Plant Archives Vol. 20, Supplement 2, 2020 pp. 1857-1862 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

FIELD EVALUATION OF SYNTHETIC PHEROMONE, ALLOMONE, PALM KAIRMONE AND ESTER IN CAPTURING ADULT RED PALM WEEVILS, *RHYNCHOPHORUS FERRUGINEUS* (OLIVIER) BY AGGREGATION PHEROMONE TRAPS IN DATE PALM PLANTATIONS

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Abstract

The red palm weevil (RPW), *Rhynchophorus ferrugineus* adults captured by attractants pheromone traps in date palm plantations were studied at Sharkia Governorate, Egypt. The tested treatments were pheromone (ferruginol), allomone (juice sugar beet), kairomone (ethyl acetate), ester (ethyl propionate) in traps alone or together compared with untreated traps control. The higher capture of females compared with the male. The best attraction to capturing RPW adults was trap baited with ferrugineol + sugar beet juice+ ethyl acetate and ethyl propionate which recorded 782 adults. Ferrugineol+ ethyl acetate and ethyl propionate, which caught 756 adults, followed by ferrugineol +ethyl acetate +sugar beet juice caught 682 adults, followed by ferrugineol and ethyl propionate, which caught 627 adults, followed by ferrugineol + ethyl acetate, which caught 559 adults, followed by ferrugineol +sugar beet juice which caught 486 adults, followed by, ferrugineol which caught 417 adults, followed by ethyl propionate which caught 311 adults, followed by ethyl acetate. which caught 211I adults, followed by sugar beet juice with yeast which caught 111 adults, followed by sugar beet juice without yeast (90) and traps with Control (empty trap) as control caught no number adults. The obtained results indicated that the numbers of captured adults increased highly significantly in traps supplied with ferrugineol + sugar beet juice + ethyl acetate + ethyl propionate than other chemical materials. Accordingly, it is recommended to use the pheromone trap. The results obtained provide information that should help improve the control of *R. ferrugineus* by mass trapping systems.

***Keywords* :** Red palm weevil; control; date palm; mass trapping; pheromone; ethyl acetate; molasses sugar beet; ethyl propionate.

Introduction

The red palm weevil (RPW), *Rhynchophorus ferrugineus* Olivier (Coleoptera: Curculionidae), is an internal tissue borer attacking palm trees in diverse agro-ecosystems worldwide (Milosavljević *et al.,* 2019). This ten-fold leap in the host range and also increasing geographical expanse of RPW has been mainly after it gained foot hold on date palm *Phoenix dactylifera* L. in the Middle-East during the mid-1980s, where it entered and spread through infested planting material (Al-Dosary *et al.,* 2016; Giblin-Davis *et al.,* 2013).In Egypt, it has become the major pest of date palm. RPW was reported in 1992 first recorded in date palm plantations of Sharkia and Ismailia Governorate (Saleh, 1992). However, to avoid severe harm in the environment, caused by an overuse of insecticides, the possibilities of adopting sustainable strategies to control RPW are under evaluation, with particular attention being paid to the possibility of developing a mass trapping method (Go´ Mez Vives *et al.,* 2009). However, in 1993a male-produced aggregation pheromone was reported for RPW and identified as a racemic mixture of 4-methyl-5-nonanone and 4-methyl-5-nonanol at a ratio of 10-90, respectively (Hallett *et al.*, 1993). The two components of RPW pheromone have been formulated with certain plant kairomones and this mixture has shown to be effective in monitoring and reducing the population of RPW from Asia and the Americas (Oehlschlager *et al.*, 1993). In semiochemical-based mass trapping, traps are baited with chemical lures such as pheromones and/or attractants (El-Sayed *et al.*, 2006 and Rosell *et al.*, 2008). Volatile chemicals produced from fermenting palm tissues, known as 'palm kairomone and ester', such as ethyl acetate, ethyl propionate, (Giblin-Davis, 1994 and Rochat *et al.*, 2000). Several studies report that most of these compounds strongly enhance the attractiveness of pheromone-baited traps (Faleiro, 2006 and Gries *et al.*, 1994). In the case of RPW, previous studies on mass trapping commonly incorporate the use of ethyl acetate as a synergistic kairomone of the aggregation pheromone (Go´ Mez-Vives *et al.*, 2009; Faleiro, 2006 and Soroker *et al.*, 2005) but there is lack of data about the responses of the RPW to other allomone and pheromone. The present study aims to evaluate the capture efficacy of four types putting in funnel bucket traps provided with selected synthetic allomone, palm kairomone, palm ester, and commercial RPW aggregation pheromone lure in date palm plantations, under Sharkia, Egyptian environmental conditions, by using a more reliable method for calculating lures release rate based on gas chromatographic analysis.

Materials and Methods

Sampling Sites

This study was conducted at a selected date palm plantation in Abo Hammaed district, Sharkia Governorate, Egypt. The plantation, consisting of date palm trees, was approximately 15 feddans in size. A total number of 36 traps (3 traps/12 treatment) were installed in each block.

Trap design

The pheromone traps were designed using plastic funnel bucket pheromone traps in the present study as shown in figure (1). They used traps commonly consist of the plastic bucket (9 liters in size) with a funnel of 8 cm in diameter fixed above the bucket. The bucket was punctured around its wall with holes, each of 2.5 cm diameters just under its top, the bucket walls were perforated forming 4 holes. Four holes were made to allow adult weevils to enter inside the trap safely and easily. The side funnel had a small knob fixed with a screw hook to hang the synthetic ferrugineol sac, allomone, selected synthetic palm kairomone, and ester bottles.

Experimental Design

Each trap contained ferrugineol is a synthetic pheromone lures. It is a mixture of {4 methyl-5-nanol and 4-methyl-5-nanone (9:1)}. It is imported from Chem Tica Natural; Costa Rica, and released its active chemicals blames through a plastic membrane (as 3-10 mg /day) from 400 and 1500 N/ tube, respectively under laboratory conditions of 27°C and 50% RH. under identical conditions (Hallet *et al.,* 1993), and allomone (2 L of a 10% v/v aqueous solution of sugar beet + yeast obtained from *Beta vulgaris* L. *var. saccharifera* L.) put in a plastic box in the bottom of traps containing synthetic sponge (5 cm width x 20cm Length x 5cm height) and mixed with Both lannate 90 % (methomyl) at 5 g/liter (Oechlschlager *et al.*, 1993) and Chloroforse EC 48% at 3cm^3/1 liter or Cholozane EC 48% at 3cm^3/1 liter to kill the captured weevils on it. 10 ml of Selected kairomone (ethyl acetate) putting in an aerated plastic bottle containing synthetic sponge (20 cm Length x 2cm thick x5 cm width), was used as a synergist to activate the potent ability of releasing ethyl acetate blooms, Ethyl acetate bottle were hanged from the underside surface of the bucket trap top about 10 cm below the trap lid releasing chemicals (as 100 and 128 mg/day). (Abbas, 2000 & 2010 and Olfat, Arafa, 2015) and 10% v/v emulsions of select ester (ethyl propionate) in the water putting in an aerated plastic bottle containing synthetic sponge (20 cm Length x 2cm thick x5 cm width) was used as a synergist to activate the potent ability to release ethyl propionate blooms, Ethyl propionate bottle were hanged from the underside surface of the bucket trap top about 10 cm below the trap lid and 10 % v/v emulsions of ethyl acetate, ethyl propionate or both in the water putting in an aerated plastic bottle containing synthetic sponge (40cm Length x 4cm thick x10 cm width) was used as a synergist to activate the potent ability to release ethyl propionate blooms, Ethyl propionate bottle were hanged from the underside surface of the bucket trap top about 10 cm below the trap lid. All the chemicals were purchased from Sigma–Aldrich (Germany) and were >98% chemically pure.

The experiment used complete randomized block design (CRBD) with 36 traps of the new type shape trap (funnel bucket trap with 4 holes), 12 treatments and was replicated three times consisted of :

1. Water + insecticide + aggregation pheromone + (allomone) 2 L of a 10% v/v aqueous solution of sugar beet juice + yeast+ (kiromone) 10% v/v emulsions of ethyl acetate + (ester) 10% v/v emulsions of ethyl propionate (attractive1).
2. Water + insecticide + aggregation pheromone + (kairomon) 10% v/v emulsions of ethyl acetate + (ester) 10% v/v emulsions of ethyl propionate (attractive 2).
3. Water + insecticide + aggregation pheromone + (kairmone) 10% v/v emulsions of ethyl acetate + (allomone) 2 L of a 10% v/v aqueous solution of sugar beet juice+ yeast . (Attractive 3).
4. Water + insecticide + aggregation pheromone + (ester) 10% v/v emulsions of ethyl propionate (attractive 4).
5. Water + insecticide + aggregation pheromone + (kairmone) 10% v/v emulsions of ethyl acetate (attractive 5)
6. Water + insecticide + aggregation pheromone + (allomone) 2 L of a 10% v/v aqueous solution of sugar beet juice +yeast (attractive 6).
7. Water + insecticide + (ester) 10% v/v emulsions of ethyl propionate (attractive7)
8. Water + insecticide + (kairmone) 10% v/v emulsions of ethyl acetate (attractive 8)
9. Water + insecticide + (allomone) 2 L of a 10% v/v aqueous solution of sugar beet juice+ yeast (attractive 9).
10. Water+insecticide+ (allomone) 2L of a 10%v/v aqueous solution of sugar beet juice (attractive10).
11. Water + insecticide + aggregation pheromone (attractive 11).
12. Control (empty trap) (attractive 12).

Food baits such as sugar beet (allomone), Ethyl acetate (kairomone) and ethyl propionate (ester) and the mixture (water soap and insecticide) was replaced every week to maintain sufficient moisture in each trap and to avoid the growth of fungi or algae on the water surface (Al-Saoud *et al.*, 2010). Small amounts of detergent were added as a replacement for insecticide. The addition of detergents also functioned to break the surface tension of water and kill the RPW instantly. Further addition of ethyl acetate was done every week to enhance the efficiency of the food–baited pheromone trap. Pheromone capsules within each trap were replaced by another new fresh one bi-monthly depending on the temperatures and relative humidity of the period.

Trap Installation

The experiment was carried out in 2018; from April 15th until end March 2018 to evaluate the relative efficiency of selected synthetic pheromone, allomone, palm kairomone, and ester in 36 traps with or without aggregation pheromone and ethyl acetate aerated plastic bottle containing synthetic sponge (20 cm Length x 2cm thick x5 cm width), was used as a synergist to activate the potent ability to release ethyl acetate blooms (Abbas, 2000 & 2010 and Olfat, 2015) was used for putting different chemicals on it. Traps were set under the shade of the date palm plantation and not exposed to direct sunlight to obtain a sustained and uniform release of the chemical lure into the environment. All traps were placed tightly on the soil surface and tied with steel wire next to the date palm tree trunks to prevent it from being overturned by wind or animals. The 36 above mentioned tested trap types were placed in a row keeping an approximate distance of 25 meters between each trap. 12 rows were used as treatments each row constants of three replicates and the distance between rows was 50 meters. Fluctuations in weevils' population were determined by the numbers of captured adult weevils in aggregation pheromone traps were removed and counted weekly, sexed intervals and sexed according to gender-specific external characteristics of the rostrum, as suggested from (Booth *et al.*, 1990). Besides, the sex ratio about pheromone, allomone, kairomone, and ester, fluctuations of weevil adults and the total number of RPW caught in each trap were also studied. Only the palm ester was tested in the pheromone-baited traps.

Statistical analysis:

All analyses were made using a software package a computer COSTAT programs a product of Cohort Inc., Berkeley, California, mean± standard deviation (SD), ANOVA and the means were compared by carrying out the

Least Significant Difference test 5 % (COSTAT software, 1990).

Results and Discussion

Developing synthetic pheromone, Kairmone, allomone and ester with different attractant:

The results of the study revealed four promising compounds, *i.e.* treatment (1). Data was recorded during12 months. Results presented in Tables (1 and 2) clarifies that the bait that gave the highest captured insects was attractive (1) which consisted of water+ insecticide+ aggregation pheromone+ (allomone) 2 L of a 10% v/v aqueous sugar beet juice +yeast + (kiromone) 10% v/v emulsions of ethyl acetate + (ester) 10% v/v emulsions of ethyl propionate .This bait collected 782 adults, followed by attractive (2) which consisted of water + insecticide + aggregation pheromone+ (kairomon)10%v/v emulsions of ethyl acetate+(ester)10% v/v emulsions of ethyl propionate collected that 756 adult weevils, followed by attractive (3) consisted of water + insecticide + aggregation pheromone + (kairmone) 10% v/v emulsions of ethyl acetate + (allomone) 2 L of a 10% v/v aqueous solution of sugar beet juice yeast captured 682 adults, followed by attractive (4) which consisted of water +insecticide +aggregation pheromone + (ester) 10% v/v emulsions of ethyl propionate collected 627 adults, followed by attractive (5) which consisted of water + insecticide +aggregation pheromone + (kairmone) 10% v/v emulsions of ethyl acetate collected 559 adults, followed by attractive (6) which consisted of water + insecticide + aggregation pheromone +(allomone) 2 L of a 10% v/v aqueous solution of sugar beet+ yeast collected 486 adults ,followed by attractive (7) which consisted of water + insecticide + (ester) 10% v/v emulsions of ethyl propionate collected 417 adults, followed by attractive (8) which consisted of water + insecticide+ (kairmone) 10% v/v emulsions of ethyl acetate collected 311 adults, followed by attractive (9) which consisted of water + insecticide + (allomone) 2 L of a 10% v/v aqueous solution of sugar beet + yeast collected 211 adults, followed attractive (10) consisted of a 10% v/v aqueous solution of sugar beet + collected 111 adults, followed attractive(11)consisted of water + insecticide +aggregation pheromone only, (90 adults were captured). Whereas, the least bait in capturing adults in combination (12) empty trap. Thus, it will be interesting to use these attractive (1), in mass trapping and/or monitoring of *R. ferrugineus* in palm trees as one of the stone corners of IPM.

Results for all evaluated attractives indicated highly significant differences in RPW catch for attractive (1, 2 and 3) compatered with other 9 attractives.

Data agreed with obtained by (Hallett *et al.*, 1993) who stated that emission of the pheromone alone from a trap does not attract many weevils as compared to a red palm weevil pheromone trap with a fermenting food source. (Gries *et al.*, 1994 and Rochat *et al.*, 2000) they studied that air collections and SPME head-space analysis already carried out from decaying tissues of *Elaeis* spp., *Jacaratia* spp., coconut palm and sugar cane showed that high percentages (60– 90%) of the volatiles trapped comprise ethyl acetate and ethyl alcohol; nevertheless, other compounds such as ethyl propionate, ethyl butyrate, and ethyl lactate were also found in smaller amounts. Moreover, literature evidence shows that molecules produced by young palm tissues could also be attractive to weevils. working on volatiles produced from the coconut palm, *Cocos nucifera* L., found two compounds that showed short-range attractant properties for the RPW in laboratory bioassays: 4-nonalactone and 4-hydroxy-3-methoxy styrene. On the other hand (Hallett *et al.*, 1999) they founded that natural palm baits have poor attractant power by themselves but strongly synergize the effect of the aggregation pheromone. (Rochat *et al.*, 2000) they reported that the trap catch experiments using pheromone molasses traps complemented with ethyl propionate recorded several catches similar to the one obtained using ethyl acetate. Moreover, the use of the two esters in combination determined more captures than ethyl propionate alone, suggesting that the blend of esters mimics more strongly the palm odor than the individual esters. Palm esters such as ethyl acetate and ethyl propionate have been identified by GC-MS from the volatiles of fermenting palm tissues. In the case of the American palm weevil, *R. palmarum*, it has been demonstrated that the volatiles produced during the fermentation processes can play a role as kairomones triggering the primary attraction of insects to oil palms. (Soroker *et al.*, 2005) they founded these aspects support the commonly accepted fact that RPW is attracted by dying and damaged parts of palm. the higher proportion of females captured in the traps complemented with ethyl acetate and ethyl propionate might be due to the higher sensitivity of females to these esters, as evidenced by the EAG experiments. Nevertheless, in this contest, the role of a pheromone and molasses complex in influencing the attractant action of the synthetic esters cannot be underestimated. The high number of adults captured demonstrates the sustainability of the use of the mass trapping technique in an urban environment, following the results of mass trapping experiments carried out in field conditions. Longo (2006) reported similar results for the trap catches, the number of captured females was greater than the number of males in all the treatments tested, with a proportion of 1/1.56 males/females. This value is different from the sex ratio of 1.08/1 males/females observed on infested palms of urban areas of Sicily. (Abdallah *et al.*, 2008; Guarin *et al.*, 2011) Several authors found that ethyl acetate also appeared to have an important role in the effectiveness of traps and increase the attraction of red palm weevils when used along with pheromone and food bait. Salvatore Guarino *et al.* (2010) studied that the means (SE) of adults of RPW captured weekly in pheromone molasses traps complemented with ethyl acetate alone, ethyl propionate alone and ethyl acetate and ethyl propionate in combinations were respectively 33.05± 2.83, 28.65, 3.24 and 39.54, 4.14. The trap catch experiments using pheromone molasses traps complemented with ethyl propionate recorded several catches similar to the one obtained using ethyl acetate. Moreover, the use of the two esters in combination determined more captures than ethyl propionate alone, suggesting that the blend of esters mimics more strongly the palm odor than the individual esters. The ester that elicited the strongest responses was ethyl propionate (F 54.47; $P <$ 0.001; df 4; ANOVA). The means (SE) of adults captured per trap during each sampling period reached a peak of 49.5± 6.0 on the 20 August 2018; the lowest number of adults captured (22.9± 2.5) was registered on the 7 July 2018. Globally, the total number of adult RWP captured was 3544, with a proportion of male/female of 1/1.56 ($\chi 2$ 169.9; $P < 0.001$). The number of females captured was consistently greater than the number of males in all treatments. The means (SE) of adults of RPW captured weekly in pheromone molasses traps complemented with ethyl acetate alone, ethyl propionate alone and ethyl acetate and ethyl propionate in combinations were respectively 33.05± 2.83, 28.65, 3.24 and 39.54, 4.14.The analysis of variance revealed that the pheromone +molasses traps complemented with the two esters in combination captured more adults than the pheromone +molasses traps complemented with ethyl propionate alone (*F* 2.51; *P* 0.027; df 102). Traps complemented with only ethyl acetate caught a statistically intermediate number of weevils.(Vacas *et al.*, 2013) they studied that the addition of water to traps baited with palm tissues was found to be essential, which catches increasing more than threefold compared with dry traps. (Faleiro *et al*., 2019) they showed that weevil captures in both the dry trap and the food baited traps were statistically similar. The above semiochemical mediated techniques offer sustainable trapping solutions for RPW management, and could be deployed especially in areas where the trap density has to be increased due to high weevil activity.

In the field experiments the selected synthetic pheromone, allomone, palm kairomone, and ester showed; (1) differences among the treatments; (2) a greater attractant to ethyl propionate; (3) a higher captured of female compared with male. In Ismailia governorate, RPW capturing evaluated over six weekly observations on pheromone- and molasses-baited traps, showed that more adults were caught by traps supplemented with ethyl propionate and ethyl acetate than by traps supplemented with only ethyl propionate. Similar catches were recorded in the traps supplemented with ethyl propionate or ethyl acetate.

The Costat statistical analysis program was used also to detect the fluctuation of the RPW during the 12 months of the experiment in the 36 previously mentioned traps. Table (1) shows that the highest number of weevils was registered in the April,2018 of data collection, while the least registered number of weevils was during the January,2019 month.

Sex Ratio of *R. ferrugineus* Captured in Aggregation Pheromone Traps:

Results are shown in Table (1) revealed that the total numbers of attracted weevils were 782 during the 12 weeks of the experiment. Males' captures registered 321 while females' captures reached 461, with a sex ratio of 1: 1.4. Similar results were reported by Al-Saoud (2015), where he indicated that the sex ratio between males and females was 1:2.1.The present results are agreement with those obtained by some authors such as (Abbas, 2000) who reported that the number of females attracted aggregation pheromone traps was generally twice. The sex ratios of male to female were 33.67 and 33.7: 66.3 during the two successive seasons, respectively. The sex ratio of males was increased to its maximum ratios at the end of November. (El-Sebay, 2003) found that female density was higher than male density and constituted 52.8-57.8% of the total population in the field more than male at a ratio of 1.35: 1., (Al-Saoud, 2004; Abdallah and Al-Khatri, 2005; Al-Saoud, 2010 and 2013 and Al-Saoud *et al*., 2010) found that the sex ratio (males: females) of RPW was (1:1.33), (1:1.56), (1:1.75), (1:1.44), (1:2), (1:0.64), (1:1.66) and (1:1) during the period from July 2003 to February 2004, respectively and (Olfat, 2015) showed that the % of males of *R.ferrugineus* was 38.20 % and reached its maximum in March (44.44%). Metwally and Basheer (2019). reported that the sex ratio was: 1:0.99 (female: male) during two seasons. Mohammed *et al*. (2015) found that significant difference was found between males and females as sex ratio was about 1 male: 2.6 females; this proved the ability of the tested pheromones to capture more females than males weevils in the traps which makes trapping a potential tool for managing this economic insect. Salama *et al*. (2018). Studied that the ratio of females to males captured was 1.3♀: 1.0 ♂ (2016) and 1.0♀:1.0♂ (2017).

Conclusion

Demonstrate that in the results of this study support monitoring the activity of RPW is essential for keeping a close watch on the establishment and subsequent build-up of the pest. Early detection, on the other hand, is crucial to avoid the death of palms; the application of mass trapping implemented with palm esters as an important tool for and is the key to the success of any the management of RPW populations and to prevent the infestation of ornamental plants in urban environments, where other techniques such as chemical control could have strong consequences on environmental pollution and human health. A better understanding of the attractive capacity of the palm ester mixtures and the relatively optimal doses could not only provide fundamental ecological knowledge but also make it possible to improve pheromone-baited trap efficiency in RPW control. Generally, the results indicated that the suitable trap supplied with ph+ kairomone +all+ ester with funnel bucket with 4 holes and topless hanging on ground level in date palm plantations area, all over the year, and these traps should be maintained regularly. Replacing pheromone with a new fresh one every two weeks. All of the ethyl acetate, sugar beet solution, ethyl propionate and soap water was provided when required are recommended for mass trapping and monitoring of the red palm weevil.

Table 1 : Total Number of RPW weevils attracted to essential attractive types pheromone, allomone, Kairmone and ester attractive.

Essential attractive types	Atr 1	Atr. 2	Atr. 3	Atr. 4	Atr. 5	Atr. 6	Atr. 7	Atr. 8	Atr. 9	Atr. 10	Atr.11	Atr. 12
April 2018	120	117	105	90	80	76	70	55	40	18	8	0
May.2018	90	85	65	60	70	56	41	40	28	18	10	0
Jun.2018	80	78	72	64	57	53	50	35	10	6	6	0
Jul.2018	75	73	65	56	40	36	30	20	15	8	8	0
Aug.2018	40	35	40	39	45	41	35	25	20	12	10	0
Sep.2018	35	33	45	46	32	18	20	10	10	6	6	0
Oct.2018	63	65	60	64	61	47	40	30	20	10	10	0
Nov.2018	110	98	75	68	62	58	45	30	20	10	12	0
Dec.2018	54	55	45	41	31	27	20	16	10	6	6	0

Jan.2019	5	4	4	3	3	2	2	2	1	1	1	0
Feb.2019	10	8	6	6	8	6	4	3	2	1	1	0
Mar.2019	110	105	100	90	70	66	60	45	35	15	12	0
Total	782^{a}	756^{ab}	682^{ab}	627^{bc}	559^{cd}	486^{de}	417^{ef}	311^{fg}	211^{gh}	111^{hi}	90^{hi}	0^{i}
Mean	65.17	63	56.83	52.25	46.58	40.5	34.75	25.92	17.58	9.25	7.5	0
Sex ratio%	100	100	100	100	100	100	100	100	100	100	100	0
S.E.±	10.84	10.65	9.06	7.96	7.10	6.76	6.01	4.77	3.51	1.66	1.06	0

M=male F=female S.E.±=standered error Combination(1):Water + insecticide + aggregation pheromone+ (allomone) 2 L of a 10% v/v aqueous solution of sugar beet +yeast+ (kiromone) 10% v/v emulsions of ethyl acetate + (ester) 10% v/v emulsions of ethyl propionate; Combination(2):Water + insecticide + aggregation pheromone+ (kairomon) 10% v/v emulsions of ethyl acetate + (ester) 10% v/v emulsions of ethyl propionate ; Combination (3):Water + insecticide + aggregation pheromone + (kairmone) 10% v/v emulsions of ethyl acetate + (allomone) 2 L of a 10% v/v aqueous solution of sugar beet +yeast. Combination (4): Water + insecticide + aggregation pheromone + (ester) 10% v/v emulsions of ethyl propionate ; Combination (5):Water + insecticide +aggregation pheromone + (kairmone) 10% v/v emulsions of ethyl acetate ; Combination (6): Water + insecticide + aggregation pheromone + (allomone) 2 L of a 10% v/v aqueous solution of sugar beet +yeast ;Combination(7):Water + insecticide + (ester) 10% v/v emulsions of ethyl propionate; Combination (8) : Water + insecticide+ (kairmone) 10% v/v emulsions of ethyl acetate ; Combination(9): Water + insecticide + (allomone) 2 L of a 10% v/v aqueous solution of sugar beet + yeast ; Combination(10): Water + insecticide +aggregation pheromone and Combination (11): Control (empty trap).

Table 2 : Mean number and SD of RPW in each of the 11 tested essential attractive combination in funnel pheromone traps.

Essential attractive types	Mean	Std. Deviation
Atr.1	260.67^{a}	±10.84
Atr.2	252^{ab}	±10.65
Atr.3	227.33^{ab}	±9.06
Atr.4	209^{bc}	±7.96
Atr.5	183.33^{cd}	±7.10
Atr.6	162^{de}	±6.76
Atr.7	139^{ef}	±6.01
Atr.8	103.67^{fg}	±4.77
Atr.9	70.33^{gh}	±3.51
Atr.10	37^{hi}	±1.66
Atr.11	30^{hi}	±1.06
Atr12(control)	0^{i}	±0.00

Means followed by the same letter are not significantly different according to F-test=36.559*** (L.S.D.0.05=43.75). *statistical analysis during the first weeks only.

Acknowledgements

The authors are grateful to Prof. Mohamed Kamal Abbas of plant protection research institute, agriculture research center for helpful comments that improved an earlier version of this manuscript.

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