian Northwestern Coast (ENC). The current paper discusses the first experience in mass-trapping of *T. griseus* adults by McPhail traps made with re-used PET water bottles. Traps were lured by unmarketable fig fruits immersed in a small amount of water with a bit of any insecticide. This kind of trap is considered competitive for low cost, easily handled and the re-use of PET bottles lowers the wasted plastic that may have good environmental impacts. Also the use of non-tradable fig-fruits as lure advantages the management of wastes. This study confirms the knowledge on *T. griseus* bionomics in ENC. Sixty traps were installed at a rate of 15 traps/site and 1 trap/tree. The traps were succeeded to catch 714 adults throughout the whole study period. The mean catches/trap recorded its highest value at Barrani site and the lowest at Marsa Matrouh. Throughout the whole study period, July month showed the highest capture. Seasonal fluctuation of *T. griseus* adults showed the peaked range from June till October. Although the present findings suggest the efficacy of the traps in mass-trapping of adult borer, we consider the need of further studies and insights to improve trap performance. All the studies will concur to demonstrate the mass-trapping effectiveness in the proposed fig IPM strategy. Finally, local growers, after short training period, enjoyed and disseminated among them how to manage the traps independently.

Keywords: Cerambicidae; *Trichoferus griseus*; Fig tree borer; Mass trapping; Rain-fed agriculture; Matrouh Governorate; Egypt

Introduction

Egyptian Northwestern Coast (ENC) considers as a unique site in terms of the agricultural practices in Egypt. Both prevailing environmental conditions (about 100 mm. annual precipitation rate with irregular events and rain-fed conditions, soil salinity, hot and drought summer season) and the natural northward slope inspired local Bedouins for unique cultivation style, which is the cultivation of fig and olive trees at the rehabilitated wadis in order to exploit the soil-infiltrated rain water to barely provide the trees with their water requirements (rain-fed irrigation). The full description regarding the climate, geomorphology and tableland of this area were mentioned at Yousif et al. [1]. The removal of large areas of indigenous wild vegetation to be replaced by fig and olive trees beside the non-environmental agricultural practice, facilitate biodiversity deterioration, elicit the outbreak of more than one pest and induce invasive infestation on domestic plants with sensible yield reduction as the final output. Such theme was the domain for the data of Shinji et al. [2] that concerned the replacement of natural forests by invasive alien trees in isolated oceanic islands, which was the main reason for deteriorating the biodiversity of many indigenous organisms.

In the current study longicorn fig tree borer, *Trichoferus griseus* (Fabricius, 1792) (Coleoptera Cerambycidae) is one of the most dangerous pest of fig tree trunks. The drought stress that fig tree is subjected to constitute a crucial pre-requisite for *T. griseus* outbreak as stated by Hanks et al. [3] for *Phoracantha semipunctata* F. The larval wood boring life style of *T. griseus* also makes its control practices quite difficult (Gul-Zumreoglu) [4], Hoskovec et al. [5] and Imam and Rabab [6]. In practice, most Bedouin farmers are unlikely forced to cut back the main tree branches of their fig trees due to their inability to manage this pest.

Künckel d'Herculais [7] reported the occurrence of *Trichoferus griseus* in Algiers as introduced species from Syria by infested Acacia (*Acacia eburnea* Willd.) stakes. In 1904 the same Author Künckel d'Herculais [8] confirmed the introduction event and discussed the species life cycle length. Later in Lichtenstein and Picard [9] obtained two Braconid parasitoids in spring; *Iphiaulax flavator* Fabr. and *Doryctes leucogaster* Nees. They considered both enclosed from fig-infesting *Trichoferus griseus* (sub *Hesperophanes griseus*). Lichtenstein and Picard [10] clarified further note that *D. leucogaster* parasitoid originated from *Clytus pilosus* Forst. (=glabro maculatus Goeze) but not from *T. griseus*. Picard [11] also described *Sycophrurus hesperophanis* (Ichneumonidae Cryptini) from fig-infesting *T. griseus* in Montpellier. Balachowsky [12] reported the presence of sub *Hesperophanes fasciculatus* and the major fig pest status of *T. griseus* for most of the Mediterranean shores and North Africa, from El-Goléa Oasis (El Ménia District, Ghardaïa Province, Algeria). Also he documented the infestation pattern of *Acacia* sp., *Acanthyllis numidica*, *Acer obtusatum*, *Ceratonia siliqua*, *Cytisus* sp., *Eucalyptus globulus*, *Morus* sp., *Nerium oleander*, *Pistacia lentiscus*, *Quercus mirbeckii*, *Q. ilex*, and *Taxus baccata* by the fig bores. Balachowsky [12] considered *T. griseus* as univoltine species and suggested to cut

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and burn infested twigs and branches in winter as control measure. Later on Balachowsky [13] discussed again the species as a fig tree pest, and focused on the differences in phenology between the populations in France and in North Africa where the eclosion occurs in full summer. In the meantime Villiers [14] detailed several findings in Morocco, Algeria and Tunisia and reported that adults mate and lay eggs during night. Avidov and Harpaz [15] reported the presence of *T. griseus* in Israel infesting fig and Carob mainly on hills. Hegyessy and Kutas [16] found *T. griseus* in Hungary, a comparatively very cold country.

Accordingly, sustainable and integrated management program should be precisely scheduled to target different life forms of this borer depending on its bionomics. Although, the capture of Cerambycid species adults using light traps is generally recommended as an effective tool either for monitoring or control practices Amitava et al. [17] the difficulty for regular distribution of light traps to cover the intended fig tree area (s) under Matrouh Governorate conditions (due to the scattered pattern of fig orchard cultivation and the lack of power supply sources in most localities) was the main challenge that motivated us to find an effective alternative way to make such treatment practically possible. Accordingly, the current study aimed to evaluate the efficacy of fig fruit trap in the mass collection of fig tree borer adults. The innovative idea of the proposed study is the availability of trap components, environmental friendly, easily handled, cost-competitive and sustainable. We share this first approach as a starting point for further studies to improve the effectiveness of the proposed trap to demonstrate the possibility of their engagement in *Trichoferus griseus* IPM.

Materials and Methods

Study sites

Study sites are administratively followed Matrouh Governorate at the north-western corner of Egypt parallel to the Mediterranean Seashore line (Figure 1). The current study had been conducted from March, 2015 till January, 2016 and the selected sites were chosen to cover the main fig tree cultivation districts throughout the ENC area. Table 1 showed the selected sites and their GPS coordinates.

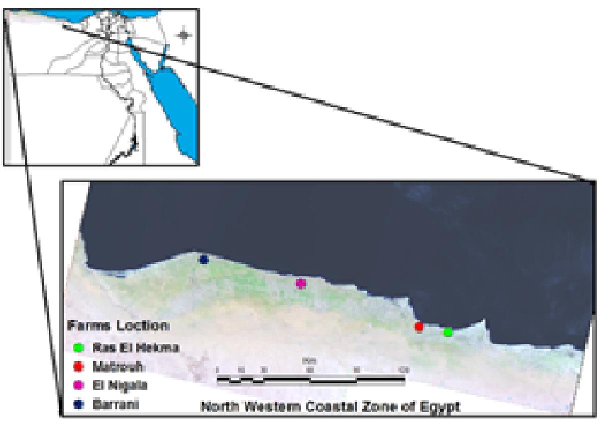

Figure 1: Location map of the study area.

Experimental design

At each selected site, 15 fig trees similar in their height and DBH (diameter at breast height) had been selected for trap installation and evaluation. Each trap consisted of 1.5 L. clear plastic bottles (PET) with four circular holes of about 2 cm. diameters at its upper part. Each trap was lured by one ripe fig fruit soaked in a little bit amount of water. Each trap is hanged on the tree by a piece of plastic cord or iron thin wire at the upper middle portion of the tree canopy. That is to say the 4 sites under evaluation have 60 fig trees (15 trees/site). Traps were weekly checked for counting and evacuating the caught insects and biweekly recharged by new fig fruit.

Study sites	Coordinates	
	Latitude	Longitude
Ras El-Hekma "Sidi Henash"	31° 9′ 58.57″	27° 36′ 41.32″
Matrouh "Wadi Retam"	31° 11′ 54.06″	27° 25′ 4.86″
El-Nigala "Wadi Gebali"	31° 26′ 54.12″	26° 37′ 12.42″
Barrani "Abo Melad"	31° 35′ 0.12″	25° 57′ 31.5″

Table 1: Coordinates of the demonstrated sites.

Trap catchment evaluation

To evaluate the efficacy of fig fruits as *T. griseus* adult attractor, the following parameters had been measured:

-The monthly catch per each site.

-The total and mean catch per site throughout the season.

-The mean catch per trap at each site {total caught insects at each site/165 traps (15 traps X 11 months)}.

-The total and mean catch per month at all sites under evaluation.

-The mean catch per trap at each month (total monthly caught insects/60 traps).

At each site trap evaluation had been done under the ordinary practices implemented by the Bedouin farmers.

The ANOVA analysis was run using SPSS PASW Statistics ver. 18.

Results

Data at Table 2 represented the monthly catch of fig tree borer adults. The total caught insects at the all study sites were represented by 714 adults. At the current study, trapping effectiveness that expressed as the mean catch per trap at each site (total caught insects/165 traps) could be ranked in an ascending manner as 0.38, 0.82, 1.47 and 1.65 adults at Marsa Matrouh, El-Nigala, Ras El-Hekma and Barrani, respectively. From statistical viewpoint, the sites were different (F.=99.04 and P.<0.05). Moreover, catching dynamic as mean catch per trap/month (total monthly caught insects/60 traps) was fluctuated among the minor catch at January (about 0.05) and the maximum at

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July (about 2.30) with in-between fluctuation throughout the whole study period (Table 2).

	March	April	May	June	July	August	September	October	November	December	January	Total catch	Mean catch/site	Mean catch/trap
Ras El-Hekma	11* 0.73 ± 0.88*	13 0.87 ± 0.74	14 0.93 ± 0.79	20 1.33 ± 0.48	45 3.00 ± 1.19	34 2.26 ± 0.70	38 2.53 ± 0.63	42 2.80 ± 0.67	20 1.33 ± 0.72	5 0.33 ± 0.48	1 0.07 ± 0.25	243	34.03	1.47^{b}
Marsa Matrouh	1 0.07 ± 0.25**	3 0.20 ± 0.41	0 0.00 ± 0.00	6 0.40 ± 0.63	13 0.87 ± 0.74	10 0.67 ± 0.48	13 0.87 ± 0.51	9 0.60 ± 0.50	5 0.33 ± 0.48	2 0.13 ± 0.35	1 0.07 ± 0.25	63	8.82	0.38^{d}
El-Nigala	4 0.27 ± 0.45	5 0.33 ± 0.61	11 0.73 ± 0.88	24 1.60 ± 1.12	38 2.53 ± 0.91	15 1.00 ± 0.75	15 1.00 ± 0.84	10 0.67 ± 0.72	8 0.53 ± 0.74	4 0.27 ± 0.45	1 0.07 ± 0.25	135	18.91	0.82^{c}
Barrani	9 0.60 ± 0.73	13 0.87 ± 0.83	22 1.47 ± 1.06	35 2.33 ± 1.71	42 2.80 ± 1.14	46 3.07 ± 0.88	55 3.67 ± 0.97	36 2.40 ± 1.24	12 0.80 ± 1.01	3 0.20 ± 0.41	0 0.00 ± 0.00	273	38.24	1.65^{a}
Total catch	25	34	47	85	138	105	121	97	45	14	3	714		
Mean catch/ month	3.50	4.76	6.58	11.90	19.33	14.71	16.95	13.59	6.30	1.96	0.42			
Mean catch/ trap	0.42^{fg}	0.57^{ef}	0.78^{e}	1.42^{d}	2.30^{a}	1.75^{bc}	2.02^{b}	1.62^{cd}	0.75^{e}	0.23^{gh}	0.05^{h}			

*: data represents the monthly catch **: data represents the mean ± SD.

Table 2: Efficacy of fig fruit traps in the mass capturing of adult stages of fig tree borer, Tricoferous griseus, under the Egyptian NWC conditions (2015/2016 season).

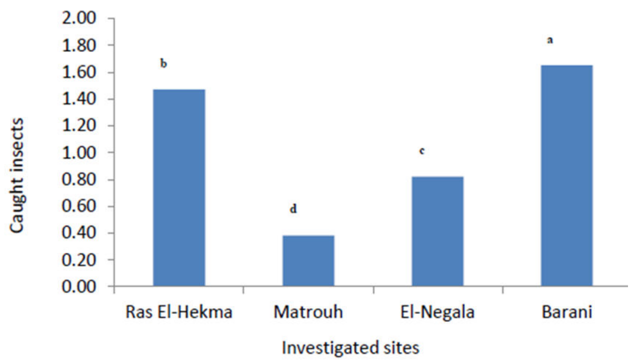

Figure 2: Mean catch per trap at the investigated sites.

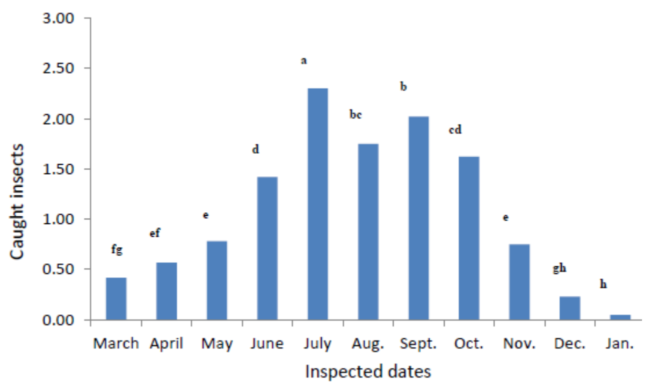

Figure 3: Mean catch per trap at the inspected months.

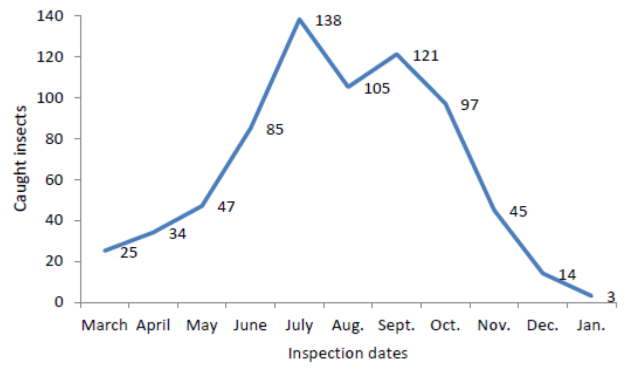

Figure 4: Seasonal flight activity of *T. griseus* adults.

Coherently, the same catch trend per site and per month for the mean and total caught insects was also shown at Table 2 and graphically illustrated at Figures 2 and 3. The data showed that as fig fruit traps at Barrani site attained the highest catch (273 total collected insects with about 38.24 mean catch) among the investigated sites, July month by 138 total collected insects and about 19.33 mean catch was the highest and significantly differed from the remainder months (F.=61.21 and P.<0.05). Not only that, but the obtained data referred also to the highest collection at July at all sites under evaluation, where caught beetles were 45, 13, 38 and 42 adults at Ras El-Hekma, Marsa Matrouh, El-Nigala and Barrani sites, respectively (Table 2).

Upon shedding light on the seasonal fluctuation of the caught insects, Figure 4 illustrated the overall flight activity of T. griseus adults all over the study period that showed the peaked pattern from June till October. Flight activity of T. griseus adults exhibited an ascending pattern from March to May and descending one from November till January with a sort of plateaux from July to September.

Discussion

Cerambycid beetles are a group of insect borers that harshly invade their woody hosts. Infestation cause direct damages and significant losses both on timbers and crops. Also, boring process indirectly weaken the infested tress by opening the way to the secondary fungal infection that rotten and eventually stain the wood, thus hastening the decay of the plant Michael et al. [18].

Accumulated knowledge Künckel d'Herculais, Lichtenstein and Picard [9,10] Balachowsky [12,13] Villiers [14] Avidov and Harpaz [15] agree on the occurrence of T. griseus and its status as a major pest of fig (*Ficus carica*) trees around the Mediterranean shores, in Wadis, Oases and rain fed orchards in North Africa with some detected differences in the pest phenology that depends on the time of eclosion and infestation at the observation sites [19,20].

Data on *T. griseus* occurrence that missed in Malta Mifsud et al. and in Biskra Oasis, Deghiche-Diab et al. [20] must be confirmed because of the different collection methods used in the two studies. Having the study in Malta explored decaying *Ficus* wood, we may consider the datum consistent. On the contrary, the study in Biskra is based on pitfall traps: a method that cannot guarantee Cerambycid collection. The Biskra datum must be carefully considered as a "false negative", consequently.

As different types of traps are dedicated for insect borer studies Amitava et al. [17] and Serdar and Peyman [21], the current data behaved similar trend with highlighting on the possibility of using such trap model as an effective IPM component through attracting *T. griseus* adults and consequently participating in the breaking of its life cycle. Moreover, this mass trapping technique is of fully sustainable with positive impact over the environmental habitat management [22,23].

Rain-fed agriculture at the Egyptian Northwestern Coast characterizes by scattered patterns of fig orchards with large bare areas between each neighboring plantation. Such agriculture style could impede or minimize the continuous flow of the borer adult stages among fig plantations, i.e., these abandoned areas may act as physical barriers for longicorn beetle migration. Accordingly, under this situation trapped beetles will not be compensated or replaced by others from the adjacent orchards. This argument could underpin the suggested hypothesis that mention to the possibility of employing this mass trapping technique as an effective tool in the IPM programs dedicated for fig longicorn beetle.

The point that drawn the attention was the significant variation in the number of captured beetles among the different study sites. The practices that implemented by the farmers may be the interpretation key. Marsa Matrouh site is located at the flood stream, which means that fig trees have adequate humidity that may adversely affect the larval growth of the borer Hanks et al. [3]. Furthermore, during the annual plant cares that include appropriate winter sanitary pruning of the infested branches, the farmers burned the pruned branches and applied prevention (sulphur dusting or cupper oxi-chloride spraying) treatment at the injured spots. Comparable situation was noticed at El-Nigala site with an exception that the farm workers didn't apply the prevention practice after pruning, which may be the reason for the observed higher borer catch in the farm. At the remainder sites, installed fig fruit traps showed higher borer capture than the former sites. As Ras El-Hekma and Barrani sites are far-away from the flood stream, their fig trees are under water shortage stress that may act as good habitat for the larval stage of the borer. Also, this drought conditions especially during the hot summer season are coincided with the flight activity period of the adult borer stages Hanks et al. [3]. In this concern, Larsen mentioned the use of live traps, traps baited with banana fruits, as butterfly attractant. The current data also illustrated the flight activity of the intended borer that exhibited its peak during the summer season (June till September). Similar pattern of *Monochamus galloprovincialis* (Coleoptera, Cerambycidae) flight activity was noticed by Pedro et al.

During the course of this study, there are some practical points that should be highlighted to serve as a technical IPM guideline against this pest under the rain-fed agriculture. First of all, although borer adult capture technique is an effective tool in hindering the borer counts in the farm, it doesn't reflect a real infestation percentage. But the role of mass capture can by maximized through involving this tool in a good designed IPM program.

Other important issue was the capability of this tool to monitor the flight scenario of *T. griseus* borer under Matrouh rain-fed conditions. This finding could be exploited not only as an actual guide for the commencement of the IPM program but also to detect the suitable time of the proposed interventions that meet the targeted stages.

The core concept is to prevent or at least diminish the new infestation through implementing effective practices for killing or keeping the adult borer females away from the trees and consequently decrease the chance of egg deposition. Also, as adult flight period is correlated with egg deposition so ovicidal treatment(s) should be applied in synchronization with the flight period to affect the laid eggs. Other effective treatments are to target *T. griseus* larval stage through trunk injection process and apply, if possible, supplemental irrigation for the purpose of rising up the internal humidity of the tree trunks to a level that could hindering the larval growth. Such suggested points need further studies. Finally, it is of an urgently important to state that IPM program of this Cerambycid beetle is a long-term program that needs more patience and studies to attain acceptable results.

Conclusion

This study highlights the possible use of mass trapping to manage the population and damages of *Trichoferus griseus* on fig orchards in dry lands. We stress the need to investigate the efficacy of McPhail traps prepared and serviced on site by local growers using otherwise wasted plastic and non-tradable and discarded fig fruits and avoiding the use of any insecticide formulate. The background or our proposal lies on the respect for a delicate ecosystem and the search for equilibrate, sounded and sustainable pest control action. Starting from this first approach we need to design series of studies to tune and improve crucial trap use details as: placement, elevation, numbers per tree/ha, orientation and more. Our target is the opportunity to enroll the proposed trapping technique as a principal component for *Trichoferus griseus* IPM in fig orchards.

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