

IMPROVING PHEROMONE TRAPS EFFICACY FOR DEPRESSION OF THE RED PALM WEEVIL (*RHYNCHOPHORUS FERRUGINEUS* (OLIV.) POPULATION ON DATE PALM PLANTATIONS

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Abstract

Improve RPW *Rhynchophorus ferrugineus* (Oliv.) pheromone trap efficacy through several experiments. Experiments were conducted during two successive years (2009-2010) in Wardan and Abu-Ghalep villages, 6th October Governorate. Results showed that, addition of Kairmone and food bait to the pheromone traps improved the catchability of RPW adults by 3.35 x. Addition of sugar cane to the pheromone trap gave significantly the highest catch of total RPW adults. Red color trap attract more traps adults compared to green and blue. Renewing water, date fruits in traps were very necessary to increase its weevil attraction and the addition of propylene glycol extends the effective life of trap.

INTRODUCTION

Rhynchophorus ferrugineus Olivier (Coleoptera: Curculionidae), commonly called the red palm weevil (RPW), is a pest accidentally introduced into several European countries of the Mediterranean Basin during the last 10 years as a consequence of commercial exchanges of date palm trees from contaminated areas of North. In Italy, the first palms killed by RPW were recorded in 2005 in Sicily. Then, a few years later, the pest was found in most of the Italian regions facing the Mediterranean Sea, where it is killing mostly the Canary island date palm, *Phoenix canariensis* Hortorum ex Chabaud. Longo *et. al.* (2008).

In Asiatic and North African countries, RPW is a serious pest in plantations of date, oil and coconut palms, and its populations are efficiently controlled by IPM programmes that include cultural management, chemical control and semiochemical-based tools for monitoring and mass trapping Faleiro (2006). In Italy, similarly to other European countries, RPW has assumed the role of a major pest of landscape palms, because palm trees are grown only for ornamental purposes Noto and Romano (1987). Normally, landscape pests do not need to be managed constantly, as their damage should decrease through time Weissling and Broschat (1999). By contrast, the RPW, which is included in the EPPO alert list, requires strong control measures (quarantine, eradication), as it is lethal to palms. To date, the dominant strategies

applied in the short term to prevent and/or reduce further RPW infestations are removing and destroying infested palm materials and applying insecticide treatments Longo *et. al.*(2008). However, to avoid severe harm in urban environments, 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 Gómez *et. al.* (2009). Mass trapping aims to catch enough target insects in order consistently to reduce their population to a level that results in a significant decrease in plant attacks as a consequence Foster and Harris (1997). In semiochemical based mass trapping, traps are baited with chemical lures such as pheromones and/or food attractants Rosell *et. al.* (2008). The mass trapping technique for *Rhynchophorus spp.* is often improved by the presence of synergistic palm volatiles in the pheromone-baited traps, as palm tissues develop fermentation processes that produce volatiles that are synergistic to weevil aggregation pheromones Rochat *et. al.* (1993). In fact, pheromone-baited traps supplemented with host palm volatiles have been found to catch significantly more adults of *R. cruentatus* F., *R. palmarum* L., *R. phoenicis* L. and *R. ferrugineus* than pheromone alone Weissling *et. al.* (1994). Volatile chemicals produced from fermenting palm tissues, known as 'palm esters', such as ethyl acetate, ethyl propionate, ethyl butyrate, ethyl isobutyrate and ethyl lactate, and their perception by adult weevils have been proven by electroantennogram bioassays (EAG) Rochat *et. al.* (2000). Several studies report that most of these compounds strongly enhance the attractiveness of pheromone-baited traps Faleiro (2006). 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, Gómez *et. al.* (2009), Faleiro (2006). But there is lack of data about the responses of the RPW to other palm esters. In the present study improve RPW *Rhynchophorus. ferrugineus* (Oliv.) pheromone trap efficacy through several experiments.

MATERIALS AND METHODS

These experiments were carried out during 2009/2010 in certain date palm plantations, which infested by the Red Palm weevil (RPW). The chosen Area is Wardan and Abu Ghaleb Villages, situated in the 6th October Governorate , Egypt.

1. Impact of kairomones and food bait on the attraction of the RPW adults to pheromone trap.

This experiment was conducted to study the effect of Kairomone and Bait in improving the catchability of RPW traps. The experiment was conducted in date palm

plantations located in Wardan Village, the 6th October Governorate Egypt, during two successive seasons 2009&2010 from March to June. This time period (3months) was selected because it includes the part of season in which the adults of *R.ferrugineus* are more active and reach their population peak according to (Al-Saoud *et. al.* 2010).The experiment was designed as randomized completely block design with three different locations as replicates .The treatments were as follows:

- 1- Aggregation pheromone + Kairomone + food bait.
- 2- Aggre gation pheromone + Kairomone.
- 3- Aggregation pheromone
- 5- Kairomone.

The treatments were applied in a locally plastic bucket Traps were without cover. Traps were put in each farm, and installed. The distance between traps was 50 m and each trap was 4 m away from date palm trees (to avoid that any adult could missed the trap and lay egg on the palm tree) in the shade to avoid water evaporation. Traps were buried in the ground down to the level of 15 cm to facilitate entrance of *R. ferrugineus* part-burying the trap also prevented it from being over-turned by wind or animals or water of flooded irrigation. Water was always replenished every two weeks to keep sufficient moisture in each trap to avoid escaping of the adult and it help to kill the insect. Food bait (dates) was renewed every two weeks, the pheromone and the kairomone were replaced every 2 months. Traps were checked and trapped weevils were collected every two weeks. Trapped weevils were counted, removed, sexed and recorded every two weeks.

Pheromone : 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).

Kairomone : dispenser of the kairomone containing 45 mL of the active ingredient ethyl acetate in gel, at 95% minimum purity, release rate 200-400 mg/ day colorant added (Kairomone manufactured by ChimTica international S.A. Company, costa Rica. Trade Name PO80A Weevil magnet 45 mL lure) .

2. Comparison between different types of food bait and its influence on captured adults of RPW.

This experiment was carried out to investigate the effect of three different food Baits in improving the catchability of RPW with aggregation pheromone traps. The experiment was conducted in date palm plantations located in Wardan Village,

the 6th October Governorate during three months (from September to November) of 2009&2010. Food bait (sugar cane, gommar and dates, 250g) was renewed every two weeks, water was always replenished every two weeks and, the pheromone and the kairomone were replaced every 2 months. Trapped weevils were removed, sexed and recorded every two weeks. The experiment was designed as randomized completely block design with three different locations as replicates. The food baits were as follows:

- 1- Sugar cane : The outer layer of the stem of sugarcane was removed and put in the trap.
- 2- Gommar (date palm tissue) : Parts of cutting trunk was taken.
- 3 Date Fruit: Normal dates from dry varieties were taken and put in the trap.

3. Effect of pheromone trap color on attraction of RPW adults .

This experiment was conducted to study the effect of Trap color in improving the catchability of RPW traps. The experiment was implemented in date palm plantations located in Wardan Village, 6th October Governorate with three different colors (red, blue and green) during two successive seasons of 2009&2010 (from September to November). Traps were checked every two weeks. Trapped weevils were removed, counted, sexed and recorded. The traps design and maintenance as described before in the first experiment. The experiment was designed as randomized completely block design with three different locations as replicates the treatments were as follows:

- 1- Red color trap (Aggregation pheromone + Kairomone + food bait).
- 2- Blue color trap (Aggregation pheromone + Kairomone + food bait).
- 3- Green color trap (Aggregation pheromone + Kairomone + food bait).

All Components were placed in three different trap colors: Red, Blue and green.

4. Effect of renewing water and food bait on pheromone trap efficacy.

In order to study the effect of maintenance of pheromone baited traps on the catchability of the RPW adults and reduction of its population in the date palm farms such as renewing the water and food bait, this experiment was conducted at Abu-Ghalep Village, 6th October Governorate during two successive seasons of 2009 & 2010 (from March to June). Three types of traps were compared (first non renewed water and bait, second renewed water and bait every two weeks and the third propylene glycol was added to decrease water evaporation). The whole traps were weighted. The traps were checked every two weeks. Trapped weevils were counted, removed, sexed and recorded every two weeks. The experiment was designed as randomized completely block design with three different locations as replicates. The treatments were as follows:

T1 = 250 gr. Date + 2 liters water (not renewed).

T2 = 250 gr. Date added each week, and complete to 2 Liters(renewed).

T3 = 250 gr. Date + 1 liter water mixed with 1 liter Propopylen Glycol.

Propylene glycol, also called 1,2-propanediol or propane-1,2-diol, is an organic compound (a diol or double alcohol) with formula $C_3H_8O_2$ or $HO-CH_2-CHOH-CH_3$. It is a colorless, nearly odorless, clear, viscous liquid with a faintly sweet taste, hygroscopic and miscible with water, acetone, and chloroform. The compound is sometimes called α -propylene glycol to distinguish it from the isomer propane-1,3-diol $HO-(CH_2)_3-OH$, also called β -propylene glycol. It used in this experiment to reduce the evaporation of water and increase trap age.

RESULTS AND DISCUSSION

1. Impact of kairomones and food bait on the attraction of the RPW adults by pheromone trap during 2009 and 2010:

The results presented in Table (1) demonstrated that the trap containing aggregation pheromone + food bait + Kairomone attracted significantly the highest adults population with an average of 83.67&83.33 RPW adults in the two seasons of 2009 and 2010, respectively, followed by the trap containing aggregation pheromone + Kairomone with an average of 36.67 and 42.00 RPW adults. The trap containing pheromone only showed moderate catchability (25 and 26.67 adults /trap). While the least population was caught by the trap containing kairomone only (3 and 5 adults / trap) during 2009 and 2010. This result of 2010 was similar to that obtained during 2009. In this respect Abdallah and Al-Khatiri (2005) in the Sultanate of Oman found that a combination of pheromone + Kairomone + food bait recorded significantly higher mean cumulative weevil capture with 58.7% of total capture of weevils in all trials. The lowest mean cumulative weevil capture was recorded by Kairomone only with 0.6%. The study also revealed that all trials caught more females than males. In addition, AL-Saoud (2008) in the United Arab Emirates evaluated the role of Kairomone on number of captured Weevils during May 2005-April 2006. The author found that the treatments which contained pheromone, kairomone and dates were better than the treatments without kairomone during the studying period for these treatments, respectively. The treatments containing pheromone + kairomone + date fruits, significantly increased the number of captured individuals (2693 weevils 62.3%) compared opposed to (1631 weevils 37.7%).

2. Comparison between different types of food bait and its influence on captured adults of RPW during 2009 and 2010.

Data shown in table (2) indicated that addition of sugar cane to the trap gave significantly the highest catch of total RPW adults with an average of 55.67 and 56.67 adults / trap compared to the addition of dates or gommar to the pheromone trap that had an average of (32.67&32.33) and (24.33&30.33) adults / trap, respectively. Significant differences were shown between the catch of the total adults of each treatment during 2009 and 2010. The same trend was observed for the catch of male and female of the RPW adults in case of adding sugar cane to the trap, while in the case of addition of gommar and dates there was no significant difference between the average captured RPW adults male and female of the two treatments.

In this respect they reported the following: Qin *et al* (2004) tested five attractants of RPW adults with four-armed olfactometer. The results suggested that all the five attractants showed attractive efficacy to some extent, among which the aggregation pheromone, the female weevils and sugarcane showed strong attractive effect. The field test showed that the aggregation pheromone, female weevils and sugarcane had good attractive effect. Pineapple and *Archontophoenix alexandrae* had no effect in the field. Faleiro and Satarkar (2005) reported that the best RPW captures was found and was statistically difference with sugarcane. Addition of food bait helped maintained the trapping efficiency of the pheromone lure.

Table 1. Impact of kairomones and food bait on the attraction of the RPW adults by pheromone trap during 2009 and 2010.

Treatments	Average captured RPW adults 2009			Average captured RPW adults 2010		
	Total	Male	Female	Total	Male	Female
Pheromone only	25.00 c	10.00 b	15.00 c	26.67 c	9.67 c	17.00 b
Kairomone only	3.00 d	1.33 c	1.67 d	5.00 d	1.67 d	3.33 c
Pheromone+ Kairomone	36.67 b	13.33 b	23.33 b	42.00 b	16.67 b	25.33 b
Pheromone +Kairomone + Bait	83.67 a	30.67 a	51.67 a	83.33 a	29.00 a	54.33 a
LSD 0.05	5.601	3.895	4.06	11.930	3.506	9.969

Table 2. Comparison between different types of food bait and its influence on captured adult of RPW during 2009 and 2010.

Treatments	Average captured RPW adults/trap 2009			Average captured RPW adults/trap 2010		
	Total	Male	Female	Total	Male	Female
Sugar cane	55.67 a	23.67 a	32.00 a	56.67 a	20.33 a	36.33 a
Gommar	24.33 c	10.33 b	14.00 b	30.33 b	10.00b	20.33 b
Date	32.67 b	12.00 b	20.67 b	32.33b	10.33 b	22.00 b
LSD 0.05	5.204	4.624	9.647	9.910	2.700	7.086

3. Effect of pheromone trap color on attraction of RPW adults during 2009 and 2010.

The results showed that trap color has significant effect on attracting RPW adults' as there were significant differences between trap colors in the average number of captured weevils according to Table (3). During the trapping period, the maximum average total number of *R. ferrugineus* captured adults per trap was captured in the red traps (59&62.33) adults / trap in the two seasons of 2009 and 2010, which was significantly different from green traps (33.67 and 32.00) adults / trap and blue traps 28.67 and 29.67 adults / trap which was the lowest average RPW captured adults . There was significant difference occurred between the catchability of green and blue color traps during 2009. However there was no significant difference between the green and blue color traps during 2010. The same trend was observed in the catchability of male and female RPW adults population during 2009 and 2010.

These findings are in harmony with the data obtained by Abdallah and Al-Khatri (2005) in Oman revealed that the trap color has significant effect on attracting of red palm weevil adults' where red and orange color pheromone baited trap attracted significantly more adults than blue color traps. Faleiro (2005) tested Seven different trap colors viz. green, light blue, dark blue. White (transparent), pink, orange and yellow in the field for eight weeks under a replicated trial from January to March, 2000. The results indicate that the catches ranged from 8.66 to 3.33 weevils per trap in pink and yellow colored traps, respectively and were statistically at par, proving that trap color did not significantly enhance weevil captures.

Table 3. Effect of pheromone trap color on attraction of RPW adults during 2009 and 2010.

Treatments	Average captured RPW adults/trap 2009			Average captured RPW adults/trap 2010		
	Total	Male	Female	Total	Male	Female
T1 Green	33.67 b	11.00 b	22.67 b	32.00 b	11.67 b	20.33 b
T2 Red	59.00 a	23.67 a	35.33 a	62.33 a	22.33 a	40.00 a
T3 Blue	28.67 c	10.67 b	18.00 c	29.67 b	11.67 b	18.00 b
LSD 0.05	3.541	5.753	3.460	7.797	3.293	4.867

4. Effect of renewing water and food bait on pheromone trap efficacy during 2009 and 2010.

Replacing the water and food baits inside the pheromone trap every 15 days showed the highest trap catches according to the data presented in Tables (4&5) with average captured RPW adults of 43.67&52.67. The average of weevil captures declined to 24.67&36.33 when propylene glycol was added to the water. Data also indicated that the lowest average of RPW captured adults were 20.33&27.67 when the traps stayed all the testing period without any replacement of water or food bait. Data also showed that in spite of that there was no significant difference between averages captured RPW adults of traps which not renewed its water and bait and the trap in which propylene glycol was added to the water. The addition of propylene glycol to the water of the trap had increased the age of the trap for about two months without need of maintenance (renewing water or food bait).

These results are similar to those obtained by Sans and Hidalgo. (2009) mentioned that there is a fact implies a smaller need for maintenance and replacing of food baits that is often tiresome and makes the counting of captured insects difficult. However, the addition of water, date fruits, aggregation pheromone and kairomone to the RPW traps is very necessary to increase its weevil attraction and increase the number of captured weevils (AL-Saoud, 2009).

Table 4. Effect of renewing water and food bait on pheromone trap efficacy during 2009 and 2010.

Treatments	Average captured RPW adults 2009			Average captured RPW adults 2010		
	Total	Male	Female	Total	Male	Female
T1(non Renewed)	20.33 b	6.33 b	14 b	27.67 c	8.67 c	19.00 b
T2(Renewed)	43.67 a	15.33 a	28.33 a	52.67 a	18.33 a	34.33 a
T3(Propylene glycol)	24.67 b	7.66 b	17.00 b	36.33 b	12.00 b	24.33 b
LSD 0.05	6.456	2.388	4.596	5.972	2.442	6.045

Table 5. Weekly catches of RPW adults in the different treatments during 2009 and 2010.

Weeks	Average captured RPW adults 2009			Average captured RPW adults 2010		
	T1	T2	T3	T1	T2	T3
1	5.7	9.7	3.7	10.0	11.0	7.7
2	5.7	8.7	3.0	7.0	10.7	4.3
3	4.0	7.7	6.3	5.3	9.7	6.3
4	4.0	5.3	3.7	4.0	8.7	6.3
5	1.0	6.7	3.3	1.3	4.7	6.0
6	0.0	5.7	4.7	0.0	8.0	5.7

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تحسين كفاءة المصائد الفرمونية لخفض تعداد سوسة النخيل الحمراء بمزارع النخيل

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كما اشتملت الدراسة على عدة تجارب لزيادة كفاءة المصيدة الفرمونية فى جذب حشرات سوسة النخيل وأظهرت النتائج أن اضافة مادة الكيرمون والطعم الى المصيدة قد ساعد على زيادة فاعلية المصيدة فى إصطياد الحشرات بمقدار 3.5 مرة مقارنة بالمصيدة التى تحتوى على الفيرمون فقط وقد كانت أفضل المعاملات هى المصيدة التى تحتوى على (فيرمون+كيرمون+طعم). وبمقارنة ثلاثة أنواع مختلفة من الطعم النباتى (قصب وجمار وبلح) أعطت المصيدة المضاف إليها قصب أعلى معدل جذب للحشرات يليها المصيدة التى تحتوى على بلح وكان أقلها جذبا المضاف إليها جمار. وبمقارنة تأثير لون المصيدة على معدل جذب الحشرات وجد ان المصيدة ذات اللون الاحمر اعطت أعلى معدل جذب يليها المصيدة ذات اللون الاخضر ثم المصيدة ذات اللون الازرق مع وجود فروق معنوية بين الثلاث ألوان. ودراسة تأثير تجديد وإضافة الماء والطعم النباتى إلى المصيدة وجد أنه عند تجديد إضافة الماء والطعم إلى المصيدة كل اسبوعين أدت إلى جذب أكبر عدد من الحشرات مقارنة بالمصيدة التى لم تجدد والمصيدة المضاف إليها بروبولين جليكول ومع ذلك فإن إضافة هذه المادة إلى المصيدة أدى إلى إطالة عمر المصيدة وثبات معدل الاصطياد.