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Evaluation of the Effectiveness of Attractant Trap Colors on Attractive Red Palm Weevil, *Rhynchophorus ferrugineus* (Olivier) in Egypt

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Abstract

Red palm weevil (RPW), *Rhynchophorus ferrugineus* (Olivier) (Coleoptera: Curculionidae) is at present considered the biggest threat to palm trees worldwide. Due to the current trend towards the use of environmentally-friendly control measures: Including pheromone traps. Experiments were carried out in date palm farm at Abo Nagi El-Kassasein district, Ismailia Governorate, Egypt during one season (2017/2018). Eight trap colors were tested for attraction to the red palm weevil .Adding colors (red, blue and yellow, green, orange, violet, black and white). The black traps color was the best color to attract RPW .The obtained results obviously indicated that the numbers of captured adults increased highly significantly in traps black color which representing 16.26 % of the total catch than other colors; red represented 15.8 %; blue which represented 14.42 %; green which represented 13.41% ;orange which represented 12.15 %; violet which represented 10.81%; yellow which represented 9.5 % and white represented 7.63 % .Accordingly, it is recommended to use black pheromone trap. Males captures in all color traps registered 2308 while females' captures reached 3112, with a sex ratio of 1: 1.35. There was temporal variation in number of *R. ferrugineus* per trap per month during the trapping period. Population attained highly peak in November for all trap colors, all traps captured more in April, May and November (591,733 and 828, respectively). Generally, to achieve more capturing effectiveness of aggregation pheromone traps in controlling red palm weevil, it is necessary to use trap colors black (holes and funnel without cover) and ground height.

Key words: *Rhynchophorus ferrugineus* (Olivier), pheromone traps, colors.

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Introduction

The red palm weevil (RPW), *Rhynchophorus ferrugineus* (Olivier) (Curculionidae: Coleoptera) is the most serious and difficult to control insect pest on date palm (*Phoenix dactylifera* L.) in Egypt (Al-Saoud *et al*., 2010). RPW was first discovered in date palms in the Governorate of Ismailia in 1992, Saleh, (1992). Moreover, several studies carried out in different regions of Egypt show that pheromone traps, used as a part of an integrated pest management program, reduced infestation levels and captures rates of the pest (Abbas, 2000 and 2005; Olfat, 2015). Many studies have examined the trap colour preferences of *R. ferrugineus*,identified black as the insects favorite color (Abuagla and Al-Deeb, 2012; Al-Saoud, 2013; Vacas*et al*., 2013; Abdel-Azim *et al*., 2014). Although the aforementioned studies analyses weevil chromatic attraction, there is a lack of knowledge about the effect of the color as the main factor in their captures, and the possible reasons for this color preference. The aim of the present study was to analyses the importance of the chromatic factor in captures of *R. ferrugineus* adults. In order to confirm the effect of chromatics attraction on the number of captures, tests were carried out on the attractiveness of traps

baited with and without olfactory lures. The efficacy of colored traps were also assessed in relation to internal trap climatic conditions (temperature and relative humidity), and the spectral reflectance of the leaves and external fibers of the trunk of the Canary Island date palm, *Phoenix canariensis* (Hort. ex Chabaud) (Arecace; Arecaceae). The sex ratio of the natural populations of this weevil was analyzed and a check was made to determine whether trap color had any influence on the female/male ratio of captured *R. ferrugineus* adults .The results obtained provide information that should be helpful in improving the control of *R. ferrugineus* by mass trapping systems. The aim of this study was to evaluate the attraction of the weevil by different colors to assess the most effective ones sex ratioand temporal variation in number of adultsper trap per month during the trapping period and population attained a peak.

Materials and methods

1. Attraction the weevil to different colors

At El-Kassasein district (Abo-Nagi), Ismailia Governorate, in farm, 15 faddans which date palm trees were extensively distributed. Was chosen for one year (2017/2018) experiment, twenty four pheromone traps were randomly distributed where the distance between each two traps was100 m. The experimental design was a randomized complete blocks design and the trap shape (holes and funnel without cover) at height on ground level placed near 5 date palm tree trunks. Varieties being: Zaghloul, Hayani, Samani, Bent-Esha and Amry. Attracting of colors were tested and three replicates for each attraction for colors. A total of 24 traps were placed for the trapping period from April, 2017 until March, 2018. The experimental design was a complete randomized blocks design with eight treatments (red color ; blue color; yellow color; green color; orange color; violet color; black color and white color) using three replicates in each treatment, traps were sited on ground surface. Changes in the population density were determined by numbers of captured *R. ferrugineus* adults based on aggregation pheromone traps in selected area. The number of collected weevils caught in the pheromone traps was counted weekly and sexed. Kairomone (ethyl acetate) bags were renewed every one month and pheromone capsules and soap water solution in each trap were renewed weekly.

1.1. Trap type color description

The used traps common were the plastic buckets (9 liters in size). The bucket was punctured around its wall with four holes each of 2.5cm in diameter at 15cm from the bottom applying funnel without cover 8cm in diameter on the top of bucket traps and placed on ground surface (Fig.1).

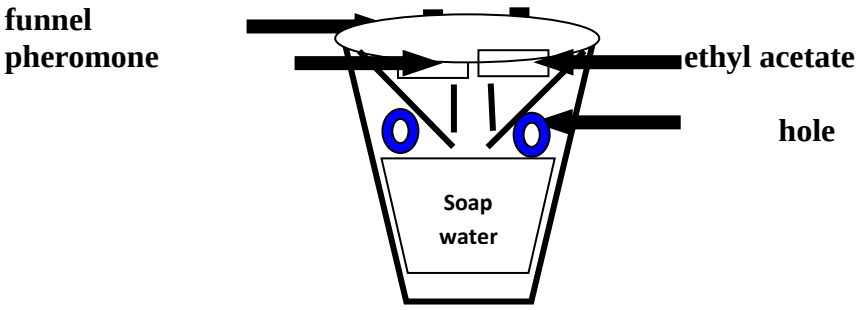

Fig (1): Diagram of trap type 1

1.2. Synthetic aggregation pheromone lures

The commercially used pheromone "PO28 Ferrolure+" is a synthetic pheromone lure, (a mixture of 4-methyl–5-nonanol and 4–methyl–5-nonanone (9:1). Purity of both >95%. Components used were imported from ChemTica International S.A., Costa Rica. Pheromone sac was hanged on the underside of trap top surface. The pheromone releases its active chemicals blames through a plastic membrane. Release Rate (3-10 mg/day). Minimum 700 mg/lure total mixture from 400 and 1500N/tube, Bubble formulation one lure per pack. Colorant and stabilizer added. Respectively under laboratory conditions of 27°C and 50% R.H. under identical conditions. (Hallet *et al*., 1993). Selected kairomone was used as a synergist to activate the potent ability of releasing ethyl acetate blooms. However, ethyl acetate bags were hanged from the underside surface of the trap top releasing chemicals through a fine plastic tube (as 100 and 128 mg/d).

1.3. Killing materials

Liquid soap was mixed with trap water and used inside the bucket trap.

2. Statistical Analysis

The obtained results were statistically analyzed using a software package 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

1. Effect of weevil attraction by different colors

1.1. Evaluation of the efficiency of pheromone traps supplied with different colors

Data in Table (1) and illustrated by Fig (3) present the weekly numbers of both adult sexes captured in traps supplied with different colors and with aggregation pheromone placed in date palm tree orchards in Abo-Nagi farm ,El-kassassein district ,Ismailia Governorate, during 2017 /2018 season.

1.1.1. The population dynamic relatively to color types

Adding colors (red, blue, yellow, green, orange, violet, black and white). Adding black color was the best color to attract RPW where the number of weevils captured was 882^{a} adults representing 16.26 % of the total catch compared to red color, which caught 856^{b} adults, represented 15.8 % of the total catch compared to blue color, which caught 782^{c} adults, represented 14.42% of the total catch compared to green color, which caught 727^{d} adults, represented 13.41% of the total catch compared to orange color, which caught 659^{e} adults, represented 12.15% of the total catch compared to violet color, which caught 586^{f} adults, represented 10.81% of the total catch and compared to yellow color, which caught 517^{g} adults, represented 9.533% of the total catch and traps with white color caught the least number 411^{h} adults ,represented 7.63% of the total catch. There is no significant difference between the traps color black, red, blue and green compared other color trap, the numbers of captured adults increased highly significantly differences in RPW catch in traps black color than other colors; red; blue; green ;orange; violet; yellow and white .Accordingly, it is recommended to use black pheromone trap it was the most attractive. Data agreed with Hallet *et al*. (1999), Abuagla and Al-Deeb (2012), Al-Saoud (2013), and Abdel-Azim*et al*. (2014)

reported that black traps were only tested in comparison with white traps by confirming the significantly higher attraction of *R. ferrugineus* adults to black. Sansano *et al* .(2008) who found the most plausible explanation is simply that *R. ferrugineus* uses dark colors as visual cues to the trap and Al-Saoud *et al*. (2010) suggested that in United Arab Emirates the maximum number of *R. ferrugineus* per farm was captured in dark-colored traps captured more than the light–colored traps. Trap color has a significant effect on trap effectiveness, dark-colored traps in general and the red in particular, catch more weevils. Therefore, the use of black traps will be more effective in the control programs of this economic pest. Abuagla and Al-Deeb (2012) and Abdel-Azim *et al*. (2014) reported similar results for red traps. The aforementioned studies generally combined the chromatic. There is a lack of knowledge about the effect of trap color as the only factor influencing the captures of this weevil. Moreover, none of the current papers examines the possible reasons of the color preferences of *R. ferrugineus*. Vacas *et al*. (2013) compared black pyramidal traps with white bucket traps, analyzing a combination of color and shape, but without explaining if the greatest captures in the first one were due to the color or the shape of the trap. The second most efficient trap color in our study was red, which captured significantly fewer adult *R. ferrugineus* than the black traps, but significantly more than the white and Juan and Antonio (2015) found that in Spain black traps, captured significantly more *R. ferrugineus* adults than red and white traps.

1.1.2. Sex ratio relatively to colors materials:

Results in Tables (1) and illustrated by Fig (3) revealed that Males captures in traps with black color registered 370 while females captures reached 512, with a sex ratio of 1: 1.38 followed by red color registered 359♂ and 497 ♀ with a sex ratio of 1: 1.38 followed by blue color registered 340♂ and 442♀ with a sex ratio of 1: 1.29 followed by green color registered 311♂ and 416♀ with a sex ratio of 1: 1.33 followed orange color registered 273♂ and 386♀ with a sex ratio of 1: 1.41 followed by violet color registered 255♂ and 331♀ with a sex ratio of 1: 1.29 followed by yellow color registered 226 ♂ and 291♀ with a sex ratio of 1: 1.28 and least number was recorded during white color registered 174♂ and 237♀ with a sex ratio of 1: 1.28 and Males captures in all color traps registered 2308 while females' captures reached 3112, with a sex ratio of 1: 1.35 and here is no difference in sexual ratios due to the color of the traps. The present results are agreement with those obtained by some authors such as Abbas (2000) who reported the sex ratios of male to female attracted aggregation pheromone traps were 33.67 and 33.7: 66.3 during the two successive seasons, respectively. El-Sebay (2003) found that in the field female more than male at a ratio of 1.35:1., Al-Saoud (2004),Abdallah and Al-Khatri (2005), Al-Saoud *et al*.(2010) and Al-Saoud (2010; 2013) 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), respectively. This conclusion obviously demonstrates that the attractiveness of red palm weevils to pheromone traps is always in favor of adult females irrespective of trap colors. Generally, the results indicated that the suitable trap color is the black pheromone trap with 4 holes and without cover hanging on ground level in date palm plantations area, all over the year, and these traps should be maintained regularly. Replacing pheromone with new fresh one every two weeks. Both of ethyl acetate and soap water were provided when required.

1.1.3. Seasonal abundance

Results in Tables (1) and illustrated by Fig (3) revealed that there was temporal variation in number of *R. ferrugineus* per trap per month during the trapping period. Population attained a peak in November for all trap colors. The highly attractive in April, May and November were numbers of adults 591,733 and 828, respectively, with all colors traps. The results obtained provide information that should be helpful in improving the control of *R. ferrugineus* by mass trapping systems. The present results are agreement with those obtained by some authors such as Abbas (2000) who reported five peaks for adult capture of RPW during mid-March, end of April, end of June, mid-September and the end of October were recorded during the first season 1995. Six peaks of activity mid –March, end of April, mid of June, mid-July, the end of September and mid-November were recorded during 1996 season. Vidyasagar *et al*. (2000) showed that the peak adult population of RPW trapped during April and May. A much lower second peak was observed during October and November. El-Sebay (2003) determined that the first adult of RPW brood was observed in April and the second one was in November. Abbas *et al.* (2006) population of RPW increased gradually from January and peaks in March, April or May. Al-Souad *et al*. (2010) showed that the population dynamics date palm growers in UAE should maintain the traps during the season and particularly in March when the *R. ferrugineus* population reaches its peak in order to capture the maximum number of insects. Sujatha *et al.* (2010) recorded that RPW higher catches of weevils in March, April, May, June and July. Olfat (2015) showed that seasonal abundance of *R. ferrugineus* adults using pheromone traps during two successive seasons, 2012 and 2013 clear that the highest number captured by pheromone traps was recorded in April. Four peaks were recorded for RPW during April, June, September and November respectively.

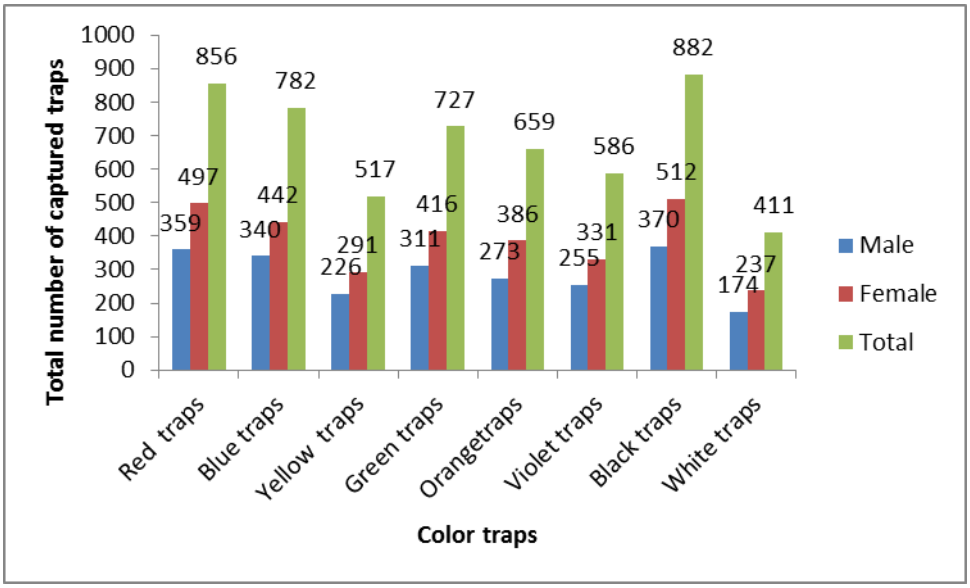

Fig (2): Total numbers of *R. ferrugineus* adults captured by eight colors of plastic pheromone traps sited in date palm orchards at El-Kassasein district, Ismailia Governorate during one year of 2017/2018.

Table (1): Monthly average number of *R. ferrugineus* (Oliv.) adults captured in twenty four pheromone funnel traps, without cover and with four holes top with different colorsplaced on ground level in date palm orchard at farm, El-Kassassein, Ismailia Governorate during 2017/2018 seasons

Color attractive types	Red traps			Blue traps			Yellow traps			Green traps			Orange traps			Violet traps			Black traps			White traps		
Date	M.	F.	Total	M.	F.	Total	M.	F.	Total	M.	F.	Total	M.	F.	Total	M.	F.	Total	M.	F.	Total	M.	F.	Total
Apr.2017	39	59	98	32	48	80	23	32	55	32	46	78	30	42	72	33	35	68	40	60	100	20	20	40
May.2017	49	75	124	42	60	102	30	40	70	40	60	100	40	40	80	30	46	76	50	76	126	25	30	55
Jun.2017	45	49	94	38	40	78	25	35	60	36	38	74	30	37	67	27	36	63	46	50	96	20	25	45
Jul.2017	22	57	79	30	40	70	18	22	40	28	38	66	21	29	50	21	25	46	23	58	81	15	15	30
Aug.2017	17	29	46	25	30	55	20	25	45	22	27	49	18	37	55	20	31	51	18	30	48	10	25	35
Sep.2017	10	30	40	20	32	52	10	10	20	20	26	46	10	22	32	10	18	28	10	32	42	5	10	15
Oct.2017	37	39	76	33	37	70	20	30	50	30	34	64	23	48	71	23	34	57	38	40	78	15	25	40
Nov.2017	62	65	127	55	65	120	35	45	80	45	65	110	45	55	100	39	47	86	64	66	130	30	45	75
Dec.2017	30	30	60	27	43	70	12	18	30	25	35	60	20	31	51	16	21	37	31	33	64	12	14	26
Jan.2018	1	3	4	2	2	4	1	1	2	1	2	3	1	2	3	1	1	2	1	4	5	1	1	2
Feb.2018	4	4	8	3	5	8	2	3	5	2	5	7	3	5	8	3	3	6	5	5	10	1	2	3
Mar.2018	43	57	100	33	40	73	30	30	60	30	40	70	32	38	70	32	34	66	44	58	102	20	25	45
Total	359	497	856[a]	340	442	782[ab]	226	291	517	311	416	727[abc]	273	386	659 [abc]	255	331	586[abc]	370	512	882a	174	237	411[cd]
Mean	29.9	41.4	71.3	28.3	36.8	65.1	18.8	24.2	43.0	25.9	34.6	60.5	22.7	32.1	54.9	21.2	27.5	48.8	30.8	42.6	73.5	14.5	19.7	34.2
Sex ratio%	41.9	58.0	100	43.4	56.5	100	43.7	56.2	100	42.7	57.2	100	41.4	58.5	100	43.5	56.4	100	41.9	58.0	100	42.3	57.6	100
%	38.8	40.4	39.7	36.7	35.9	36.2	24.4	23.6	23.9	37.0	36.7	36.8	32.5	34.0	33.4	30.3	29.2	29.7	68.0	68.3	68.2	31.9	31.6	31.7
S.E.±	5.55	6.65	11.77	4.32	5.38	9.60	3.13	4.05	7.13	3.88	5.38	9.19	3.93	4.58	8.28	3.46	4.25	7.62	5.66	6.61	11.8	2.64	3.56	6.07

Means followed by the same letter horizontal are highly significantly different according to F-test=4.42** (L.S.D.0.05=78.79). M=male F=female S.E.±=Standered error%=percentage

Conclusion

Red palm weevil (RPW), is at present considered the biggest threat to palm trees worldwide. Eight trap colors were tested for attraction to the red palm weevil .Adding colors (red, blue and yellow, green, orange, violet, black and white). The black traps color was the best color to attract RPW. Generally, to achieve more capturing effectiveness of aggregation pheromone traps in controlling red palm weevil, it is necessary to use trap colors black (holes and funnel without cover) and ground height.

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تقييم تأثيرألوان المصائد الفرمونية التجمعية على معدل جذب سوسة النخيل الحمراء فى مصر

ألفت السيد عرفة

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الملخص العربي

تعتبرالمصائد الفيرومونية التجميعية طريقة ضرورية للمكافحة المتكاملة لسوسة النخيل الحمراء فى التجارب الحقلية التى أجريت فى مزرعة لنخيل البلح بمنطقة القصاصين محافظة الاسماعيلية في مصرلمدة موسم واحد (٢٠١٨/٢٠١٧م) باستخدام ثمانية ألوان من المصائد الفرمونية تم اضافة ألوان (أحمر وأزرق وأصفر وأخضر وبرتقالى وبنفسجى وأسود وأبيض) وجد أن اضافة اللون الأسود اصطاد أعلى تعداد للسوسة كما أوضحت النتائج المتحصل عليها أن أعداد الحشرات المصادة زاد بمعنوية عالية فى المصائد السوداء بنسبه ١٦.٢٦% من المجموع الكلى للاصطياد عن الألوان الأخرى الأحمربنسبة ١٥.٨% والأزرق بنسبة ١٤.٤٢% والأخضربنسبة ١٣.٤١% والبرتقالى بنسبة ١٢.١٥% والبنفسجى بنسبة ١٠.٨١% والأصفر بنسبة ٩.٥% والابيض بنسبة ٧.٦٣ %.وطبقا للتوصيات يجب استخدام المصائد السوداء. سجل عدد الذكورالمصاده بكل المصائد ٢٣٠٨بينما كان عدد الاناث ٣١١٢ بنسبة جنسية قدرها ١: ١.٣٥. يوجد اختلافات فى عدد سوسة النخيل الحمراء لكل مصيدة لكل شهر اثناء فترة الاصطياد .تعداد سوسة النخيل الحمراء له أعلى فترة نشاط فى نوفمبر فى كل ألوان المصائد .اصطادت كل المصائد تعداد عالى من السوسة فى ابريل ومايو ونوفمبر (٨٢٨،٧٣٣،٥٩١على الترتيب). عموما لمكافحة سوسة النخيل الحمراء والحصول على أعلى تأثيرللاصطياد بالمصائد الفرمونية التجميعية لابد من أستعمال المصائد السوداء (بفتحات وقمع وبدون غطاء) وتوضع على مستوى الارض.

الكلمات الدالة: *Rhynchophorus ferrugineus* (Olivier) ،**مصائد الفرمون، ألوان**