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EVALUATION OF SPECIFIC PHEROMONE TRAP DESIGNS AND COMPONENTS TO IMPROVE THEIR EFFECTIVENESS IN REDUCING THE RED PALM WEEVIL POPULATION IN EGYPTIAN PALM FARMS

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ABSTRACT: Due to the extreme danger of the red palm weevil (RPW), *Rhynchophorus ferrugi*neus (Coleoptera: Curculionoidea: Dryophthoridae) on date palms and its rapid spread in many countries in the world. This work was carried out to evaluate the effect of using different pheromones, baits and trap shapes on the attraction of the RPW adults by pheromone traps in date palm plantations. Results revealed that the traps contained Rhyncho gel pheromone recorded the highest average of captured RPW 20.17 adults/ trap compared to the three other tested pheromones, Rhyno cap, English and Costa Rican which recorded, 17.44, 12.94 and 7.44 adults/ trap respectively. Also, the traps contained dates as a food bait attracted the highest average of RPW adult 55.47 adults/ trap compared to the other four tested baits, Pineapple, Sugar beet, sugar cane and palm pollen grains that collected 27.56, 25.25, 11.83 and 10.39 adults/ trap respectively. In addition, trap shape No. three achieved the highest average of attracted RPW adults 16.81 adults/ trap followed by the trap shape No. two, 13.81 adults/ trap without significant differences between them, while the trap shape No. one collected the least insects number, 10.22 adults/ trap with a significant difference with the other two forms. It is clear from the results that we recommend the use of the third-shaped trap containing Rhyncho gel pheromone and dates as a food bait, as each of these three treatments has achieved the highest efficiency of attracting RPW adults in date palm farms to reduce their population.

Key words: *Rhynchophorus ferrugineus*, RPW trap, Aggregation pheromone, Rhyncho gel, Rhyno cap, food bait,trap shape.

INTRODUCTION

In North Africa and the Middle East, the date palm is regarded as one of the most significant fruit trees (El-Shafei 2015; Abd El-Fattah *et al.* 2019; El-Shafei 2020 and Mahmoud *et al.* 2022). In addition to shelter, wood, and handicrafts, it is a source of revenue for people and it is also rich in Carbohydrates content. As a fruit with significant nutritional and medicinal significance, dates are regarded as one of the most significant (El-Shafei 2018; Zinhoum and El-Shafei 2019). All parts of the palm tree, including the trunk, leaves, bracts, leaves, and fruits, are susceptible to infestation by a variety of insect and pest diseases, which can reduce both the quantity and quality of production (El-Lakwah *et al.* 2011a; El-Lakwah *et al.* 2012; El-Shafei *et al.* 2018 and Assous *et al.* 2022) . The red palm weevil is one of the most significant and harmful pests that affects the trunk of all cultivars of date palms, ornamental palms, and all species of palm trees (El-Lakwah *et al.* 2011b; El-Shafei, 2011; Habib *et al*., 2017; Milosavljevic *et al*., 2019 and Abd El-Wahab *et al.* 2020). The red palm weevil has been found in more than 50 countries worldwide, according to Salem *et al.* (2018). This expansion has been attributed to the movement of infested palm trees to nations that are not yet afflicted with the red palm weevil (RPW). The ability to fly over 900 meters in a day and over 7 kilometers in three to five days is also demonstrated by (Abbas *et al.*

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2006). *Phoenix dactylifera* L., a species of date palm, is suffering widespread damage throughout the Middle East as a result of RPW, which also has an adverse effect on the environment. The mechanism of infestation, which frequently affects young trees, involves the weevil laying eggs inside and eventually developing larvae that feed on the palm tissue. This weakens the structure of the tree trunk and eventually results in extensive damage that causes the tree to deteriorate and even break (Kagan *et al*., 2021). Even though it originated in Asia's tropical regions, the RPW has grown to be a global issue (Gerson and Applebaum, 2020). In accordance with data provided by the EPPO (European and Mediterranean Plant Protection Organization), the RPW has spread to 85 different nations and areas globally (Eppo, 2021). The RPW threat may also cause palm trees to fall down, increasing the risk of threatening human life because palm trees are frequently seen as ornamental trees in residential areas (Kagan *et al.,* 2021; Kang *et al.,* 2022 and Koubaa *et al.,* 2020). Due to the limited appearance or discovery of symptoms of red palm weevil infestation through visual examination methods or acoustic detection, except in the late stages of infestation, and the inability to follow all stages of the RPW from the outside, which leads to the difficulty of success in applying control methods in the advanced stages, there is strong need for early detection methods of RPW infestation which has become an important challenge, as it saves a lot of effort in the control process, increases the opportunity for treatment, and reduces losses in palm trees, because control in the early stages is more efficient and faster (FAO 2020). Therefore, one of the necessary solutions to this problem is the use of integrated pest management strategy in the face of the insect and its components of internal and external agricultural quarantine, periodic examination and removal of severely infested palm trees, and preventive spraying with chemical pesticides Abraham *et al*., (1998). In order to avoid severe damage of environment as a result of the sharp increase in the use of pesticides in RPW control, sustainable strategies must be assessed and adopted with attention given to mass trapping of RPW using aggregation pheromone traps in order to reduce their numbers to the lowest level continuously, reduces the number of palm trees that will attacked by RPW, in which the use of pheromones and food baits increase the efficiency of trapping. (Foster and Harris 1997; Rosell *et al.* 2008 and Gomez *et al.* 2009). It is concluded from previous studies that the use of baits with aggregate pheromone in the trap increases the efficiency of collecting RPW (Faleiro 2006) and due to the emergence of many types of aggregate pheromones recently, as well as the use of many forms of traps, whether wet or dry, this study aimed to compare certain types of pheromones that are newly presented in the market, as well as a comparison between different types of food baits, in addition to a comparison between some forms of traps to reach a higher efficiency pheromone trap in attracting the largest number of red palm weevil insects in date palm farms.

MATERIALS AND METHODS

1. Field experiments location

The experiments were examined at a palm farm in the reclaimed land east of Cairo-Alexandria Desert Road, Village of Wardan in Giza Governorate (30°17'26.3"N 30°53'35.4"E) During 2022/2023 (from beginning of March 2022 to the end of May2023) to evaluate the efficiency of different pheromone trap component (aggregation pheromones & food baits) and trap shapes on the attraction of RPW adults in date palm plantations to Improve the efficacy of RPW *R. ferrugineus* (Oliv.) pheromone trap under field conditions. The experiments were designed as a randomized block design with three different sites as replicates. Traps were rotated every one week so that all traps are exposed to similar conditions. Traps were distributed on the edges of the farm that contains palm trees and mango trees and placed in the ground under mango trees in the shade and surrounded by sand until the near of the holes in the trap sides to facilitate the entry of RPW adults into the trap through the holes. The distance between one trap and the other is 100 meters and the trap is 20 meters away from the

nearest palm tree to keep the palm trees in the condition that the attracted insects did not enter the trap.

2. Traps design

This experiment was performed using black traps. These traps were made from a 10 liter plastic bucket with stick paint on the body and lid. Sand was sprayed over the entire barrel from the outside to hold the sand in place and make it easier for RPW adults to walk into the trap's hole. The traps were left for a day to dry, then painted with black color as the drake traps caught a lot of weevils compared to other colors, (Al-Saoud and Ajlan 2013; Abd El-Wahab *et al.* 2020).

3. Pheromones types

Four different aggregation pheromones types, Rhyncho gel, Rhyno cap, English and Costa Rican (Table 1) and (Fig. 1) were used to determine the most efficient one. The trap contains pheromones which exchanged every 3 months, while kairomone and water (renewed weekly). The trap has four circular holes on the sides at a height of 16 cm from the base, and the diameter of the hole is 3 cm as shown in Fig. 2. (Abuagla and Al- Deeb, 2012; Al Saud and Ajlan, 2013; Al Saud *et al., 2*016 and Gilal *et al.*, 2017). Trapped weevils were removed every one week after they sexed and recorded. 12 traps were used in this experiment, three traps (replicates) for each pheromone type. The traps were randomly distributed in the order of, Trap No. 1 containing Costa Rican pheromone, Trap No. 2 containing English pheromone, Trap 3 containing Rhyno cap pheromone, and Trap 4 containing Rhyncho gel pheromone. Traps 5, 6, 7 and 8 were repeated in the same pattern for the second repeater to be Costa Rican, English, Rhyno cap and Rhyncho gel pheromones, respectively. Likewise, the third repetition of the four pheromones, so that the traps 9, 10, 11and 12 were in the same pattern, consisting of Costa Rican, English, Rhyno cap and Rhyncho gel pheromones, respectively. Then, a rotation of the traps was made every week after collecting and counting the insects. Traps were rotated every week to make all traps are exposed to similar conditions, where Trap 1 is placed in place of trap No. 2 and trap No. 2 in the place of trap No.3, and so on, until that trap No. 12 was placed in the place of trap No. 1.

The Aggregation pheromone types were as follows in Table (1)

Rhyncho gel: pheromone dispenser for *R. ferrugineus*, consist of 600 mg pheromone and synergists, net weight: 16 g (Pheromone was manufactured by Nov Agica biological product and solutions Company www.novagrica.com).

Rhyno cap ™: pheromone dispenser for *R. ferrugineus*, consist of 3% Cypermethrin and 97% other ingredients, net contents 750g (Pheromone was manufactured by ISCA Technologies-USA Company, www.iscatech.com).

English: 700 mg *R. ferrugineus* R03 lures consist of the pheromone components 4-Methyl-5-nonanol and 4-Methyl-5-nonanone formulated with a proprietary mix of extenders and wax, on a fibrous cellulose cylinder. Description: Proprietary wax formulation and extenders absorbed onto a cellulose plug. Dimensions: 40 mm length x 10.5 mm diameter Weight: 3,000 mg (±5%) Colour: Pale Orange, Packaged within an impermeable aluminium foil sachet. (Pheromone was manufactured by international pheromone systems Est.1985. Company, England).

Costa Rican: dispenser of the *R. ferrugineus* male aggregation pheromone (Pheromone lure was manufactured by Chim Tica international S.A. Company, Costa Rica. Trade Name PO28 Ferroluree+,700mg lure, consists of a mixture of 4-methyl 5 – nonanol and 4- methyl 5-nonanone (9:1part purity of both components >95% release rate 3-10 mg/day).

4. Effect of five different food baits on the attraction of red palm weevil adults

Five local food bait material were chosen i.e. 250 g of sugarcane, date fruits Siwi cultivar, sugar beets, date palm pollen grains and

pineapple. The selected food baits were obtained from the market Fig. (3). The same trap design that was explained in the experiment comparing the four types of pheromones were used (Fig. 2). 15 traps were used in this experiment, each food bait was replicated three times (Three traps). The traps were randomly distributed in the order of trap No. 1 containing dates, trap No. 2 containing sugar cane, trap 3 containing pollen, trap 4 containing sugar beets, and trap No. 5 containing pineapple. Traps 6, 7, 8, 9 and 10 were repeated in the same pattern for the second repeater to be dates, sugar cane, pollen, sugar beet and pineapple, respectively. Likewise, the third repetition of the five materials, the traps 11, 12, 13, 14, and 15 were in the same pattern, consisting of dates, sugar cane, pollen, sugar beets, and pineapple, respectively. The rotation of the traps was made every week after collecting and counting the insects. Traps were rotated every week so that all traps were exposed to similar conditions, where Trap No. 1 is placed in place of trap No. 2 and trap No. 2 in the Place of trap No. 3, and so on, until that trap No.15 was placed in the place of trap No. 1.

Taple (1). Tested red palm weevil aggregation pheromones.

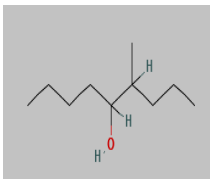
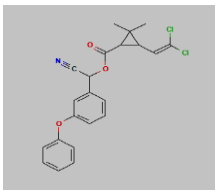
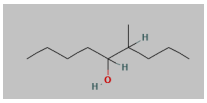
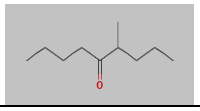
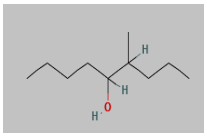
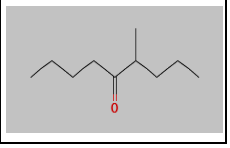
Trade name	Common name	chemical name	Molecular Formula	Molecular Weight	Chemical Structure
Rhyncho gel (Nov Agrica)	Rhyncho gel	4-Methule-5nonanol	C10 H22 O	158.28	
Rhynocap (ISCA Technologies – USA)	Cypermethrin	α-cyano-3-phenoxybenzyl 3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate	C22H19Cl2 NO3	416.3	
English Lure wax plugs (International Pheromone system)	*Rhynchophorus ferrugineus* R03 Lure	4-methyl-5-nonanol + 4-methyl-5-nonanone	C10H22O + C10H20O	158.28 + 156.26	 + 
Costa Rican PO28 Ferrolure+ (Chim Tica international S. A. company, Costa Rica)	ferrugineol	4-methyl-5-nonanol + 4-methyl-5-nonanone	C10H22O + C10H20O	158.28 + 156.26	 + 

Fig. (1): Different pheromones types: a(Costa Rican),b(English), c (Rhyncho gel) and d(Rhyno cap).

Fig. (2): **Trap used in pheromones types experiments.**

Fig. (3): **Types of tested food baits.**

Types of food baits were as follows:

1- Sugar cane: The outer layer of the stem of sugarcane was removed and put 250 g in the trap.

2- Palm pollen grain: 250 g from palm pollen grains was used.

3- Date Fruit: 250 g from semi dry dates, Siwi cultivar were taken and put in the trap.

4- Sugar beet: 250 g from sugar beet were taken and put in the trap.

5- Pineapple: The outer part of the pineapple fruit was peeled, then the fruit was cut from the inside into circular parts, then weighed 250 g to be placed in the trap.

5. Trap shapes

In order to evaluate the effect of three different forms of pheromone traps in collecting RPW adults and reducing their population in date palm farms, three trap shapes were used. All the tested traps contained aggregation pheromone, Rhynch gel type which achieved the highest number of attracted RPW adults (renewed every three months), kairomone, water (renewed weekly) and 250 g date fruits Siwi cultivar as food bait (renewed every 15 days). To make it easier for RPW adults to enter the trap through the circular entrance of trap type 1, through the holes for trap form 2, and through the funnel for the third form, the tested traps were placed in the ground shadow and surrounded by sand until the base edge of trap forms shape 1 and edge of trap shape 3, and near the holes in the sides of the trap type 2.

Shapes of trap were as follows:

Type 1 (Rhyncho gel (Nov Agrico)): It is a yellow cone-shaped trap with a capacity of 3 liters with total height 28 cm and 19 cm diameter. It consists of a base in which the pheromone, water, and food bait were placed at a height of 13 cm. It is covered with sand up to its edge, and the lid was above the surface of the ground, with the same height of the base (13 cm), between the lid and the base there is a circular space with 2 cm height that allows the entry of red palm weevil adults and does not allow them to exit as shown in Fig. (4 a).

Type 2 (Trap with lid and 4 circular holes on the sides): This trap has a capacity of 10 liters of water, its height is 20 cm, and it has four circular holes on the sides at a height of 16 cm from the base, and the diameter of the hole is 3 cm. Both the body of the plastic bucket and its cover were painted with adhesive paint. The coarse sand was sprayed onto the whole bucket from outside to stick the coarse sand grains to facilitate walking of RPW adults to reach the trap holes, then the traps were left for a day to dry and then paint with black color as shown in Fig. (4 b).

Type 3 (Trap with lid, funnel and 4 holes on the lid): This trap has a capacity of 10 liters of water, and it has a big hole in the cover measured (3.5 x 18 cm) with a funnel installed on this hole in the cover of the trap equipped with valve at the end of funnel which allows the entry of RPW adults and it is not allowed to leave it to exit and it has 4 holes in diameter 1 cm distributed on the 4 cover directions of the trap to increase the amount of the releasing pheromone as shown in Fig. (4 c) according to Abd El-Wahab *et al.* (2020) with some modification.

6. Statistical analysis

The gathered data were subjected to analysis through the utilization of Proc., ANOVA. The software SAS (SAS Institute 2006) was used.

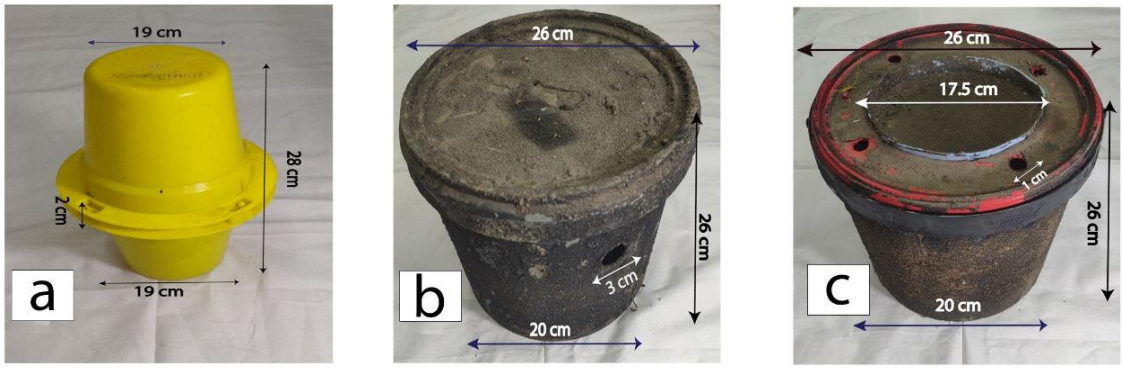


Fig. (4): **Measurements and specifications for the three tested shapes of traps: a. Shape 1 , b. Shape 2 and c . Shape 3.**

RESULTS AND DISCUSSION

1. The impact of different pheromone types on *Rhynchophorus ferrugineus* adult catchability using pheromone traps.

This experiment was conducted to compare the efficiency of four different types of aggregation pheromones in collecting RPW adult for pheromone traps in date palm fields. Obtained data presented in Table (2) and illustrated in Fig. (5) indicated that the trap contained Rhyncho gel pheromone attracted the highest average number of captured RPW adults/ trap during 12 weeks of experiment with an average of 20.17 adults/ trap , followed by the trap contained Rhyno cap pheromone 17.19 adults/ trap. Moderate collecting effect of English pheromone 12.94 adults/ trap, while the lowest number of insects captured was for the trap containing the Costa Rican pheromone, with an average of 7.44 adults/ trap. Our results are in agreement with Batt, *et al.* (2023) who evaluated the effect of both Rhyncho gel and Rhino cap pheromone in attracting red palm weevil insects in the Sharkia and Menoufia governorates, and it was found that the effect of the Rhyncho gel pheromone was higher in collecting a greater number of RPW insects than the Rhino cap pheromone throughout the study period. On the other point of view, Abdelazim *et al.,* (2017) In a field experiment, compared two types of commercial red palm weevil pheromones, Ferrolure^{+TM} (ChemTica International Co., Costa Rica), Rhyfer™ (Alpha Scents Inc., USA) Which are the same two pheromones used in our research, Costa Rican and English, respectively. Also, It was found that the two pheromones are similar in their attraction to the red palm weevil, and there are no significant differences between them. In contrast, Al Ansi *et al.,* (2022) found that when comparing two types of pheromones in Riyadh, Saudi Arabia, the results showed that the Ferrolure^{+TM} pheromone (Costa Rican) collected more insects from the red palm weevil than the Rhylure pheromone (English).

2- The effect of different types of food baits on *Rhynchophorus ferrugineus* pheromone traps catchability of adults.

The data in Table (3) and shown in Fig. (6) showed a comparison between 5 different types of food baits used in pheromone traps for collecting adults of the red palm weevil. Results revealed that the aggregation pheromone trap contained dates as food bait captured the largest average number of RPW adults per trap which was 55.47 adults/ trap, Followed by both traps containing food baits of pineapple and sugar beet, which there was no significant difference between them in the number of captured RPW adult, 27.56 and 25.25 adults/ trap, respectively. While the least effect was observed on the average number of RPW adult insects collected for both pheromone traps that contained both sugarcane and palm pollen,11.83 and 10.39 adults/ trap respectively. Our results are consistent with Kaakeh *et al.,* (2000) who reported that using date fruits as food bait in pheromone traps for the red palm weevil was one

of the best baits to attract insects compared to other teste baits. Also, Abuagla and Al-Deeb (2012) found that when food baits, particularly dates placed on black bucket traps, and combined with the pheromone, increased the capture rates. Moreover, Abdel-Azim *et al.,* (2017) compared some food baits in pheromone red palm weevil traps and found that date fruits in the trap attracted a greater number of insects compared to sugar cane in the traps. Regarding the results of pineapple as a food bait, it turns out that our results are consistent with Haris-Hussain *et al. (*2020) who mentioned that pineapple was the best food lure in RPW pheromone catching since it was the most favored food trap and oil palm was the least. The pineapple significantly outperformed the other treatments in terms of RPW responses (F = 20.44, d.f.) and attracted the highest percentage of responses (83 percent). = 7, p < 0.05), followed by Sugar cane (60 percent). Azmi *et al.* (2014) found that using pineapple as food bait in red palm weevil traps in Malaysia collected a significantly number of insects than traps that contained sugarcane. Rita *et al.* (2011) found that in addition to the alcohol scent of pineapple, the fermented pineapple's palm ester has a sweet and fruity aroma that attracts more RPW. Azmi *et al.* (2014) trial of pheromone-based mass catching framework was directed in a coconut estate in Kuala Terengganu, Malaysia to look at the impacts of chosen food goads (pineapple organic product, sago palm stem and sugarcane stem) and aggregation pheromone (ferrugineol; 4-methyl-5-nonanol) in drawing in RPW grown-ups. When compared to the other food baits, the pineapple with ferrugineol caught the most adult RPW (n = 76 individuals; p < 0.05). Kalleshwaraswamy *et al.* (2006) tested five food baits, including chopped pineapple, chopped sugarcane, hand-crushed grapes, bits of coconut petiole, and peeled bananas, at various locations in coconut groves to see how they increased the effectiveness of synthetic pheromone lures for capturing prey. Their findings showed that increasing the attraction of red palm weevils required the use of food bait. The weevil population attracted by the pineapple bait traps was much higher than that of the sugarcane traps. Future studies should be conducted on analyzing the components of the tested food baits, especially those that achieved the highest results in attracting insects, to find out the components responsible for the attraction and how to produce them industrially in an economical manner.

Table (2): Impact of pheromone types on the attraction of the RPW adults by pheromone trap.

weeks	Average captured RPW adults/ trap±SE			
	Costa Rican	**English**	**Rhyno cap**	**Rhyncho gel**
week 1	7.67±0.33	13.33±0.67	17.67±0.88	20.00±1.00
week 2	7.67±1.86	13.33±3.18	17.33±4.26	20.33±4.70
week 3	7.67±1.76	13.33±2.96	17.33±4.10	19.67±4.41
week 4	8.67±1.20	15.00±2.08	19.67±2.73	22.67±3.28
week 5	6.33±1.76	11.00±2.65	14.00±3.61	16.67±4.67
week 6	7.33±0.67	12.67±1.33	16.00±1.53	19.33±1.67
week 7	6.67±1.33	11.67±2.33	14.83±2.92	17.67±3.33
week 8	8.00±1.00	13.33±1.33	18.33±2.33	20.67±2.67
week 9	8.00±0.58	14.33±1.76	21.33±1.76	25.33±2.96
week 10	7.00±0.58	13.67±2.60	19.00±2.08	21.33±2.03
week 11	7.00±1.00	12.00±1.53	16.00±2.00	18.33±2.67
week 12	7.33±1.20	11.67±1.86	15.00±2.31	20.00±2.65
Mean	7.44 d	12.94 c	17.19 b	20.17 a
pt	<.0001			
L.S.D.	1.665			

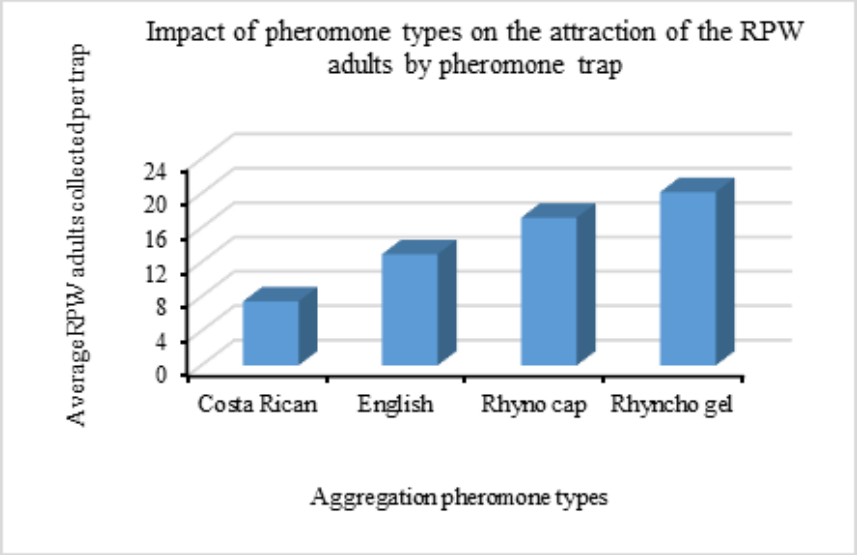


Fig. (5): Comparison between the efficiency of four types of aggregation pheromones in collecting RPW adults.

Table (3): Comparison between different types of food bait and its influence on captured adults of RPW.

weeks	Average captured RPW adults/ trap ±SE				
	sugar cane	dates	palm pollen grains	Sugar beet	Pineapple
week 1	11.00±3.46	47.33±14.72	9.33±3.18	22.33±6.12	22.67±7.80
week 2	11.67±3.48	53.00±14.57	10.00±3.21	25.67±7.27	21.67±7.84
week 3	14.00±4.00	61.67±17.17	12.00±4.00	26.00±4.00	29.00±8.00
week 4	12.00±3.06	55.00±15.13	10.33±2.73	27.00±6.56	25.33±7.31
week 5	15.00±2.08	67.33±9.62	13.00±2.08	31.67±3.48	34.00±5.03
week 6	10.67±2.40	47.33±10.91	9.00±2.08	24.00±5.29	26.00±6.00
week 7	10.67±3.18	49.33±15.88	9.00±2.89	23.33±6.94	25.67±8.09
week 8	11.00±3.46	69.33±10.84	9.67±2.91	24.33±6.64	29.33±8.95
week 9	13.00±2.00	60.00±15.50	13.33±3.18	31.00±4.51	36.67±7.62
week 10	8.67±.88	38.67±6.36	7.33±1.20	19.00±2.89	22.00±4.73
week 11	11.33±0.88	58.00±6.66	11.00±1.53	26.00±4.00	29.33±3.84
week 12	13.00±1.73	58.67±6.64	10.67±186	22.67±2.91	29.00±3.21
Mean	11.83 c	55.47 a	10.39 c	25.25 b	27.56 b
pt.	<.0001				
L.S.D.	5.183				

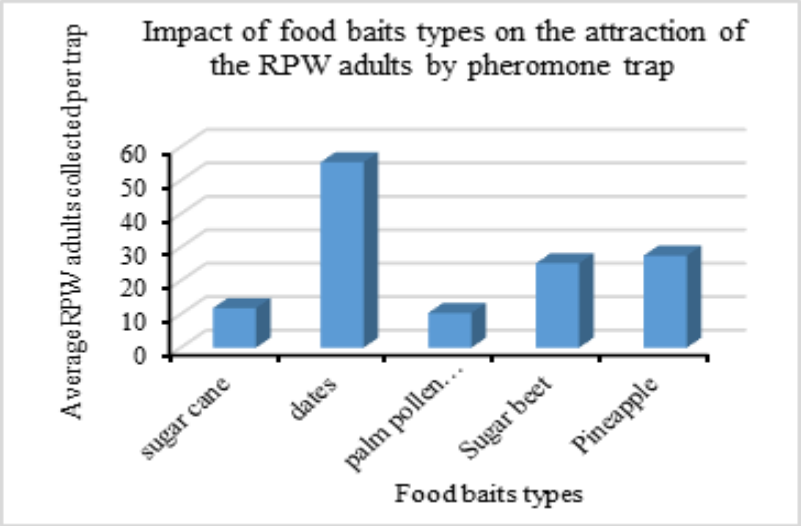


Fig. (6): Comparison between the efficiency of five types of food baits in RPW adults capturing.

3- The influence of different trap shapes on *Rhynchophorus Ferrugineus* pheromone traps catchability of adults.

Data tabulated in Table (4) and illustrated in Fig. (7) showed the comparison between three shapes of aggregation pheromone trap type shape 1 which is Rhyncho gel (Nov Agrico) yellow trap Fig.(4a) and the second one shape 2 is the traditional trap with lid and 4 circular holes on the sides Fig. (4b). The third trap shape is trap with lid, funnel and 4 holes on the lid Fig. (4 c). Obtained data mentioned that the third pheromone trap shape caught the highest mean number of RPW adults 16.81 adults/ trap, followed by the trap with the second form,13.81 adults/ trap without significant differences between them, while the trap with the first form was the trap that collected the least insects number, 10.22 adults/ trap with a significant difference with the other two forms. These findings were consistent with those of El-Banna *et al.* (2017), who reported that following a comparison of the effectiveness of four different trap designs, they discovered that the total number of RPW adults by trap design 2 (which was comparable to our traditional trap type 2) and trap design 4 (which was comparable to our funnel trap type 3) did not differ significantly. But in the case of our experiment, adding 4 holes in the lid of trap No. 3 with a funnel led to an increase in the release of pheromone and increased the efficiency of the trap in catching a greater number of insects compared to trap No. 2 with holes only on the sides and a lid without holes. While the quantity of RPW gathered with ElectrapTM and the conventional trap does not differ significantly (AL-Saroj *et al.,* 2017). Additionally, Abd El-Wahab *et al.* (2020) noted that, over the course of the test, there was no discernible difference in the total number of RPW adults collected by the two types of traps that were tested: the traditional trap, which resembled our trap shape 2, and the funnel trap, which resembled our funnel trap shape 3 to which we added four holes. Although all of these references and research stated that there were no significant differences between the two types of mentioned traps, the number of insects collected by the traditional trap was greater than by the funnel trap. However, in the case of our research, the precedence and greater number went to the funnel trap (Figure 3) and this is due to our modifications.

Table (4): Effect of pheromone trap shapes on attraction of RPW adults

weeks	Average captured RPW adults/ trap±SE		
	Shape 1	**Shape 2**	**Shape 3**
week 1	7.67±1.20	16.00±3.06	20.67±4.81
week 2	13.33±0.88	20.33±1.45	24.00±3.06
week 3	8.33±2.40	14.33±5.24	17.00±4.73
week 4	7.33±2.40	11.00±1.15	14.67±2.40
week 5	9.67±0.33	15.33±4.26	19.33±3.93
week 6	5.67±0.88	6.33±1.20	8.67±1.45
week 7	6.33±0.88	3.00±1.15	6.67±2.40
week 8	11.00±1.15	22.00±2.08	21.33±5.81
week 9	16.00±2.08	17.67±4.91	13.67±3.18
week 10	6.67±0.67	8.67±1.45	15.33±3.76
week 11	13.67±1.20	15.33±0.88	27.00±5.03
week 12	17.00±3.06	15.67±2.60	13.33±2.85
Mean	10.222 b	13.806 a	16.806 a
pt	0.0002		
L.S.D.	3.082		

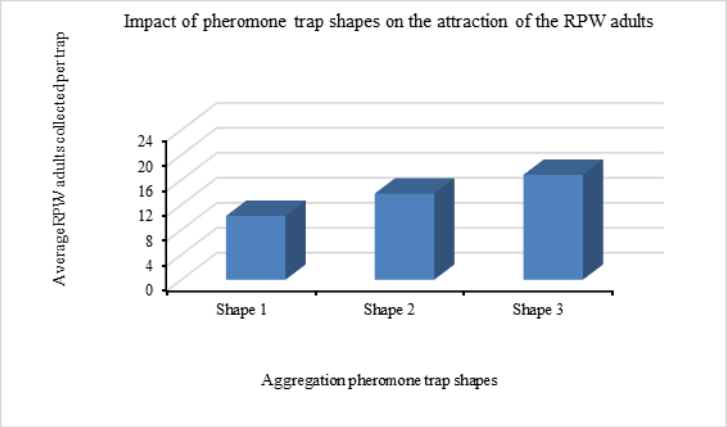


Fig. (7): comparison between the effect of three trap shapes in attracting RPW adults.

CONCLUSION

One of the most crucial components of RPW integrated pest management is the use of RPW aggregation pheromone traps, which can be used for bulk RPW adult trapping as well as early infestation detection. Because of the necessity to grow and enhance its effectiveness, this study compared different types of aggregation pheromones, food baits, and forms of RPW adults pheromone traps. Obtained results led to the recommendation to use the pheromone trap in shape No. 3 containing the pheromone Rhyncho gel and dates as food bait because these three treatments were the most efficient treatments in attracting the largest average number of RPW adults in a date palm farm as one of the elements of integrated pest management of this pest.

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تقييم بعض تصميمات ومكونات المصائد الفرمونية لتحسين فعاليتها في خفض تعداد سوسة النخيل الحمراء في مزارع النخيل المصرية

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الملخص العربى

نظرا للخطر الشديد الذي تمثله حشرة سوسة النخيل الحمراء على النخيل مؤخرا وانتشارها السريع في العديد من دول العالم. تم تنفيذ هذه التجارب لتقييم تأثير استخدام الفرمونات والطعوم الغذائية والأشكال المختلفة للمصائد على جذب حشرات سوسة النخيل الحمراء البالغة بواسطة المصائد الفرمونية في مزارع النخيل. أظهرت النتائج أن المصائد المحتوية على فرمون رينكو جيل سجلت أعلى متوسط لحشرات سوسة النخيل الحمراء البالغة المجمعة ٢٠.١٧ حشرة/مصيدة مقارنة بالفرمونات الثلاثة الأخرى التي تم اختبارها، رينو كاب، الإنجليزية والكوستاريكية التي تم تسجيلها، ١٧.٤٤، ١٢.٩٤ و٧.٤٤ حشرة/ مصيدة على التوالي. كما أظهرت النتائج أن المصائد التي تحتوي على التمر كطعم غذائي جذبت أكبر متوسط لحشرات سوسة النخيل الحمراء البالغة ٥٥.٤٧ حشرة/مصيدة مقارنة بالطعوم الأربعة الأخرى التي تم اختبارها وهي الأناناس وبنجر السكر وقصب السكر وحبوب لقاح النخيل التي جمعت ٢٧.٥٦، ٢٥.٢٥، ١١.٨٣. و١٠.٣٩ حشرة /مصيدة على التوالي. بالإضافة إلى ذلك، أظهرت النتائج أن المصيدة ذات الشكل الثالث حققت أعلى متوسط جذب لحشرات سوسة النخيل الحمراء البالغة ١٦.٨١ حشرة/مصيدة تليها المصيدة ذات الشكل الثاني ١٣.٨١ حشرة/مصيدة بدون فروق معنوية فيما بينها، بينما جمعت المصيدة ذات الشكل الأول أقل عدد من الحشرات، ١٠.٢٢ حشرة/ مصيدة مع اختلاف معنوي عن الشكلين الآخرين. يتضح من النتائج أنه يمكننا التوصية باستخدام المصيدة ذات الشكل الثالث التي تحتوي على فيرومون رينكو جيل والتمر كطعم غذائي، حيث حققت كل من هذه المعاملات الثلاث أعلى كفاءة في جذب حشرات سوسة النخيل الحمراء البالغة وتقليل تعدادها في مزارع نخيل التمر.