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Short Communication

Population fluctuations of the red palm weevil, *Rhynchophorus ferrugineus* Olivier in date palm orchards in southern Kerman

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Abstract

The red palm weevil, *Rhynchophorus ferrugineus* Olivier is one of the key pests of date palm trees worldwide, and its severe damage can lead to the death of the trees. In the present study, the population fluctuations of the adults of this pest were studied in date palm orchards of Anbarabad County, Kerman Province, using aggregation pheromone traps. Weekly sampling was conducted from March 2023 to March 2024. Furthermore, the effect of temperature, as an abiotic factor, on the population fluctuations of the pest was investigated. Based on the results, the first red palm weevil adults in the studied area were attracted to the traps in late March, and the pest population increased gradually to reach its peak in June, July, and August. During the samplings, the number of adult females attracted to the pheromone traps was 2.26 times higher than those of adult males. No adult insects were attracted to the traps from the third week of October to the third week of February. However, the pest activity resumed in March. During the active period of the pest, a significant positive correlation was found between temperature and population fluctuations. Any temperature rise was accompanied by an increase in the number of adult insects attracted to the pheromone traps. In conclusion, the results of this study provided important information about *R. ferrugineus*, including its appearance date in the environment, its activity and inactivity period, and population trends. This information could be valuable for developing integrated pest management strategies in date palm orchards of Kerman Province.

Keywords: pheromone trap, temperature changes, population peak, date palm tree, Integrated Pest Management

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گزارش کوتاه انگلیسی

نوسانات جمعیت سرخرطومی حنایی خرما، *Rhynchophorus ferrugineus* Olivier در نخلستان‌های جنوب کرمان

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چکیده

سرخرطومی حنایی خرما، *Rhynchophorus Ferrugineus* Olivier کلیدی ترین آفت خانواده نخیلات در سراسر دنیا می‌باشد که خسارت شدید آن روی درختان خرما می‌تواند منجر به مرگ آنها گردد. در پژوهش حاضر، نوسانات جمعیت آفت با استفاده از تله‌های فرمون تجمعی (Econex, Spain) در نخلستان‌های شهرستان عنبرآباد، استان کرمان مورد مطالعه قرار گرفت. نمونه‌برداری به صورت هفتگی از فروردین تا اسفند ١٤٠٢ انجام شد. علاوه بر این، تاثیر دما به عنوان یک عامل غیرزیستی بر تغییرات جمعیت آفت نیز مورد بررسی قرار گرفت. بر اساس نتایج به دست آمده، اولین حشرات کامل سرخرطومی حنایی خرما در منطقه مورد بررسی، در اواخر فروردین ماه جلب تله‌ها شدند و جمعیت آفت به تدریج تا رسیدن به اوج خود در ماه‌های خرداد، تیر و مرداد افزایش یافت. طی نمونه‌برداری‌ها، تعداد حشرات کامل ماده جلب شده به تله‌های فرمونی (٢/٢٦ برابر) بیشتر از حشرات کامل نر بود. از اوایل آبان ماه تا اواسط بهمن ماه هیچ حشره کاملی جلب تله ها نشد ولی از هفته سوم اسفند ماه فعالیت مجدد آفت شروع شد. در دوره فعالیت آفت (از فروردین ماه تا مهر ماه ١٤٠٢) همبستگی مثبت معنی‌داری بین تغییرات دما و نوسانات جمعیت آفت وجود داشت. به طوری که، افزایش دما با افزایش تعداد حشرات کامل جلب شده به تله‌های فرمونی همراه بود. در کل نتایج پژوهش حاضر، اطلاعاتی در مورد زمان ظهور، دوره فعالیت و عدم فعالیت حشرات بالغ سرخرطومی حنایی خرما در طبیعت و نیز روند تغییرات جمعیت آن فراهم کرد که می‌تواند در اعمال و توسعه روش‌های مدیریت تلفیقی آفت در نخلستان‌های جنوب استان کرمان قابل استفاده باشد.

کلید واژه‌ها: تله فرمونی، تغییرات دما، اوج جمعیت، درخت خرما، مدیریت تلفیقی آفت

دبیر تخصصی: دکتر آرش راسخ

Introduction

The date palm, *Phoenix dactylifera* L., is a monocotyledonous, perennial, dioecious plant belonging to the Arecaceae family and grows in hot and dry regions of Africa and Asia. The fruit of this tree is an important food source, providing carbohydrates and energy, and holds a special place in the human diet (Hamouda et al., 2020). The use of the fruit leaves and trunk of the date palm in various industries has given this plant a unique position in the industry, economy, and food culture of people in tropical and subtropical regions. Therefore, investing in the development and improvement of date cultivation and harvesting can significantly improve living conditions in these regions (Alotaibi et al., 2019). Among the date-growing provinces in the country, Kerman province ranks second in production after Sistan and Baluchestan province, with a share of 15.8% of the total production (Daman Keshan et al., 2022).

Several pests attack date palms, one of the most important and dangerous being the date palm weevil (RPW) *Rhynchophorus ferrugineus* Olivier (Coleoptera: Dryophthoridae) (Rochat et al., 2017). This insect has a large number of hosts from the Arecaceae family (40 palm tree species e.g. *Areca catechu* L., *Arenga pinnata* (Wurmb) Merr., *Borassus flabellifer* L., *Caryota maxima* L., *C. cumingii, Cocos nucifera* L., *Corypha gebanga* L., *C. umberaculifera, C. elata, Elaeis guineensis* Jacq., *Metroxylon sagu* Rottb., *Oreodoxa regia* (Kunth) O.F.Cook, *Phoenix canariensis* Chabaud, *Ph. dactylifera, Ph. sylvestris, Sabal umbraculifera* Mart., *Washingtonia sp. Chamaerops humilis* L. *and Howea forsteriana* Becc. (EPPO/OEPP 2013; Faleiro et al., 2014). Due to its high reproduction rate and wide distribution ability, the pest can cause substantial damage to date palm orchards in a short period (Faleiro et al., 2014; Rochat et al., 2017; Mohammadpour and Avand-faghih, 2023). This pest has been reported from almost all date palm growing areas in the Middle East, including Kuwait, Qatar, the United Arab Emirates, Saudi Arabia, Oman, and Iraq. (Mohammadpour and Avand-faghih, 2023). In 1980, damage from this pest was first reported in Iran on date palm trees in Saravan city (Sistan and Baluchestan province) (Mohammadpour and Avand-faghih, 2023). Currently, this pest has spread widely and has caused contamination of date palm trees in some areas of Hormozgan, Kerman, Shiraz, and Bushehr provinces, continuing to spread (Mohammadpour and Avand-faghih, 2023). Various biotic factors such as food quality and natural enemies affect the abundance of the RPW population throughout the year, and abiotic factors, especially wind speed, humidity, and environmental temperature also play a critical role in its population fluctuations (Arafa & Barakatt, 2021; Mahmoudi et al., 2021). For example, in Sindh province of Pakistan, the gradual increase in the adult population of RPW began in January, peaked in March, and then began to decline in late December. This increase and decrease in the pest population has been attributed to weather conditions, particularly increased temperature and decreased humidity, which shorten the pest's life cycle and accelerate the emergence of its adults (Manzoor et al., 2020). Furthermore, in Egypt, the adult population of RPW appears in July and peaks in September, influenced by weather conditions (Hamouda et al., 2020). The hidden habitat of RPW larvae inside the tree trunks makes it very difficult to identify damaged trees at the beginning of pest damage and combat this developmental stage (Mohammed et al., 2021). Therefore, focusing preventive and control measures on the adult stage of the pest can effectively avoid adult pest egg laying and consequently, reducing larval feeding and damage. (Ramezani, 2009). Pheromone

traps are commonly used to study population monitoring, population fluctuations, and pest population control in integrated management (Aliakbari et al., 2022). These traps (e.g., sex pheromones of female insects) attract adult males (Kermani et al., 2014). Using the pheromone derived from the aggregation pheromone produced by male insects, in which the substance ferrugineol (Hallett et al., 1993) attracts both males and females adult insects of the same species (Poorjavad et al., 2009; Mohammadpour et al., 2011; Al-Shawaf et al. 2012; Hoddle et al., 2013; Aghajari et al., 2024).

Materials and Methods

A Study on the population fluctuations of *R. ferrugineus*, was conducted during one year (March 2023 to March 2024) in two date palm orchards (cv: Mazafati; latitude 31.57035 and longitude 58.1752) in Anbarabad county, Kerman, Iran. The distance between orchards was 2000 meters. In each hectare of the date palm orchards, four window plastic bucket traps with a holes diameter of 4 cm and a capacity of 10 liters were installed. The traps had no holes on the lid to prevent rainwater from entering. The aggregation pheromone of RPW was provided by Econex Company (Spain) and was used in combination with a mixture of date fruit (100 - 200 grams) as bait and one liter of water for fermentation to optimize the synergy between the bait and pheromone. To aid in insect entry into the traps, the traps were red color with an outer surface covered in palm tree trunk fiber. Additionally, the traps were placed on the ground under the shade of old trees (4 meters from the trunk,) with about half of the bucket trap buried in the soil. The traps were checked once a week and the number of insects caught was recorded.

To maintain the effectiveness of attracting insects, the pheromone and water inside each trap were replaced every 15 days. To examine the relationship between environmental conditions and RPW fluctuations, temperature data were collected from the regional meteorological station.

Regression analysis was conducted using SPSS software to determine the relationship between temperature and RPW population fluctuations.

Results

The trend of population fluctuations in RPW adults, during weekly sampling from the last week of March 2023 to the last week of March 2024 in the palm orchards of Anbarabad County is shown in Figure 1. The first appearance of adult male insects was from the first week of April (2023.04.08) and adult females were from the second week of May (2023.05.13). The peak attraction of adult females to pheromone traps was between June and August (2023.06.18 - 2023.08.06). During these three months approximately, pheromone traps caught 1.45 adult insects. From the fourth week of October to the third week of February (2023.10.22 - 2024.02.25), the emergence of adult insects, or the number of insects attracted to pheromone traps, completely stopped. However, in the second week of March (2024.03.10), pest activity resumed, accompanied by the emergence of one adult female insect. The results showed that during the sampling period, by pheromone traps compared to males (Fig. 1) caught a greater number of female insects (2.26 times).

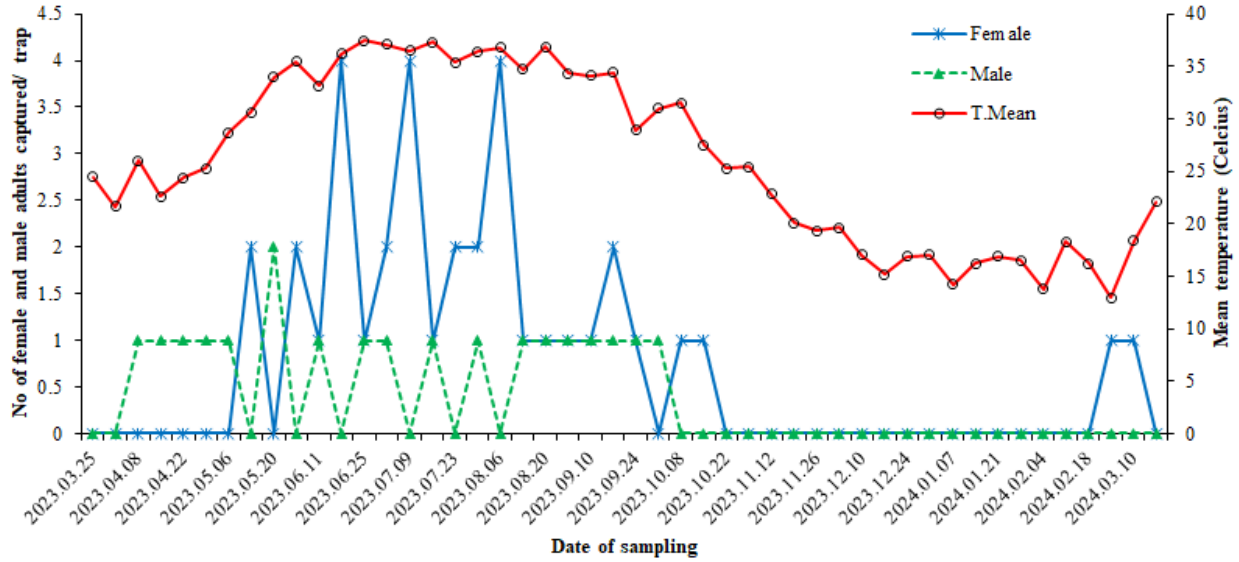


Figure 1. Population fluctuations of the red palm weevil (*Rhynchophorus ferrugineus*), during weekly sampling from the last week of March 2023 to March 2024 in date palm orchards of Anbar Abad County (south of Kerman, Iran), using aggregation pheromone traps.

Data on the mean daily temperatures during the sampling period from March 2023 (2023.03.25) to March 2024 (2024.03.17) in the palm orchards of Anbarabad County are shown in Figure 2. The mean daily temperature began to increase from the last week of March (2023.03.25). From the second week of May (2023.05.13) to the second week of October (2023.10.08), the mean daily temperature was above 30 ºC. The highest mean daily temperature recorded occurred in July, reaching above 36 ºC. From mid-October, the temperature gradually decreased. Therefore, from the second week of November (2023.11.19) to the first week of March (2024.03.01), the mean daily temperature was less than 20 ºC. After this time, the temperature began to increase gradually (Fig 2).

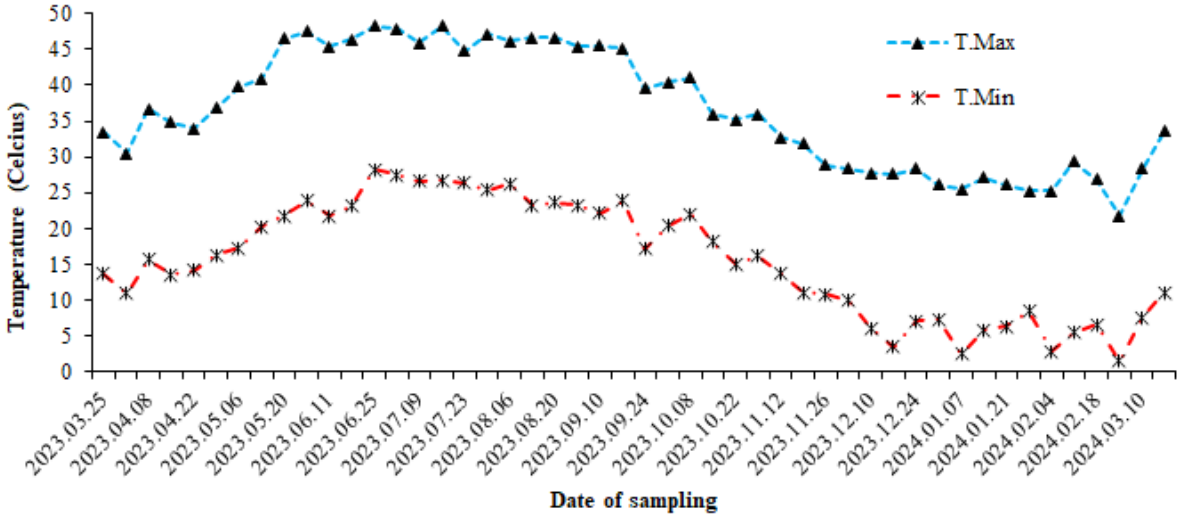


Figure 2. Temperature changes during sampling date from March 2023 to March 2024 in Anbar Abad County (south of Kerman, Iran).

As shown in Table 1, based on the calculated Pearson coefficient (r = 0.848), there was a very good correlation between insect population fluctuations and temperature changes. Additionally, according to the results, the slope of the regression line with zero fitted, is statistically significantly different (F=117.792; df= 1, 47; P<0.001), so the equation results can be used to predict population fluctuations. The calculated coefficient of determination (R^2=0.719) showed that more than 70 percent of insect population fluctuations can be predicted based on temperature changes.

Table 1. Regression analysis of relationship between the number of *Rhynchophorus ferrugineus* adults and mean daily temperature throughout the year.

	b ± SE	a ± SE	Pearson Correlation	R^2	F-statistic	df's	Beta	Sig.
Mean Temp. – Adult Num.	**0.128±0.012**	**-2.194±0.322**	**0.848**	**0.719**	**117.792****	**1: 47**	**0.848**	**<0.001**

*Significant difference at the probability level of P<0.001

Discussion

Based on the results, the abundance and fluctuation of RPW population varied during the sampling period in different months of the year. The pest activity began gradually with the emergence of adult males in April and adult females in May, continuing until the third week of October. Adult females' peak attraction to pheromone traps was between the second week of June and the first week of August. After this period, the pest population gradually decreased until no adult insects were observed inside the traps. However, the pest's reactivation occurred towards the end of the sampling period, in the third week of March. Therefore, this pest is active in Anbarabad County during the year's warm months and in a single generation. Similar to the results of the present study, it was reported that the population density of the RPW was higher in the warm summer months than in the cold winter months (Arafa & Barakatt, 2021). A study of pest demography in laboratory conditions by Payandeh and Dehghan (2010) also showed that the RPW is a single-generation species, confirming the results of the present study. Manzoor et al. (2020) also studied the population dynamics of RPW in different provinces of Pakistan and reported that the highest percentage of pest infestation with an average damage of 7-17% was in the provinces of Sindh, Dekhan and Balochistan. The peak of the pest population was recorded in their study in different provinces in the months of April, May and June. In the present study and recent studies, the increase in trap capture rates considered the peak of the pest population, can most likely be attributed to the emergence of adults from offspring that have completed their development period, especially in the cold months of the year. However, the difference in the time of emergence and the peak of the adult population of the RPW in all these studies may be affected by various factors, such as differences in the type of cultivar, age, density and quality of the date palm tree affecting the pest population. For example, Farazmand et al. (2001) reported that date palm trees aged 5-20 years are more susceptible to the RPW due to their ability to produce suckers. Additionally, a high density of date palm trees in the palm orchard increases the pest population because the pest prefers to be more active in humid environments. The difference in volatile compounds of date palm cultivars also increases the attractiveness of date palm trees and the pheromone attraction (Farazmand et al., 2001). Pest population fluctuations are likely due to differences in the geographic

location of pest activity (Manzoor et al., 2020), influenced by factors such as climatic conditions and genetic differences in pest populations.

During the sampling period, the number of adult female insects attracted to pheromone traps was higher than that of adult male insects. The highest number of adult male and female insects attracted to the traps occurred when the mean daily temperature was above 35 Cº. A similar result was reported by Mohammed et al. (2021) for female RPWs, attributing it to the higher sensitivity of female adults to the aggregation pheromone compared to adult males. The antennae of adult female RPWs have more sensory receptors than those of adult males, and these sensory receptors are highly sensitive to the aggregation pheromone (Avand-Faghih, 2004). Additionally, the instinctive exploratory behavior of mated females to find new oviposition sites makes these insects more responsive to the aggregation pheromone than males (Poorjavad et al., 2009).

The present study showed that adult insect emergence in Anbarabad County does not occur throughout the year, and its activity depends on the average daily temperature. Below 25 ºC at the beginning of sampling and during the cold months of the year, the pest did not show a tendency to be active. However, as soon as the temperature increased above 25 ºC, adult insects emerged.

Conclusion

The study's results provided information about the population fluctuations of the RPW and the impact of environmental conditions on the pest's abundance. This information can help determine the best time to combat the RPW and the trend of pest population changes for its control, especially through mass trapping by increasing pheromone traps in palm orchards. Additional studies are necessary to develop better management methods for this pest by investigating the effect of other biotic and abiotic factors on the fluctuations of the RPW population, as well as studying the pest's biology in the orchards of South Kerman.

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