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Unconventional attempts to limit the spread of red palm weevil *Rhynchophorus ferrugineus* Oliv. in palm tree plantations

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Abstract
Rhynchophorus ferrugineus (Olivier) has become dangerous pest of cultivated palm trees plantations in Monofia Governorate (Qwisa). The aim of this study is evaluate the efficacy of different guide attempts as unconventional methods compared with aggregation pheromone -lure traps as control. Data obtained showed that the experiments using up normal methods in this study encourage the trend to the growers to replacing the chemical pesticides applying by the new trends in the study. Data recorded showed that the study that used plastic belt or sex pheromone -lure traps. Significantly differences with other experiments. The total % of infestation was recorded as follow: 1.38 %, 4.42 %, 3.1 %, 26.07 % (Plastic belt, artificial wounds, phyto- pesticides and control (2019), respectively. While in 2020 they were 0.89 %, 3.62%, 2.66%, 23.71 %, respectively.

Keywords: plastic belt, sex pheromone traps, phyto-pesticides, *Rhynchophorus ferrugineus*

Introduction
Now, in Egypt the major weevil is the red palm weevil, *Rhynchophorus ferrugineus* Oliver (Abdel-Raheem, 2013) [1]. The pest attacking wounded date tree, phoenix dactylifera, RPW has become a pest of cultivated palms for relatively long time (Faleiro, 2006, Ismail, *et al*., 2016) [6, 10]. The PRW had expanded in more than 50 countries around the world. We can call the RPW (the invisible enemy) as it spends it life cycle (oviposition, larvae, pupae, and adult insects) in the trunk of the palm tree. The pest has three different generations a year, able to intermingle between it salves. The detection of infestation for early stage is very difficult (Abraham, *et al*., 1998; Oehschlager 1995, and Salem, 2015) [14, 20]. Early detection of PRW infestation is very important is starting control and prevents the spread of pest (Sabry, *et al*., 2011, Salem, *et al*., 2014, Salem, *et al*., 2015,) [16, 19, 20] Generally, it is detected only after the palm tree has been severely damaged. The symptoms of *Rhynchophorus ferrugineus* attack to date palm tree was summarized by (Kaakeh, *et al*., 2001, Abdel-Raheem, *et al*., 2016, 2019, 2020) [2-4]. The injury was categorized by the presence of tunnels on the trunk and pass of leaf petiole, oozing out of the thick yellow brown fluid. From the tunnels. Appearance of frases in and around the opening of tunnels. In infested chards, yield have been estimated to drop from 10 to only 0.7 ton./ha. (Gush 1997, Mohamed Abdel-Raheem, *et al*., 2020, 2021, Reyad, *et al*., 2020) [8, 12, 13, 15].
The aim of the present study was to determine the efficacy of square plastic (2x2 m) cover trunk to protect trees from the insect attack. Pest control will engage all the stake holders by integrating pest control mean into a shared Integrated Pest Management.

Materials and Methods
Monitoring and evaluation studies of RPW *Rhynchophorus ferrugineus* Oliver were carried out in date palm orchard in a special farm. Evaluation studies were conducted during two successive seasons using different applying methods from June 2019 until the end of December 2020 with respect to variety Hayani, and age of palm tree 10-15 years were selected. The mechanical control (Plastic belt); Phyto-insecticides and aggregation pheromone-Lure and the distance or heights between soil surface and infestation site were studied.
The farm was cultivated with dominant crop (Egyptian clover), wheat and different vegetables. The date trees were cultivated and distributed on the edges of irrigation canals and roads. At the age of 10-15 years, the trees are liable to the target pest infestation (Abraham, 1998, Sallam, *et al*., 2012, Salem, *et al*., 2015) [22, 18]. At the begining of experiments, the infested palm trees with RPW were grouped according to the date trees heights, which determined as follow: 2m. : 5m. and 7 m. from the surface of ground. The top infestations are neglected because the injury are rare. By necked eye, the choise of date tree were inspected every two week. The chosen trees was as fruiting stage with nearly distance of 5 m. between trees for each study groups are labeled and divided into three groups according to its length. The main different items of our study are:

A. Place a plastic square (2x2m) cover or around trunk trees, of palm one and two meters heights, are completely wrapped.

B. Manual removing dry bark of tree at two heights 1, 2 m. the removed bark measured 10x10 cm. (square shape). The phyto – insecticides used are the crude extracts of onion green leaves; shilies and colocassia leaves as mixtures liquid 1:1:1 ratio: weight.
C. Aggregation – lure traps were used as control to comparing items with the % of infestation.

Five replicates are determined for each experiment under study. The infestation injury symbol is calculated until of larvae fallen to penetrate trunk. After inspection eliminated even of the larvae did not penetrate the fabric of the neighiborhood tree. The distance between the two experiments is about fifty meters. The recorded data were subjected to regular analysis of variance of randomized complete block design (RCBD). T. test distribution outlined by Gomes and Gomez 1984.

Results and Discussion

First of all, results of these investigations confirm the existence of significant differences in the average number of the RPW adults caught in the sex pheromone traps and alone the percentages of infestation in the other materials. The seasonal abundance of RPW in palm tree under our investigation during 2019 & 2020 were tabulated in tables 1 and 2.

A. First experiment

The important thing in this experiment is to evaluate use of the plastic belt to cover the entire trunk of palm tree and even the height of 1 or 2 meters is useful in limiting the ability of the adult to lay their eggs and palm injury or not. In this positive attempts, it is possible to reduce the use of chemical pesticides in the ingredient of the pest, whether by injection or kill larvae by hand, thus the use of other methods in this study are good idea.

The results recorded and observed of this experiment confirm the existence of significant differences in the annual average of RPW infestation, these results were compatible with the objective of the study for the evaluation of efficiency to the effect of different heights of covered trunk with plastic belt. The percentage of infestation in inversely proportional to the height of covering trunk by plastic belts. Whether, at a height of one meter or two meter in 2019. The annual advantage number of infested tree was 0.12 % at one meter height, while it was 2.64% at two meter heights. The same trend observed at 2020 season, the percentage of infestation were 0.012 % and 1.77 % at one and two heights, respectively. The results revealed that the female preferably for laying eggs near the root zone where wounds are caused by agricultural hoeing and crop cultivation operation.

B. Second experiment

Concerning the relationship between the utilization of same phyto- pesticides as repellent effect on the ability of females to success to lay eggs on date palm trees. The choice of fifteen un infested trees were used and sprayed by using knapsake (Capacity 10 lit.) contained the crude extracts of onion; shilies and colocassia leaves in water at a height of one meter, from the surface of ground. The data cited in tables (1&2) indicated that the females escape from this applying zone of the trunk and search to lay eggs maybe on the height of 2 m.

The statistical analysis shows that there is a significant difference between the % of infestation and control data. The annual average of the infestation percent of was as follow 3.1% and 2.66 % at 2019 & 2020 seasons respectively, while in control area it recorded high infestation (2019- 19.52 %, 2020- 18.08 %).

C. The relationship between the artificial wounds at different heights and the percentage of infestation was studied.

Normally, the normal wounds occur to date trunk near the surface of ground related to agricultural practices. From the previous informations it means that the area of the wounded trunk can be attractive the females to lay their eggs due to the release of volatile oils (Salem *et al*., 2016). Data in two tables (1&2) shows that the increase of % infestation rates correlating with tree heights.

In 2019 season, the % infestation ranged between 6.6 to 26.6 % with annual average of 6.19 % (1 m. height) and 6.6 to 13.3 with annual average of 2.65 % respectively (2 m. height). The data observed in all experiments indicated that the annual fluctuations of the pest recorded three peaks in control zone (May, August and September) during 2019 season, while in 2020 season, the peaks were recorded at April, August, and September months. The data agreement with the finding of Zaggatti 1997, he said that attracted of curculionids by allelochemicals emanating by the fermenting tissues of wounded host plant and this observation are in harmony with the finding obtained by Salem, 2015. The valuable data derived from the experiments is important by recommended to neglect some agricultural practices such as pruning processes and can do it in winter season. From the results tabulated shows that females prefer to lay their eggs on wound locations near the top (2m) or the soil surface.

D. The fourth items of our experiments is to use the aggregation pheromone- lure traps as compering with the other three experiments included in our studies.

During the two years of the study, from January 2019 to December 2020 traps were placed as one trap/ Feddan. Data recorded in the two tables (1& 2) show that the highest peak of weevils captured during the first year (August 2019) with an average of 10 weevils/ trap, beside another two small peaks, occurred at April and October. At year 2020, table (2) show that there are four peaks, the highest one recorded at September (17.0

weevil / trap), the others are observed at May, October and November with an average of 7.2, 15.6 and 10.0 weevils / trap, respectively. The annual average are 3.91 and 3.41 weevils / trap seasons at 2019 and 2020 respectively. As presented above, the results confirm the fact that aggregation pheromone traps can be used effectively for a nationwide programme to monitor the red palm weevil population (Oehschloger, 1995, Gunawardena *et al*., 1995). Also, our investigation of captured adults showed that the ratio of females to males captured was equal. Looking at red palm weevil control experience in the old continent, it seems reasonable that an effective *Rhynchophorus ferrugineus* Oliv. Control strategy shall originate from preventive and protective actions. Pest control will engage all the stakeholders by integrating effective control means into a shared Integrated Pest Management.

Table 1: field evaluation of the efficient of some different processes on the percent of RPW during 2019 season

Months	Mechanical application processes					Mean count adults /trap "15 trap"	Control "15 tree"	
	Heights of plastic belt around trunk "15 tree", %infestation		Heights of manual removal bark "15 tree", %infestation		Phyto-extracts "15 tree", % infestation		No. infested trees	% infestation
	1.0m	2.0m	1.0m	2.0m				
Jan.								
Feb.			6.6			2.6±0.01		
Mar.		6.6	13.3	13.3	6.66	4.2±0.02	4.0	26.6
Apr.	0.6		20.0	13.3		5.6±0.01	4.0	26.6
May.		6.6			6.66	2.0±0.01	6.0	40.0
Jun.			6.6			1.6±0.02	2.0	13.3
Jul.		6.6	6.6	6.6		2.0±0.01	7.0	46.6
Aug.	0.6	13.3	26.6		13.3	10.0±0.02	7.0	46.6
Sep.		6.6	6.6		13.3	8.4±0.03	8.0	53.3
Oct.					6.66	5.0±0.02	4.0	26.6
Nov.	0.6					1.0±0.01	4.0	26.6
Dec.			6.6	6.6		1.4±0.02	1.0	6.66
Annual Average	0.12	2.64	6.19	2.65	3.1	3.65±0.02	3.91	26.07
Total Average	1.38		4.42		3.1	3.65	3.91	26.07

Table 2: field evaluation of the efficient of some different processes on the percent of RPW during 2020 season

Months	Mechanical application processes					Mean count adults /trap "15 trap"	Control "15 tree"	
	Heights of plastic belt around trunk "15 tree", %infestation		Heights of manual removal bark "15 tree", %infestation		Phyto-extracts "15 tree", %infestation		No. Infested trees	% infestation
	1.0m	2.0m	1.0m	2.0m				
Jan.								
Feb.						1.4±0.01	1.0	6.66
Mar.	0.6		6.66	6.66	6.66	2.0±0.03	3.0	20.0
Apr.		0.6	26.6	13.33	6.66	5.2±0.02	4.0	26.6
May.						7.2±0.03	4.0	26.6
Jun.		0.6				2.0±0.01	1.0	6.66
Jul.						2.6±0.01	6.0	40.0
Aug.	0.6	13.3	33.3	13.33	13.3	4.4±0.03	5.0	41.6
Sep.	0.6	6.6	2.0	6.66	6.66	17.0±0.05	7.0	46.6
Oct.						15.6±0.03	4.0	21.6
Nov.					6.66	10.0±0.02	5.0	41.6
Dec.		6.6				2.0±0.01	1.0	6.66
Annual Average	0.012	1.77	4.57	2.66	2.66	5.78±0.03	3.41	23.71
Total Average	0.89		3.62		2.66	5.78±0.03	3.41	23.71

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