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Effect of Red Palm Weevil *Rhynchophorus ferrugineus* (Coleoptera: Curculionidae) Aggregation Pheromone Traps Height and Colors on the Number of Capturing Weevils

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Abstract

Red palm weevil *Rhynchophorus ferrugineus* (Coleoptera: Curculionidae) is controled using Integrated Pest Management, which depends on the aggregation pheromone traps. The entomologists are doing their best to continuously. Field trials were conducted on date palm plantations of Al_Rahba in Abu Dhabi (UAE) during 20/11/2008-30/7/2009 containing 5 Replications and 8 treatments (pheromone trap colors and height) the traps were hung on four different heights on the palm tree trunks (ground level, 0.5 m, 1.0 m and 1.5 m for each colors) and the aggregation pheromone 4-Methyl-5-Nonanol 90% + 4-Methyl-5-Nonanoe 10% (700 mg), 350 gram fodder dates fruit in addition to about 5 liter water each trap to study the effect of traps height on the number of captured weevils. Results indicated that the total number of captured weevils were 5478, the numbers of cached each colors was 3360 and 2118 weevils for red and white traps respectively, and the height catches 1367, 1683, 1335, and 1093 weevils for four heights (ground level, 0.5 m, 1.0 m and 1.5 m) respectively. The highest number of 1063 weevils catches in red traps hanged on the 50 cm height, this treatment dominated on other seven treatments, the lowest catches, 453 weevils record in white traps hung on 1.5 m. There is not any significant differences between red traps which put on land service, which catches 859 weevils, and on 1.0 m height, with 798 catches, and these two treatments dominated on other five treatments, there is not any significant differences between red traps on 1.5 m, catches 640 weevils and white traps on 0.5 m, catches 620 weevils, these two treatments dominated on white traps put on land service, and catches 508 weevils. There were no significant differences between other treatments. These results indicate the importance of aggregation pheromone traps in control red palm weevil and the necessary of using red traps colors and hanging the traps on 0.5 m height on palm tree trunk and continue studying and research to improved effectiveness of this technique.

Keywords: *Rhynchophorus ferrugineus*, pheromone traps, height, color.

INTRODUCTION

Red Palm Weevil (RPW) *Rhynchophorus ferrugineus* Olivier (Coleoptera: Curculionidae) is one of the most destructive pests of coconut, *Cocos nucifera* L., in South and Southeast Asia (Sivapragasam *et al*., 1990; Sadakathulla, 1991). It is a concealed tissue borer (Faleiro *et al*., 1998; Faleiro and Satarkar, 2003; Faleiro and Satarkar, 2003a), it is a major economic importance insect attach palm trees all over the Gulf Countries now (Bokhari and Abuzuhari,1992; Abraham *et al*., 1998; Abraham *et al*., 2000; Abraham *et al*., 2002; Al-Saoud, 2006; Al-Saoud, 2008; Al-Saoud *et al*., 2010). Since the mid 1980s, (RPW) has caused severe damage to date palm trees, in several Middle Eastern countries (Abozuhairah *et al*., 1996) It is relevant to point out that this insect was first reported in the Indian Museum Notes in 1891 while; (Lefroy, 1969) first described it as a pest of coconut in India. Its first described as serious pest of date palm by (Madan Mohan Lal, 1917) in the Punjab from India (Buxton, 1920) found that this pest caused serious damage to date palm in Mesopotamia (Iraq).

The pest is difficult to control in the early stage of attack because it is an internal tissue borer (Abraham *et al*., 1998) with the synthesis of the male produced aggregation pheromone"Ferrugineol" (4-methyl-5-nonanol) by (Hallett *et al*. 1993). The food bait and pheromone act synergistically to attract adults of RPW (Abraham *et al*., 1989; Hallett *et al*., 1999; Abraham *et al*., 2000; Vidyasagar *et al*., 2000; Abraham *et al*., 1989; Nair *et al.,* 2000; Al-Saoud, 2007; Al-Saoud, 2008; Al-Saoud *et al*., 2010).

Aggregation pheromone traps the main component of any Integrated Pest Management programme, it attracts both male and female weevils (Abraham et al., 1998; Oehlschlacher *et al*., 1998; Abraham *et al*., 2001; Oehlschlacher *et al*., 2002; Al-Saoud, 2006, 2007, 2008, 2009a; Al-Saoud *et al*., 2010). In the Middle East as well as in India the sex ratio of weevil captures was reported to be female dominated in these traps (Abraham *et al*., 1999; Faleiro, 2000; Faleiro and Rangnekar, 2000; Faleiro and Satarkar, 2003a; Al-Saoud, 2004, 2006, 2009; Al-Saoud *et al*. 2010). It is desirable factor that aggregation pheromone traps attract and capture more female weevils, which lay eggs. Killing this captured male & female weevils, thus the traps play a significant role in reduction the population of the pest.

The weather conditions affected the number of captured red palm weevils', (Abraham *et al*, 1998) reported that the pheromone traps caught a huge numbers of the weevil during March-May and, September-November, and the weevils capture dropped significantly, during height summer or winter seasons. (Faleiro and Rangnekar, 2001; Faleiro, 2004) reported that red palm weevil pheromone traps caught large weevil numbers between October-November, while weevil activity is least between June- July , under costal humidity conditions of Western India. (Al-Saoud, 2004, 2006, 2007, 2009) reported the peak of activity, during March-May in Al-Rahba (UAE). The Female dominated in weevil captures in aggregation pheromone traps (Abraham et al., 1999; Faleiro and Chellapan, 1999; Faleiro and Rangnekar, 2000; Vidyasagar *et al*., 2000; Al-Saoud, 2004, 2006, 2008, 2009; Al-Saoud *et al*., 2010).

Initial attempts to control red palm weevil a major pest of the date palm in the Kingdom with insecticides were not successful (Bokhari and Abozuhairah, 1992) and since 1994 an Integrated Pest Management (IPM) strategy, modeled on the lines of tackling the pest on coconut in India was implemented in the kingdom. This IPM

strategy has successfully suppressed the pest in the date plantations of Saudi Arabia (Abraham *et al*., 1998).

The use of pheromone traps was the major components of the IPM strategy, used to capture and kill the flatting weevil population.

In any insect trapping programme, it is desirable to capture more number of females, as the adult female contributes directly to the population build up by laying eggs

In nature, male to female population was reported as 1.32: 1 (Nirula, 1956), while (Abraham *et al*., 1999) found in Arabia Saudi Kingdom that the weevil captures in different operational areas between mid 1994 to December, 1997 varied from 1:2.35 to 1: 3.06, with an overall average of 1:2.68 in favour of females, while (Al-Saoud, 2006) found this ratio 1:1.33 - 1:2.2. (Al-Saoud, 2007) found that the sex ratio was 1:1.56. (Al-Saoud, 2009) recorded sex ratio as 1:1.89. While as the captures was female dominated, pheromone trapping along with other components of the IPM strategy contributed in suppressing the build up of the pest. This is supported by the fact that the total number of weevil trapped during 1997 reduced to 3806 as compared to 5308 and 5533 weevils captured in Al-Hassa during 1995 and 1996, respectively. In this context it is relevant to point out that (Oehschlager *et al*., 1995), obtained over 90 per cent reduction in weevil captures of *R.palmarum* after two years of pheromone trapping in oil palm plantations of Costa Rica. The captures were female dominated too.

Pheromone trapping of red palm weevil is therefore, an ecologically safe and environmentally friendly tool in the IPM strategy currently adopted worldwide for red palm weevil management in date palm plantation areas. This powerful component of the IPM programme can be implemented on large scale either by the state or by farmers on a collective basis.

The trap effectiveness is affected with many factors, colors(Hallett et al., 1999; Abdallah and Al-Khatri, 2005; Al-Saoud *et al*., 2010, pheromone type, trap contents, food bait, and trap sites (Hallett *et al*., 1999; Faleiro, 2004; Al-Saoud 2008a). The pheromone trap hight affects on the effectiveness of the traps, (Faleiro, 2004; Al-Saoud, 2008) found that the height of 1m on the date palm trunk from the ground registered the best weevil captures

The purpose of this study is to evaluate the effect of trap site on trap effectiveness in date palm plantations in Al-Rahba (Abu Dhabi) through captures of RPW adults using pheromone traps.

MATERIALS AND METHODS.

The experiment was conducted at five farms at Al-Rahba, Abu Dhabi (UAE) during 20, December, 2008- 30 July, 2009. Each farm contained about 140 date palm trees of different ages (6-25 years).

40 food baited pheromone traps were set throughout Al-Rahba, date palm plantations where no IPM practices for weevil management were followed to monitor the activity of RPW in these plantations.

Traps

Pheromone traps were fabricated using about 8 liter capacity high density polyethylene (HDPE) bucket with four windows (1.5 x 1.5 cm) cut equidistantly 4 cm below the upper rim of the bucket. The distance between each window and the bottom of the bucket was 16 cm. The bucket was covered with a lid that had three windows similar to the those on sides. The upper surface of the laid had a small handle to ease opining the trap and the lower side had a small knob on which a wire was fixed to hold the pheromone and kairomone dispensers. The outer surface of the bucket was rough with small projection (1-2 mm) to help the weevils climbing to the trap and enter. Each trap contained, 350 g of dates(The date fruits used were forage fruits or those that had dropped around palm trees in the farms, and these fruits are not consumable and incur no cost, according to the farmers) dispenser of the *R. ferrugineus* male aggregation pheromone containing 700 mg of the active ingredient (4-Methyl-5-Nonanol(9 parts)+ 4-Methyl-5-Nonanone (one part) at 95% purity, was hung on the inner side of the bucket lid with a piece of wire, and about 5 L of water, with a water level inside of 4-5 cm, which was lower on the side of the opening of the bucket. Serial numbers were assigned to each trap and locations were numbered from 1 to 8 on every farm. The water was always replenished to keep sufficient moisture in each trap. Food bait (dates) was changed monthly. The pheromone was added every 45 days during, cold period (December-May) and every month during warm periods (May-July). Number of weevils captured (male, female and total) were recorded weekly, and the trap content was shaken well to prevent growing any fungi or anything. The traps were shifted to a new location after weekly results had been taken, to avoid a location effect, and to know the insect numbers in each location and in each treatment on every farm during the study period. The maintenance was done continuous.

Trap Colors

The trap colors were white which is commonly used in (UAE) and red color to compare the effectiveness.

Experimental Design and Trap Installation

The experimental design was a randomized complete block design with eight treatments (Trap height on the palm tree trunks, which, ground level, 0.5 m, 1.01 m and 1.5 m height, for each color) and five replicates (farms). A total of 40 traps were installed for a trapping period 20/11/2008 until 30/7/2009. This time period (253 days) was selected because it includes the part of season in which the adults of red palm weevil are more active and reach their population peak. Large beetle population in the field amplifies the effect of trap set and color on weevil catch. The distance between traps was about 50m. Traps were fixed to the date trees trunks with nylon wires. Captured weevils were collected weekly. The traps were sureved weekly intervals, when the results were recorded (number of males, females and total weevils, weekly, monthly and cumulative numbers during the studying period), in each trap and farm. Every trap was shifted to a new location after weekly results had been taken, to avoid a location effect, and to know the insect numbers in every location and in every treatment on each farm during the study period.

A monthly record of the number of weevils trapped in the 40 (N) pheromone traps was maintained for the period of December, 2008 till July, 2009 to see the activity of red palm weevil during the different months of the studying period.
The data was processed and subjected to ANOVA test.

RESULTS AND DISCUSSION
This study showed the following results:

1. Monthly RPW activity in Al-Rahba during studying period

The weevil is found throughout the whole studying period in the date palm area in Al-Rahba (Fig. 1). The number of catch weevils/trap/month was differing from month to another. The rate of catch was 8.4, 4.8, 13.5, 33.5, 24.6, 15.5, 12.0, and 10.3 weevil/trap/month for December, 2008, January, February, March, April, May, June, and July, 2009, respectively. The highest catch was found during March and April, and the lowest was in December and January. Similar results were found by (Abraham *et al*., 1999; Vidhyasagar *et al.*, 2000; Al Saoud, 2004, 2006, 2009; Al-Saoud *et al*., 2010). While in Saudi Arabia, (Abraham *et al*., 1999) found high weevil's activity in April to November, 1995, but in 1996 he got two peak of activity – one in May to June and the other in October. But in 1997, the two peaks were found in May and September.

Consequently, reproduction of the insect occurs all year, and the damage increased, and control is difficult to achieve, especially, using chemicals, because application of pesticides must be during mid February till the end of March (pollination period), and from the beginning until the end of the maturing and harvesting of the crop.

2. Effect of red palm weevil *R. ferrugineus* aggregation pheromone trap high on the number of catch weevils

The study shows that there were differences of catch weevils in different height of traps (Fig. 2). And the number of catch was found 1367, 1683, 1335, and 1093 weevil in ground level, 0.5, 1, and 1.5 m traps height respectively. The analysis results showed that 0.5 m traps height on date palm trunks dominant to other treatments. This result nullified the results of (Faleiro, 2004) in India where he got best results at 1m height on the trunk of date palm and coconut.

Al-Saoud (2004, 2006, 2007) recommended putting traps 3m far from the date palm and 12 cm deep in the sand. This is to avoid the infestation in the date palm. (Al-Saoud, 2008) found best results in 1 m height on date palm compare to traps put 1 m height on seeder and 3 m far from date palm on 7 and 12 cm depth in the sand. This results partly supported by (Hallett *et al*., 1999), who found best results in ground level traps compare to 2 m and more height.

3. Effect of red palm weevil *R. ferrugineus* aggregation pheromone trap colors on the number of catch weevils

The number of catch weevil is variable in two colors. The red trap catches 3360 compare to 2118 weevils in white trap (Fig. 3)

The same result was obtained by Abdallah1 and Al-Khatri (2005) in Sultanate of Oman (Al-Saoud *et al*., 2010) in the United Arab Emirates, found that red trap color is

dominant to catch the weevil of white color, which commonly used in UAE, catch the weevil in lowest number (Falerio, 2005), which shows no significant difference in number of weevil catch in different colors.

4. Sex Ratio of *R. ferrugineus* catched in aggregation pheromone traps

The results revealed that the total number of catch weevils were 5478 where as male is 1757 and female is 3721 with sex ratio: 1:2.12.

This result differs from the results obtained by (Abraham *et al*., 1999), that the weevil captures in different operational areas between mid 1994 to December, 1997 varied from 1:2.35 to 1:3.06, with an overall average of 1:2.68 in favour of females. These results reported by other workers (Al-Saoud, 2006, 2008, 2009), where he got the sex ratio between 1:1.33 to 1:2.28. But, this present study showed the female number increase due to lack of suitable control method and reproduction of the insect.

5. The number of *R. ferrugineus* males catched in aggregation pheromone traps

The numbers of caught male weevils in 8 different treatments were 250, 172, 328, 199, 250, 180, 205, and 173, respectively (Fig. 4). The statistical analysis revealed that red color on 0.5 m. height catch maximum weevil numbers and dominated to other 7 treatments. There is no significant difference between red traps of ground level and 1 m height, but these 2 treatments were dominated to others and also no significant difference was available in different height of white traps. Similar results were found by (Al-Saoud *et al*., 2010).

6. The number of *R. ferrugineus* females caught in aggregation pheromone traps

The female numbers catches is variable in different treatments, it was, 609, 336, 735, 421, 548, 357, 435, and 280 female, for these 8 treatments respectively. Statistical analysis showed that the dominant of red color on 0.5 m height over all other treatments. There are no significant differences between red color on ground level and 1 m height. The red trap on ground level dominated on other treatments. There are no significant differences between red color on 1.5 m high and white color on ground level, 1 and 1.5 m heights. The white color on 0.5 m. high is dominated on white color on 1.5 m. There are no significant differences between other treatments**.** (Al-Saoud *et al*., 2010) found similar results in Al-Rahba.

7. The total number of *R. ferrugineus* catched in aggregation pheromone traps

The total numbers of caught weevil was 859, 508, 1063, 620, 798, 537, 640, and 453 on these 8 treatments respectively. The statistical analysis showed that the red color trap on 50 cm height dominated on other 7 treatments, and there is no significant differences between red color on ground level and 1 m height, and these two treatments dominated to other treatments, there is no significant differences between red color on 1.5 m height and white color on 0.5 m height, and these two treatments dominated on white traps on ground level and 1.5 m height. There are no significant differences between other treatments. These results differs the recommendations of (Al-Saoud, 2004, 2006, 2009) that indicated to place the trap 3 - 4 m far from palm trees, and fix in a hole of 12-15 cm depth in the sand. It agrees with the results of (Faleiro, 2004; Al-

Saoud, 2008a) which found that the trap height of 1 m from the ground on the palm tree trunk recorded the best weevil captures, comparing with other treatments, while the results indicated that the 0.5 m height recorded best captures.

These results indicated the importance of use of suitable color for red palm weevil aggregation pheromone traps, and sets these traps on 0.5 m on the date palm trees trunks in infested plantation areas, all over the year, and these traps should be maintained regularly and add new pheromone, change the food dates and water as when required. Deep study is needed to get best results of pheromone traps and improve this techniques, because it's very useful and safety for environment and human being.

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Figures

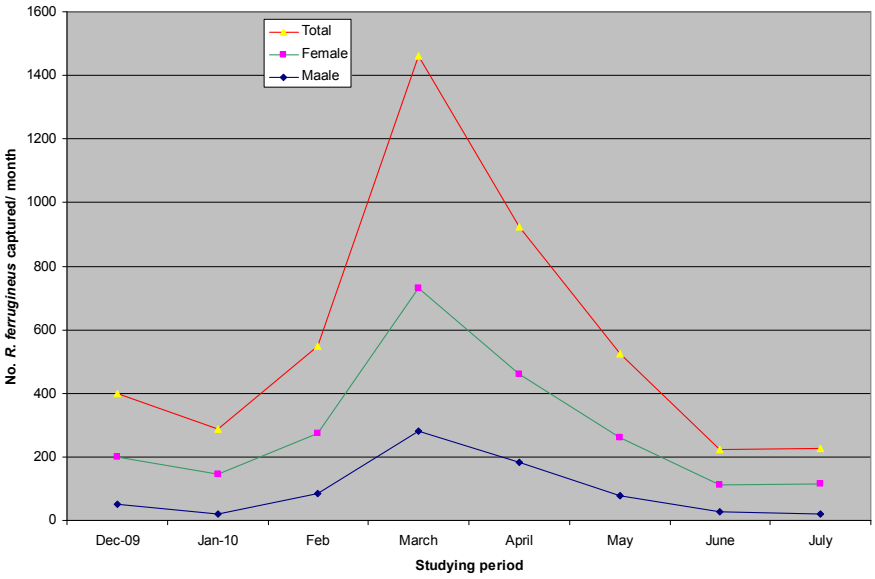

Fig. 1. Activity of *R.ferrugineus* at Al-Rahba(Abu Dhabi) during December, 2008 to July, 2009.

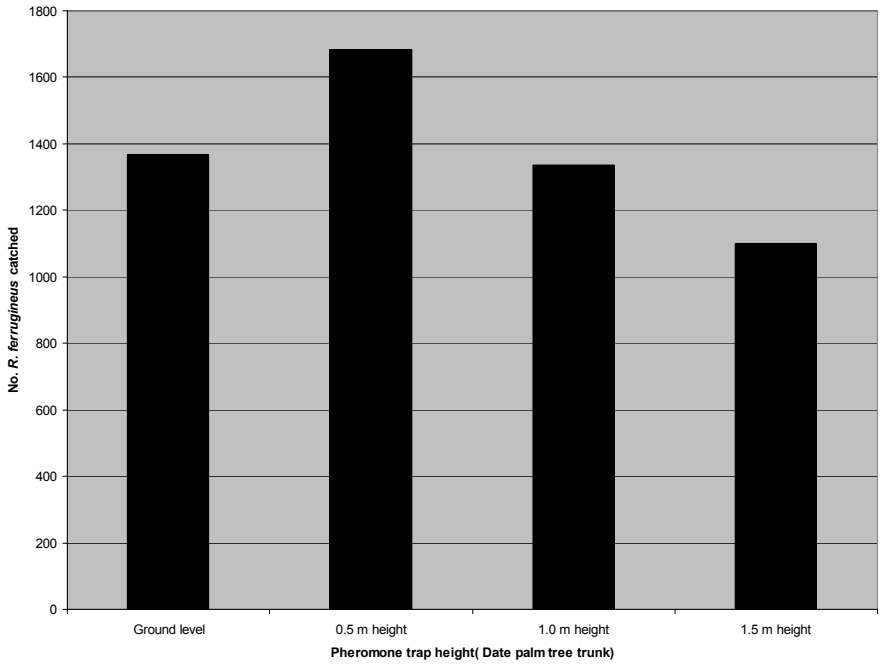

Fig. 2. Effect of *R.ferrugineus* Oliv. Aggregation pheromone traps height on the total caught weevils at Al-Rahba(Abu Dhabi) during 20 December, 2008 to 30 July, 2009.

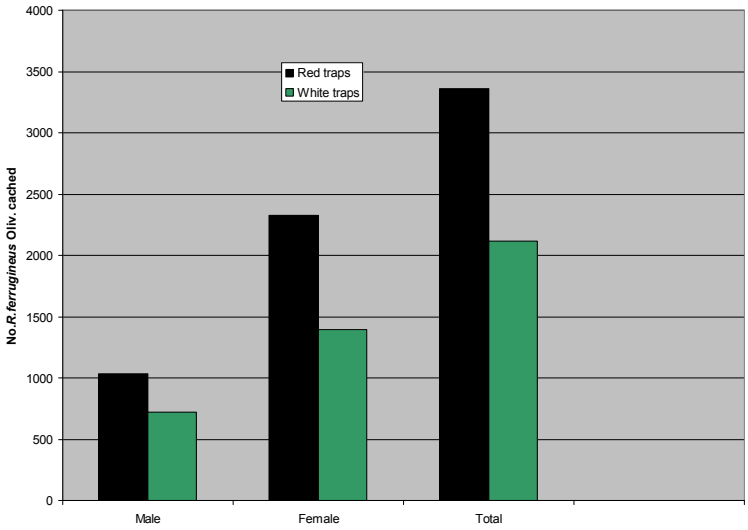

Fig. 3. Effect of *R.ferrugineus* Oliv. Aggregation pheromone traps color on the no. of males, females and total caught weevils at Al-Rahba (Abu Dhabi) during 20 December, 2008 to 30 July, 2009.

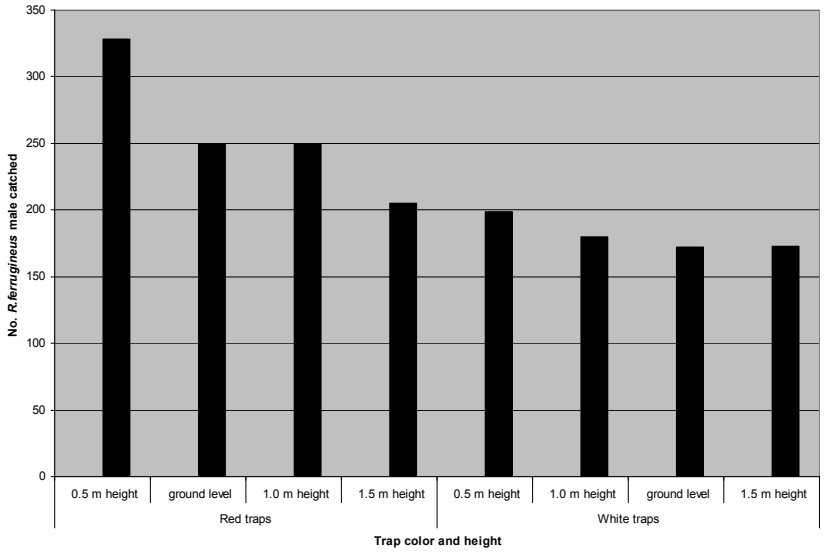

Fig. 4. Effect of *R. ferrugineus* Oliv. Aggregation pheromone traps color on the number of male weevils caught at Al-Rahba(Abu Dhabi) during 20 December, 2008 to 30 July, 2009.

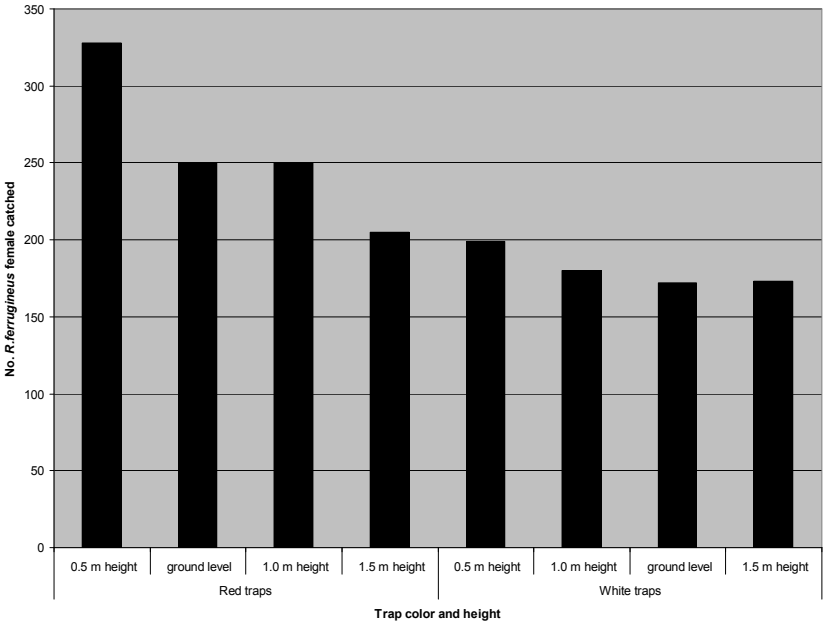

Fig. 5. Effect of *R. ferrugineus* Oliv. Aggregation pheromone traps color on the number of female weevils caught at Al-Rahba (Abu Dhabi) during 20 December, 2008 to 30 July, 2009.

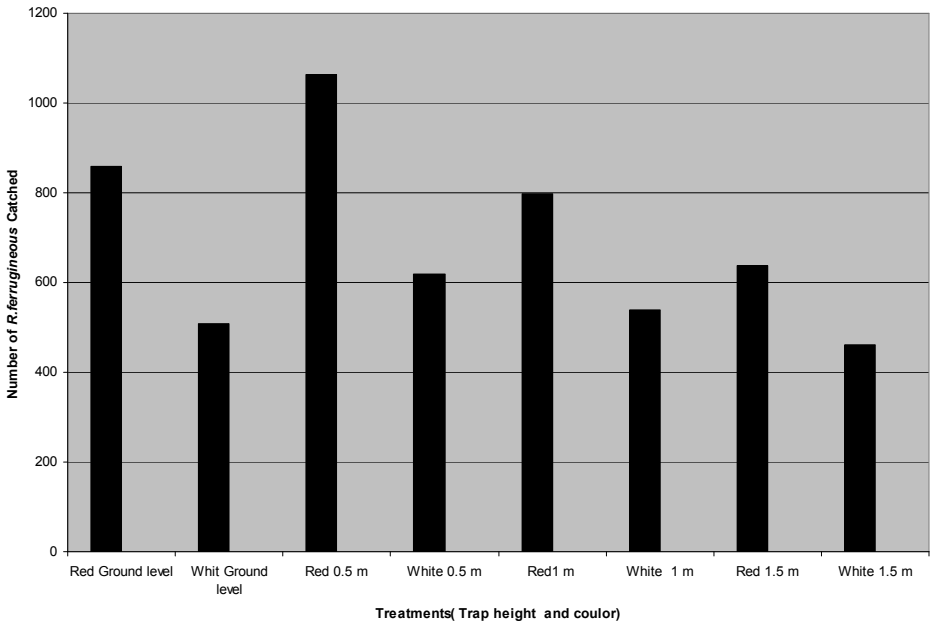

Fig. 6. Effect of *R. ferrugineus* Oliv. Aggregation pheromone traps height and color on the total number of caught weevils at Al-Rahba (Abu Dhabi) during 20 December, 2008 to 30 July, 2009.