Middle East Journal of Agriculture Research
Volume: 13 | Issue: 02| April – June| 2024

EISSN: 2706-7955 ISSN: 2077-4605
DOI: 10.36632/mejar/2024.13.2.16
Journal homepage: www.curresweb.com
Pages: 269-287

Population density and host preference of the date stone beetle, *Coccotrypes dactyliperda* (Coleoptera, Curculionidae, Scolytinae) in date palm farms as well as the efficacy of some trap attractants in Sharkia Governorate, Egypt

El-Shafei W.K.M.[1], Mesallam T.[2] and Batt M. A.[2]

[1]Department of Date Palm Pests and Diseases, Central Laboratory for Date Palm, Agricultural Research Center, ARC, Giza, Egypt.
[2]Plant Protection Research Institute, Agricultural Research Center, Dokki, Giza, Egypt.

Received: 22 Feb. 2024 **Accepted:** 30 Mar. 2024 **Published:** 20 April 2024

ABSTRACT

Date palm fruits are considered among the most important fruits grown in Egypt, the Middle East, and North Africa. These fruits are susceptible to infestation by large number of insects. One of the most important of these insects, which has spread widely recently, is the date stone beetle *Coccotrypes dactyliperda* Fabricius (Coleoptera, Curculionidae, Scolytinae), which infests immature, mature and stored date fruits, causing them to fall and the loss of a large portion of the crop. The effect of some weather factors, such as maximum and minimum temperature and relative humidity on the insect population during the two years of the study, was also studied. The *C. dactyliperda* host preference was also evaluated on date stone of 13 Egyptian palm cultivars and the date stone components of some types of tested cultivars were also analyzed. A comparison was also made between the effectiveness of 13 substances and a mixture of field trap attractants for the *C. dactyliperda* adults. The findings demonstrated that, for each of the two examined years (2021/2022 and 2022/2023), the population density of *C. dactyliperda* recorded two peaks of the three insect stages, larvae, pupae and adults. For each of the two study years, the first peak occurred in December and the second peak occurred in October in the fallen date stone under the palm trees. The results also recorded a peak in the infestation rate in immature green date fruits in mid-July of each year of the study. Results regarding the influence of weather factors were found that the partial correlation coefficient for the maximum temperature, minimum, and relative humidity was low value compared to the partial correlation coefficient between the insect population and the presence of date fruits at the appropriate time for infestation, which recorded a high value, which increased much more when calculating the combined partial correlation coefficient between the presence of green fruits, weather factors, and insect populations and infestation rate. The host preference results showed that the date stone of the Hayani cultivar was the most preferred by *C. dactyliperda* adults, followed by the Frarhi cultivar and then the Medjool cultivar, while the least preferred cultivars were the Sakkoti and Bartamouda cultivars. The results showed that the content of the date stone of Hayani cultivar, which was the most preferred by insects, was higher in total carbohydrates and proteins, and its content was lower in total phenols and flavonoids, in contrast to the same content of the Bartamouda cultivar, which was the least preferred by insects. It was also found that applying ethyl acetate or date stones resulted in the highest average number of adults was collected without a significant difference between them, while the lowest average number of insects was attracted to traps containing date fruits alone or mixed to any other tested volatile substance. Therefore, we recommend removing and disposing of the fruits and date stone that have fallen on the ground under the palm trees after collecting the crop so that they are not a source of re-infestation by the date stone beetle in the following year and to reduce its population in the field.

Keywords: Date palm stone, *Coccotrypes dactyliperda,* population density, weather factors, host preference, trap attractants.

Corresponding Author: Wael Kamal Mohamed El-Shafei, Department of Date Palm Pests and Diseases, Central Laboratory for Date Palm, Agricultural Research Center, ARC, Giza, Egypt.
E-mail: waelkamal27@yahoo.com, Orchid number: 0000-0002-9746-7832

1. Introduction

Phoenix dactylifera (Linn.), also known as the date palm, is one of Egypt's most lucrative fruit crops since its fruits are widely regarded as a balanced diet and its various parts are utilized in many handcrafts in villagers (El-Lakwah *et al.,* 2011; El-Shafei 2011; Zinhoum and El-Shafei 2019: Abd El-Wahab *et al.,* 2020; El-Shafei *et al.,* 2022). Date palm tree infestations with various insect pests can result in a significant decline in tree yield, both in terms of quantity and quality (El-Shafei *et al.,* 2019; Assous *et al.,* 2022; Mahmoud *et al.,* 2022). These pests target many tree sections, including the roots, trunk, fronds, and fruits (El-Shafei 2015; El-Shafei *et al.,* 2018; El-Shafei 2020). One of the most important insect pests that infest date palms is the date stone beetles (DSB), *Coccotrypes dactyliperda* Fabricius (Coleoptera, Curculionidae, Scolytinae). The infestation of this insect has spread in the areas where palm trees originate and its cultivation has spread historically and geographically in North Africa and the Middle East in ancient times. Due to the spread of the trade in dates for human consumption among the countries of the world, as well as the spread of the export of its products, such as date stone, especially canary palm , *Phoenix canariensis* stone which are used to make buttons on clothes, they have spread in recent days in most regions of temperate and semi-tropical temperatures (Spennemann, 2018) .The date stone beetles infests green date palm fruits in the khelal stage and punctures them to enter and feed on the date stone, which causes the fruits to fall within days (Blumberg, 2008). Some researchers estimated the percentage of losses as a result of date fruits being infested with this insect at 20 to 40% (Kehat *et al.,* 1976; Hussein, 1990). *C. dactyliperda* also infests date stone that have fallen on the ground after the outer covering of the fruit has been eaten away, whether due to decomposition or animals and rodents feeding on it. The date stone beetle also infests other types of palm trees, including in particular the canary palm (*Phoenix canariensis* Chabaud, 1882) (Spenemann 2019). El-Shafei (2018) recorded the infestation of fallen dates for 3 cultivars of fresh date palms group (Zaghloul, Samani, and Amhat) with the DSB in his survey in Giza Governorate. It has been noted that published researches regarding seasonal activity, population density, and population dynamics of *C. dactyliperda* is very limited and also outdated and has not been updated. For example, in Egypt, there were Metwally *et al.,* (2002) in Kafr El-Sheikh governorate and El-Barbary *et al.,* (2002) in the northern Delta region (Rashid, Idku, and Burj Al Arab).There are no ancient or modern studies on this beetle in Sharkia governorate, which is one of the important areas for date production in Egypt .Therefore, in view of the urgent need to know the population density of the date stone beetle throughout the year, as well as the rates of its infestation in date fruits and stones, in order to plan and prepare an integrated management program for it, this research aimed to study the population density of the date stone beetle in the fallen date stones under palm trees and study the extent to which it is affected by various climatic factors Al-Qurain region in Al-Sharqiya governorate, as well as the rates of insect infestation on date stone beetle throughout the year and on fallen date fruits during the fruit growing season. Also evaluated the *C. dactyliperda* host preference on date stone of 13 Egyptian palm cultivars and comparing between the effectiveness of 13 substances and a mixture of field trap attractants for the *C. dactyliperda* adults.

2. Materials and Methods

2.1. Experiments location

Field experiments were carried out on a palm farm of the Hayani cultivar in the Al-Qurain Center in Sharkia governorate, Egypt, (30°36'16.0"N 31°44'47.7"E) during two consecutive years 2021/2022 and 2022/2023 (from October 26 to October 17of the following year for each of the two years of the study).

2.2. Population density of the date stone beetle in fallen date stone under palm trees during 2021/2022 and 2022/2023:

This experiment was conducted for two consecutive years in 2021/2022 and 2022/2023, where 100 date stone (100 replicates) of the Hayani cultivar were taken weekly from the bottom of the palm trees from the date stone of the previous year to estimate the number of insect stages, larvae, pupae and adults in each date stone to calculate its population densities.

2.3. Estimating the infestation rate of the date stone beetle in fresh date fruits falling under palm trees during the fruiting season:

This experiment was conducted during the date fruiting period, during the period from May 30 to October 17 of each year of the study during two consecutive years, 2021/2022 and 2022/2023, where 100 date fruits of the Hayani cultivar were taken from the bottom of the palm trees to estimate the rate of infestation with the date stone beetle as shown in Fig. (1).

Fig. 1: Infestation symptom of immature and stored date fruits by *C. dactyliperda*

2.4. Climate factors

The Central Climate Laboratory, Agricultural Research Center, Egyptian Ministry of Agriculture, located in Dokki, provided the mean percentage of daily relative humidity as well as the highest and lowest daily temperature degrees for the Sharkia governorate. It is believed that these meteorological factors affect the insects under investigation. The data that was gathered was compiled for every seven-day window leading up to the sample date. The weather factor means across each determined generation are computed and shown.

2.5. Host preference of date stone beetle on 13 date palm cultivars

In a laboratory test, the adults were given the choice of feeding between the date stones of 13 date-palm cultivars cultivated in all over Egypt. This experiment was conducted laboratory-based for a month in the laboratory of the wood-burning department at the Plant Protection Research Institute in Giza, and the examination was carried out in the date palm pests and diseases department in the central laboratory of date palm at the Agricultural Research Center in Giza, at the laboratory temperature, on 13 cultivars of healthy, (infestation-free date stone representing the three main groups of date palms in Egypt). It is the group of fresh cultivars, which is represented by (Barhi, Samani, Bent-Eisha, Amhaat, Zaghloul and Hayani) cultivars, the group of semi-dry cultivars, which is represented by (Siwi, Aglani , Medjool and Amri) cultivars, and the group of dry cultivars, which is represented by (Sakkoti, Bartamouda and Frahi) cultivars. Each cultivar was marked with a specific color from the other cultivars, and 20 date stone from each cultivar were mixed together in a two-liter glass jar with a tightly sealed perforated lid. 260 adult females of date stone beetle adults were placed on them, and the insects and date stone were gently stirred, with five jars as replicates, and the insects were allowed to feed upon them in a free-choice test under laboratory condition (20±2 C° & 70±5% Rh). After a month, all the date stone were examined, and the number of holes in each cultivar (Fig.2), the infestation rate, and the number of different stages (Fig.3) were estimated and recorded.

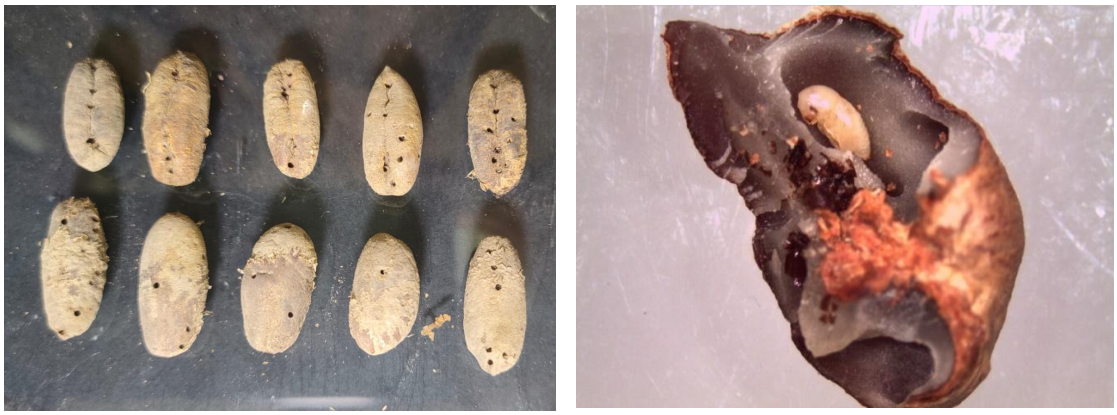

Fig. 2: Holes and symptom of infestation of date stone ,Siwi cultivar by *C. dactyliperda* adults

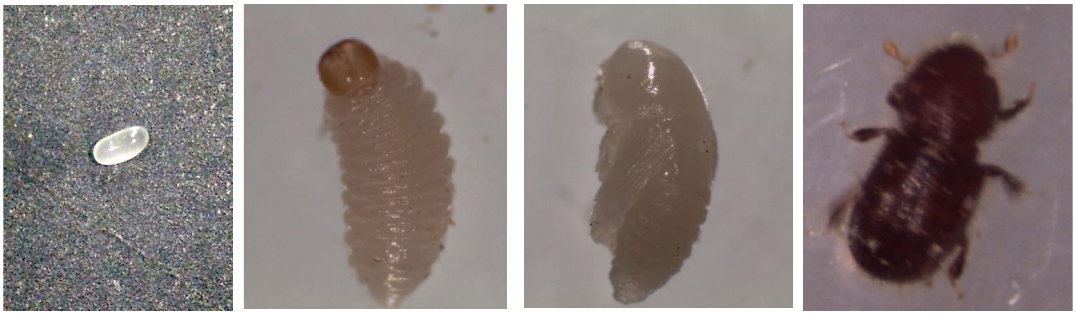

Fig. 3: *C. dactyliperda* stages (Egg, larva, pupa and adult).

2.6. Chemicals analysis of tested date stone cultivars:

For studying the relationship between the degree of date stone tested cultivars infestation by DSB and some phytochemical components of the date stones such as: total carbohydrate, total protein, total phenols, total flavonoids and PH were estimated at Chemical Analysis Constituent, Insect Physiology Department, Plant Protection Research Institute according to the methods of Crompton and Birt (1967); Bradford (1976); Singleton and Rossi (1965) and Zhishen *et al.,* (1999), respectively.

2.7. Comparison of some types of materials and mixtures that attract the date stone beetle used in field trap

The effect of 13 trap attractants on DSB catches was evaluated. This experiment was conducted on a date palm farm in the Al-Qurain Center, Sharkia governorate, Egypt, for a year during the period from October 2022 to October 2023, using plastic traps**.** The trap consists of a 200 ml plastic bottle, its height is 11 cm, its diameter is 6 cm, and its opening at the top is 3 cm in diameter. It has a tightly closed lid with a diameter of 4 cm. It is used to check the trap and change and supply the attractant. Five holes with a diameter of 0.5 cm were made at the top of the trap at a height of 9 cm from the base. Inside the trap, a tube 6 cm long and 0.8 cm in diameter was suspended in the lid, inside which the attractant was placed. The tube was closed with a small, permeable piece of cotton. The trap is buried in the surface of the soil up to the beginning of the holes in the trap so that insects can enter the trap easily and safely. The traps were placed next to the palm trees on the farm, at a distance of 25 meters between each trap, and three replicates were used for each material as shown in Fig, (4).

The attractants (trap components) were changed or supplied weekly. The volatile liquid attractants were placed inside the suspended tube, and 50 ml of water was placed at the bottom of the trap to prevent insects from leaving after they entered , which is acetone, Ethyl alcohol , ethyl acetate and vinegar at a concentration of 5%,while the mixtures were (ethyl acetate + date stone), (acetone + date stone), (Ethyl alcohol + date stone), (ethyl acetate + date fruits), (acetone + date fruits), (Ethyl

alcohol + date fruits), and both date stone (15) and date fruits (5)were evaluated alone . All treatments were compared to the control (a trap containing only water).

2.8. Types of attractants tested in date stone beetle traps.

1 Ethyl acetate ($C_4H_8O_2$)
2 date stone
3 Vinegar (Acetic acid)CH_3COOH
4 Ethyl acetate + date stone
5 Acetone + date stone
6 Ethyl alcohol + date stone
7 Ethyl alcohol (CH_3CH_2OH)
8 Acetone ($(CH_3)_2CO$)
9 Acetone + date fruits
10 Ethyl acetate + dates date fruits
11 Ethyl alcohol + date fruits
12 Date fruits
13 Control (water only)

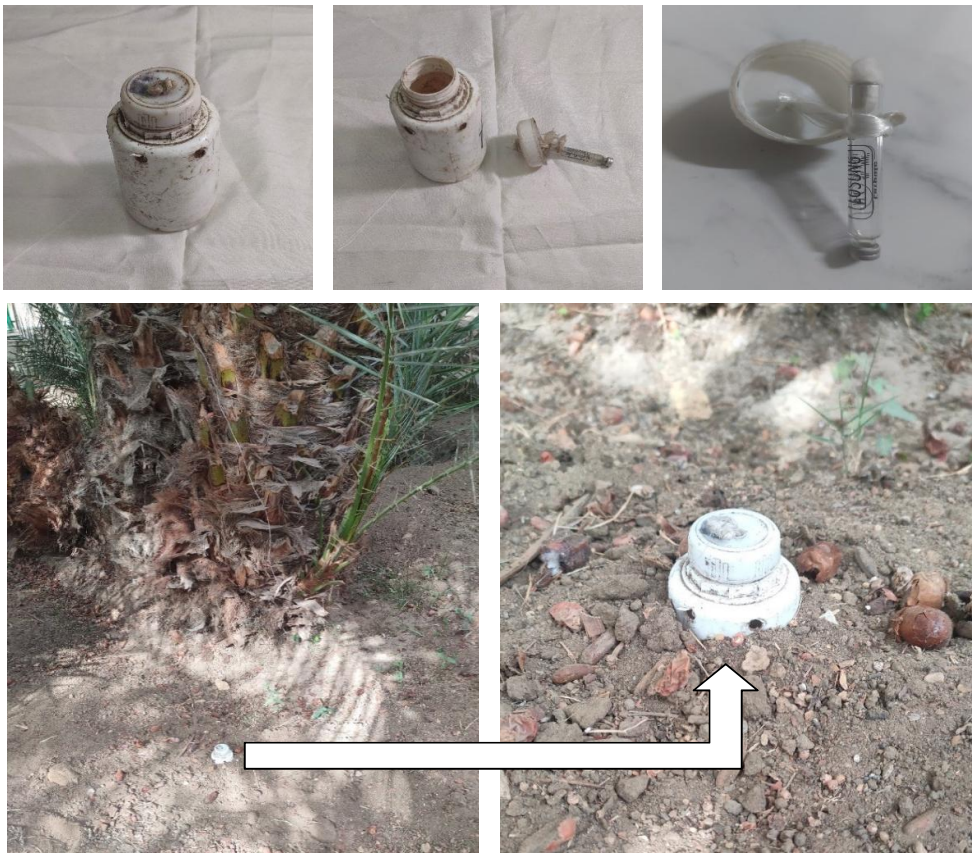

Fig. 4: Trap of *C. dactyliperda a*dults in field

2.8. Data analysis

Obtained data was analyzed as (one/two way/factorial) ANOVA, using Proc ANOVA in SAS, and means were compared by LSD (P= 0.05 level) in the same program. Procs Corr and Reg in Statistical Analysis System (2003) were used. Weather data was adjusted using running means ((a+b+c)/3) to reduce recorded variability over time. Field sampling data was adjusted using running means ((a+b+c+d+e)/5) to reduce recorded variability (sampling errors) over different counts, before conducting statistical analysis. Weather factors (i.e. maximum, minimum temperatures and %RH were considered as linear ones) as partial regression. Host age in weeks was used to emulate host available nutritional value change over the considered durations as third degree polynomial model (i.e. Age, Age2 and Age3). The multiple polynomial equation becomes

Y= a ± b1 Tmax ± b2Tmin ±b3 RH %± b4 Age ± b5 Age2 ± b6 Age3 according to Abou–Setta (2020).

3. Results and Discussion

3.1. Population density of *C. dactyliperda* on fallen date stone Hayani cultivar from 2021 to 2023:

Population density of *C. dactylperda* was monitored over 2 years (104 weeks) starting from Oct. 26, 2021 to Oct. 17, 2022 in the fallen date stone from the previous year of date palm Hayani cultivar which belong to fresh cultivars group in El Korain, Abo-Hammad region at Sharkia governorate were presented graphically in Fig. (5) and the corresponding weather factors in Fig. (6). Data indicated the weekly variance in the mean population density of the *C. dactyliperda* larvae, pupae and adults (from October 26, 2021 until October 17 ,2023). The larvae, pupae and adults populations' fluctuation trends were quite comparable. In light of this, it is preferable to discuss population densities based on the total average number of larvae, pupae and adults counted at subsequent sampling dates.

The initial total mean count of different insect stages (larvae, pupae and adults) Fig. (3) started by 8 individuals/week in the end of October then, in November ranged from 16.46 to 30.38 individuals/week on date palm cultivar, Hayani. These individuals count gradually increased in December to record the 1st peak on December 21,2021 with mean population of 36.51 individuals/week under field conditions of 17.05, 10.14 ºC and 52.68 %R.H for maximum, minimum and relative humidity, respectively. In the rest of December and January,2022, the insect populations decreased quietly to 23.79 individuals/week in the end of January. From February to May,2022 the population gradually decreased again with relatively low population to reach mean population of 0.01 individuals/week on May 17 ,2022 at 34.29, 22.71 ºC and 48.68 %R.H for maximum, minimum and relative humidity, respectively. Then the mean count of the *C. dactyliperda* population on the tested date stone settled at the lower limits every week from the End-May until the end of August. The mean number of insects gradually increased again in the beginning of September, to record the second peak of insect activity at the end of October, with an average population of 41.52 individuals/week on date palm cultivar, Hayani at 27.29, 19.57 ºC and 62.07 %R.H, respectively. Insect mean populations quickly started to decrease again in November,2022 to record 29.78 individuals/week at the third week of November. The mean count of individuals, larvae, pupae and adults populations in the end of November start to grow and it continued to grow at the first two weeks of December to reached its first peak of the second season in third week of December, with a mean population of 38.94 individuals/week on date palm cultivar, Hayani at 23.71, 13.57 ºC and 70.29 %R.H for maximum, minimum and relative humidity, respectively. Then there was a decrease in the insects population starting from last week of December 2022 and continued throughout January, February, March, April and The first two weeks of May,2023 to reach very low populations 0.02 individuals/week at the second week of May. Then, from mid-May until the second week of September, there was very low record of DSB population on the tested date stone, followed by a significant increase from the third week of September 2023, to record its second peak for this year at the third week of October with an average of 23.59 individuals/week at 29.29, 20.71 ºC and 67.95 %R.H.

3.2. The percentage of infestation by the date stone beetle in fallen date fruits during the fruiting season of the Hayani cultivar during 2021 to 2023

The rate of DSB, *C, dactyliperda* infestation in freshly fallen dates was examined during the studied years 2022 and 2023, during the fruit growth period until after harvest, from May 30 to October 17 of each year of the two studied years. The results obtained in Fig. (5) confirmed the occurrence of *C, dactyliperda* infestation in fallen date fruits of the Hayani cultivar throughout the inspected period, every week during the two years of the study, starting from May 30 until October 17. The insect infestation recorded one peak of infestation rates during each year of the two years of the study, where it was in the week of July 18 for the year 2022 and on July 11 for the year 2023. The infestation rates by the DSB began to be low at the beginning of the new fallen fruit season on May 30, with rates of (1 and 2%) for the years 2022 and 2023, respectively. Then infestation rates increased rapidly and sharply until they reached the highest peak in infestation rates on July 18 and 11, where they were recorded (68 and 76%) for the years 2022 and 2023, respectively. Then the infestation rates gradually decreased in both years of the study until they reached rates (5 and 3%) in the week of September 19 in both years of the study. Then it began to gradually increase to reach (8 and 5%) on September 26 for both study

years, then it decreased to record the lowest value at the end of the examination period (1 and 3 %) on October 17 for both years of the study.

It is noticeable from the results obtained and shown in Fig.(5) that the stages of the DSB insects are present in the fallen stones from the previous year under the palm trees during the winter period from the end of October, and their number increases until they reach their highest peak in the third week of December of the first year, then the number decreased gradually in the winter and through the spring as well, reaching the lowest number of insects in the infested date stone in the second week of July of the first year. Until its preferred host appears at the appropriate age for infestation, which is immature green date fruits a month after setting, then the insects moved to the fruits and cause them to fall from the end of May until October during the period of fruit growth and even after harvest, as the rate of infestation in the fruits begins to increase from the end of May until it reaches the highest infestation rate and recorded the highest peak in the first year, which is in the second week of July for the first year, then it decreased to reach the lowest infestation rate in the third week of October for the first year, noting that the number of insects in the date stone is very small and stable during the period of insect infestation of the fruits, and then the insects move again to the date stone. The infestation occurred in late October of the second season, so that it remained there throughout the winter in the second season and achieved two peaks in the fourth week of December and the third week of October for the second year in the study. The insect population decreases again until it reaches the lowest insect population in the date stone in the second week of May for the second year. The number in the date stone remained low at the lowest level until the second week of September for the second year. While, in parallel, at the same time that the number in the date stone decreased, it was found that the infestation rate in immature date fruits increased from the end of May until it reached its highest infestation rate in the second year, during the third and fourth weeks of July for the second year, until it decreased until it was nonexistent in the third week of October. From the second year. On the other hand, we find that the insect population in the date stone, which was recorded at the lowest number from the beginning of May until the middle of September of the second year, during the transmission of the insect infestation to green immature date fruits, it was found that this population began to increase in the date stone from the end of September until the third week in October.

The current results are consistent with Hussein (1990) in Bahariya Oasis in Giza governorate, Egypt who recorded DSB infestation on immature green dates of threecultivars: Saidi, Sultani, and Kakia. El-Sharif *et al*. (1998) recorded the infestation of date fruits with DSB during the period from April to December in the North Sinai governorate in Egypt. And Salim (1999) in Sharkia governorate, Egypt, found that the number of DST in the fallen date stone under palm trees recorded its highest numbers in early November for both the years of the study 1994 and 1995. He also pointed out that the infestation of date fruit with the DSB appeared during the date fruiting season, from July until the end of the fruiting and harvesting season. As well as Metwally *et al*. (2002) recorded the DSB infestation on both fallen fruits and date stone in the Kafr El-Sheikh governorate in Egypt in the period from July to December during the years of the study. While EL-Barbary *et al*., (2002) in both Edku and Rashid in the northern Delta of Egypt, found that the DSB was present on both cultivars of Samani and Zaghloul in the two areas of Edku and Rashid throughout the period of date fruiting, and it led to high losses, and the highest incidence of DSB was in mid-August in the two regions. Bibars *et al*. (2018) also recorded the infestation of DSB in the survey he conducted in nine governorates in Egypt, and found it infesting green dates after the set and causing them to fall. Likewise, El-Shafei (2018) recorded the DSB presence from July to October during the two years of the study in fallen date fruits under three cultivars of date palms, Zaghloul, Samani, and Amhat, in Giza governorate, Egypt.

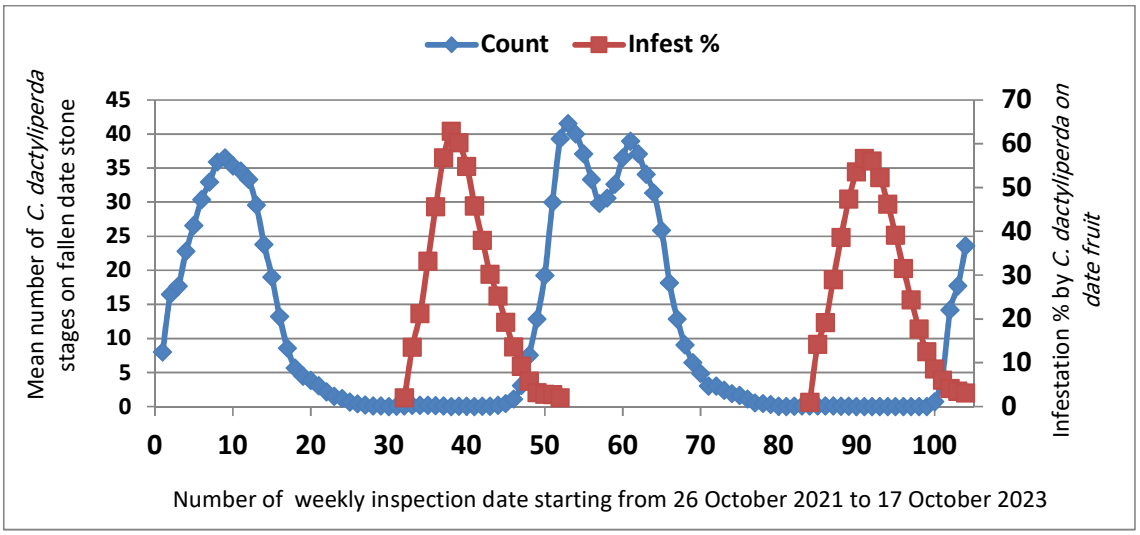

Fig. 5: Weekly mean counts of different *C. dactylperda* stages in fallen date stone and date fruits infestation % along the study period starting from Oct. 26, 2021 to Oct. 17, 2023.

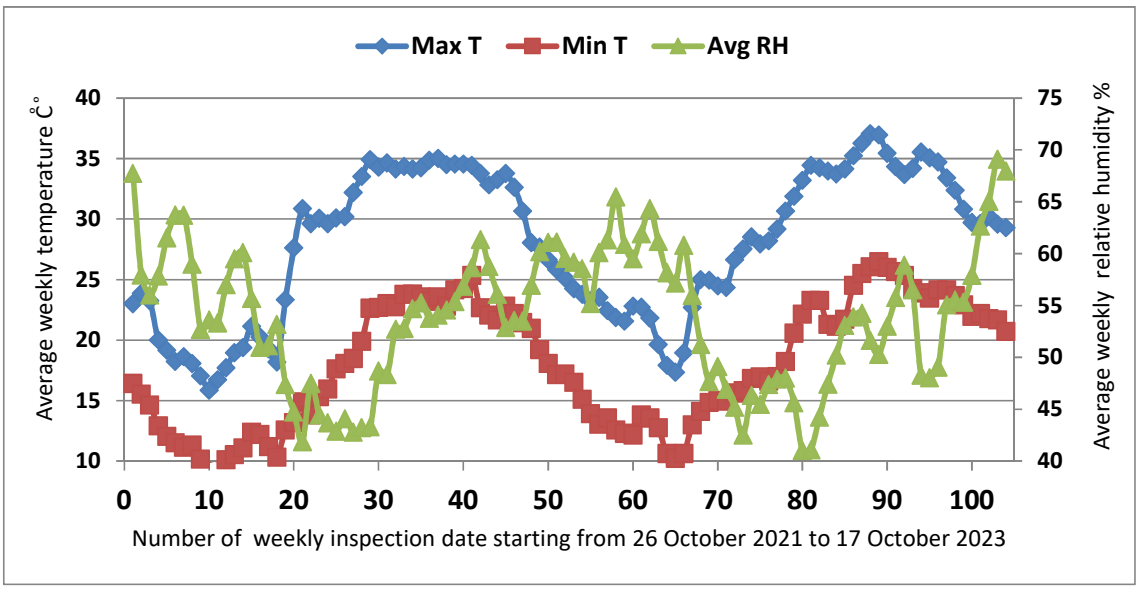

Fig. 6: Weekly mean counts of weather factors along the study period, starting from Oct. 26, 2021 to Oct. 17, 2023

3.3. Date stone beetle different stages in the date stone and infestation % in fallen fruits over the study duration (2021 to 2023)

Current results revealed that the DSB stages in fallen date stone indicated significant activity during Oct. 26, 2021 to Apr. 5, 2022 in the first year (2021/2022) and Sept. 13, 2022 to Feb. 21, 2023, in the second year (2022/2023). While other durations showed very minimal occurrence. Infestation percentage in susceptible fallen date palm fruits occurred during May 31, 2022 to Oct. 18, 2022 and May 30, 2023 to 17 Oct. 17, 2023, respectively. Means of different stages over the study duration and percent infested fruits are presented in Table (1). Age structure of DSB different stages in dropped samples is illustrated in Fig. (7).

Table 1: Means of different stages along the two years of the study period and infestation % in fallen fruits.

Year	Duration	Variable	Date stone samples			Duration	Variable	Infestation % of date fruits
			Larvae	Pupae	Adults			
First	Oct. 26, 2021 to Apr. 5, 2022	Maximum	16.86	5.90	21.31	May 31, 2022 to Oct. 18, 2022	Maximum	62.80
		Minimum	7.03	2.22	9.32		Minimum	26.09
		SD	6.20	2.12	6.71		SD	21.35
Second	Spt. 13 2022 to Feb. 21. 2023	Maximum	16.35	11.34	19.50	May 30, 2023 to 17 Oct. 17, 2023	Maximum	56.64
		Minimum	8.65	4.45	9.74		Minimum	26.89
		SD	5.81	3.51	6.07		SD	19.73

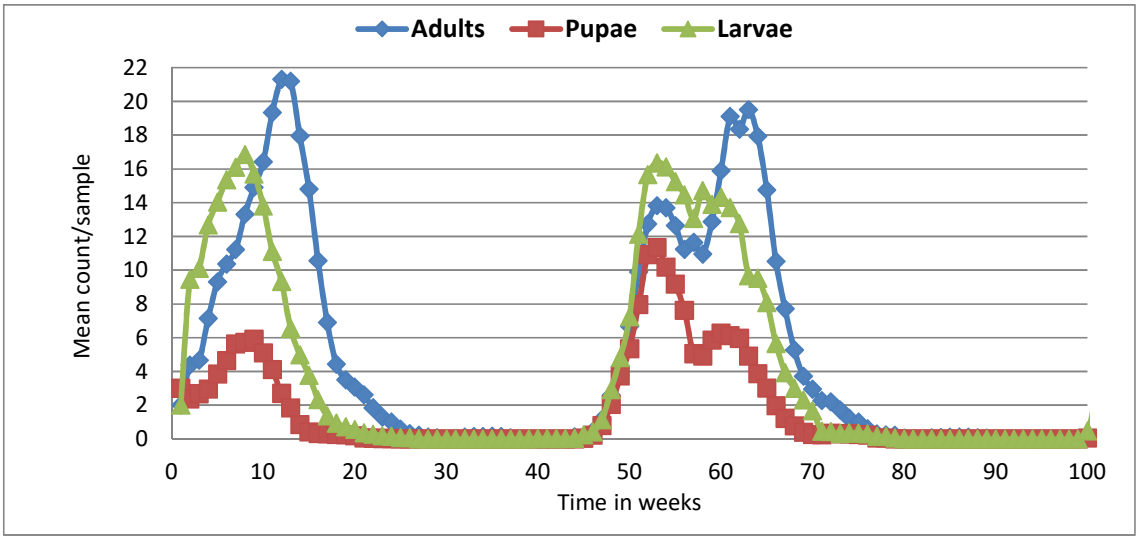

Fig. 7: Age-structure of *C. dactyliperda* stages in fallen date stone samples.

3.4. Effect of weather factors on the population density of *C. dactyliperda* on Hayani date palm cultivar from October 2021 to October 2023

Obtained pest densities over two years of study on Hayani palm cultivar are presented in Fig. (5). It was noticed that the pest dynamics behavior had similar trend regardless the studied two years. So, population density (mean population) over the two years of study was divided into four intervals (according to the pest density trend) regardless the studied years. Four intervals of activities were observed per year. The first interval was from October 26 ,2021 to April 5 ,2022 in fallen date stone. The second one was from September 13, 2022 to February 21 ,2023 in fallen date stone, while the third was from May 31 to October 18 2022 in fallen date fruits. And the fourth was from May 30 to October 17, 2023 in fallen date fruits. Three statistical models were considered. The first was the effect of weather factors (as partial regression). The second one was plant age (in weeks) as third degree of polynomial (to emulate the plant physiological behavior during these intervals). The third was the combined effect weather factors and plant age. The probability for each model was evaluated as the P value as well as the EV% (percent explained variance).Relation between obtained values for activity durations mentioned before and both weather factors Figs. (6) and host available nutritional value change over the considered durations is presented in Table (2).Statistical analysis of obtained population dynamics in relation to weather factors and hosts nutritional values and their combinations over considered durations' results are presented in Table (2). Results of first year in fallen date stone indicated strong and negative significant correlation between temperature and population as single factors, while positive with % RH. These relations were revealed no significant for single factors as partial regression. Similar results with less significance were revealed in the second year. Explained variance of 70.95 and 51.38% were obtained for both years, respectively. The relation between weather factors and populations in date stone samples revealed scientifically non acceptable relation. The

relation with temperature increase is expected to be positive. The contribution of the nutritional value available from the host (presented by the host age during the activity durations as polynomial of third degree) was highly significant and revealed higher EV% values of 96.00 and 86.76 for the two years, respectively. These values did not increase when combined the associated weather factors.

Table 2: Statistical analysis of *C. dactyliperda* population and date fruits Infestation % in relation to weather factors and hosts nutritional values and their combinations over considered durations on Hayani cultivar.

Considered durations	Factor	Level	Simple correlation		Partial regression				
			r	P	b	P	F	P	EV%
In fallen date stones, Oct. 26, 2021 to Aprl. 5, 2022	Weather	T max	-0.821	0.0001	-0.798	0.4570			
		T min	-0.698	0.0001	-2.350	0.2137	16.28	<.0001	70.95
		RH	0.617	0.0013	0.636	0.1368			
	Age[1] - Age[3]		-	-	-	-	160.09	<.0001	96.00
	Combined		-	-	-	-	72.80	<.0001	96.25
In fallen date stones, Sept. 13 2022 to Feb. 21. 2023	Weather	T max	-0.459	0.0239	-0.400	0.8375			
		T min	-0.396	0.0554	-0.826	0.6739	7.04	0.002	51.38
		RH	0.658	0.0005	1.733	0.0024			
	Age[1] - Age[3]		-	-	-	-	43.69	<.0001	86.76
	Combined		-	-	-	-	33.06	<.0001	92.11
Infestation% in fallen date fruits , May 31, 2022 TO Oct. 18, 2022	Weather	T max	0.713	0.0003	5.729	0.0894			
		T min	0.690	0.0005	0.862	0.8458	9.16	0.0008	61.79
		RH	-0.193	0.4027	3.010	0.0425			
	Age[1] - Age[3]		-	-	-	-	124.68	<.0001	95.65
	Combined		-	-	-	-	54.84	<.0001	95.95
Infestation% in fallen date fruits , May 30, 2023 to Oct. 17, 2023	Weather	T max	0.715	0.0003	0.450	0.8604			
		T min	0.849	<.0001	8.597	0.0027	15.14	<.0001	72.77
		RH	-0.498	0.0216	-0.194	0.8012			
	Age[1] - Age[3]		-	-	-	-	138.93	<.0001	96.08
	Combined		-	-	-	-	133.96	<.0001	98.29

For fallen fruits infestation percentage during the first-year maximum, minimum temperatures showed highly significant positive relations, while RH% was negative and insignificant. For partial regression nun was significantly effective. Similar results with less significance were revealed in the second year. Partial regression model was highly significant and showed explained variance of 61.79 and 72.77% for both years, respectively. The contribution of the nutritional value available from the host was highly significant and revealed higher EV% values of 95.65 and 96.08 for the two years, respectively. These values did not increase when combined the associated weather factors. Obtained

results are in the same context as Hussein (1990), who demonstrated that the rate of infestation by DSB in date fruits was positively affected by temperature, while the effect of relative humidity on the rate of infestation was weak. Salim (1999) relative humidity was the factor most influencing the DSB population in the second year of the study. Likewise, El-Barbari *et al*. (2002) found that the highest number of DSB insects and the rate of infestation with the DSB in the two tested cultivars was related to the temperature, which reached 30 to 35 C°, and the relative humidity of 75 to 80 % in the month of August. Also, El-Shafei (2018) mentioned in his findings that, the density of insect populations was negatively impacted by temperature and relative humidity, but positively by inspection dates. When the combined effect of the three factors was calculated, it was discovered to be highly significant and interpreted as indicating that the dates of the examination or the time factor is the one that indicates the presence of the insect's host, which is fallen dates. The combined effect of temperature and relative humidity was also low and negative. El-Lakwah *et al*. (2011) showed that during the course of the two-year study, there was a substantial positive association between the average temperature and the adult population abundance of RPW.

3.5. Host preference

It was found that by comparing the 13 cultivars in terms of host preference in Table (3), based on the number of holes made by the insect in each the date stones of each cultivar Fig (8), Hayani cultivar, which belongs to the group of fresh cultivars, was the most preferred cultivar by the DSB insect, with a significant difference over the rest of the cultivars, with the average 5.56 hole/date stone following by Frahi cultivar, which belongs to the group of dry cultivars with an average 3.82 hole/ date stone, followed by the Medjool cultivar, which belongs to the group of semi-dry cultivars, with an average 2.50 hole/ date stone. Then, the least favorite cultivars by the insect were Sakkoti and Bartamouda dry cultivars, with an average 0.73 and 0.73 hole/ date stone, respectively.

The infestation percentages by DSB were also determined among the date stones of the 13 tested cultivars Fig (9), and Table (3). It was found that the highest percentage of DSB infestation was in the Hayani and Frahi cultivars, with an average of 80% for each of them, followed by the Amhaat cultivar with an average infestation percentage of 55%. Then the Amri cultivar, with an average of 50%, and the lowest percentage of date stone beetle infestation was recorded in Samani cultivar during performing the free preference test with an average of 15%.

In order to facilitate the calculating of the average number of each insect stage, and due to the absence of pupae at the time of examination, we decided that an average of the three insect stages (eggs, larvae, and adults) could be calculated as an indicator for all stages Fig. (10), and Table (3) .Data indicated that the highest average number of DSB stages in the free choice host preference test was recorded in the date stones of Hayani cultivar, with a value of 17.70 insects/date stone, followed by the average number of insects in the date stones of the Bent Aisha cultivar 8 .50 insects / date stone. Then the average insect count was moderate in the date stones of Samani cultivar, which recorded 5.75 insects/date stone. While there were no insect stages in the two dry varieties Sakkoti and Bartamouda, the average was recorded as zero for each one of them. This explained that although the holes were made in the date stones of the two dry cultivars Sakkoti and Bartamouda by the DSB insect, the insect did not lay eggs and no insect stages formed in their date stones because it found them not suitable for feeding small broods and completing their life cycle. The results of our current research were in harmony with Boraei *et al.* (1994) who reported that the average number of holes in the date stones of date palm cultivars was higher in the Hayani cultivar than the Samani and Zaghloul varieties, as they recorded (1.9 , 1.5 and 1.2 holes / date stone) respectively in the host preference test that conducted in the northern Delta governorates in Egypt. Likewise, with Salim (1999), who stated that the average number of stone beetle stages in the date stones of the Hayani cultivar was highly significant and more than the rest of the tested cultivars, as it was recorded at 295. 82 individuals/50 date stone during the year 1994, while the Aglani cultivar recorded the lowest percentage of DSB infestation, 23.53%, in the same year of the study. Donia *et al.* (2002) indicated that the date stones of Amhat cultivars was significantly more preferred than Samani cultivar by the DSB.

Table 3: Host preference of *C. dactyliperda* on date stone of 13 Egyptian date palm cultivars.

Date palm groups	Date cultivars	Infestation %	Mean number of holes	Mean number of stages in tested date stone				Mean of stages (individuals)
				Eggs	larvae	Pupae	Adults	
Fresh date group	Barhi	25 ± 1.85 H	1.00 ± 0.22H	3.60 ±0.47 F	14.80 ± 0.47 D	0.00 ± 0.00 A	0.60 ± 0.19 H	4.75 ± 0.18 DE
	Samani	15 ±0.47 J	1.33 ± 0.09 E F G	4.33 ± 0.47 E	17.67 ± 0.09 C	0.00 ± 0.00 A	1.00 ± 0.22 FG	5.75 ± 0.09 C
	Bent Aisha	20 ± 0.47 I	1.50 ± 0.47 D E	12.00 ± 0.09A	20.50 ±1.85 B	0.00 ± 0.00 A	1.50 ± 0.09 C	8.50 ± 0.22 B
	Amhaat	55 ±0.47 B	1.36 ± 0.22 E F	5.09 ±1.85 D E	5.82 ± 0.09 G	0.00 ± 0.00 A	1.09 ±0.09 EF	3.00 ± 0.47 F
	Zaghloul	45 ± 0.09 D	1.56 ±0.19 D	1.22 ± 0.47 G	16.56 ± 0.47 C	0.00 ± 0.00 A	0.89 ± 0.22 G	4.67 ± 0.019 DE
	Hayani	80 ±1.85 A	5.56 ± 0.09 A	3.25 ±0.22 F	63.06 ± 0.47 A	0.00 ± 0.00 A	4.50 ± 0.09 A	17.70 ± 0.22 A
Semi dry date group	Siwi	40 ± 0.09 E	1.00 ± 0.47 H	7.38 ±0.22 B	3.88 ± 0.47 H	0.00 ± 0.00 A	0.88 ± 0.19 G	3.03 ± 0.47 F
	Aglani	30 ± 0.22 G	1.17 ± 0.19 G H	0.00 ± 0.00 G	0.00 ± 0.00 I	0.00 ± 0.00 A	0.056 ± 0.05 J	0.01 ± 0.00 G
	Medjool	33.33 ± 0.47 F	2.50 ± 0.47 C	5.75 ± 0.09 CD	10.00 ±0.22 F	0.00 ± 0.00 A	1.25 ± 0.19 DE	4.25 ± 0.09 E
	Amri	50 ± 0.22 C	1.30 ± 0.09 F G	7.00 ± 0.47 BC	11.70 ±1.85 E	0.00 ± 0.00 A	1.30 ± 0.47 D	5.00 ± 0.19 D
Dry date group	Sakkoti	30 ± 0.09 G	0.727 ± 0.05 I	0.00 ± 0.00 G	0.00 ± 0.00 I	0.00 ± 0.00 A	0.00 ±0.00 J	0.00 ± 0.00 G
	Bartamouda	30 ± 1.85 G	0.727 ± 0.05 I	0.00 ± 0.00 G	0.00 ± 0.00 I	0.00 ± 0.00 A	0.36 ± 0.09 I	0.09 ± 0.00 G
	Frahi	80 ± 0.47 A	3.818 ± 0.09 B	0.00 ± 0.00 G	16.55 ± 0.47 C	0.00 ± 0.00 A	3.27 ± 0.22 B	4.95 ± 0.047 DE
Pr.		<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
L.S.D.		1.6783	0.1678	0.1396	1.4720	0.0000	0.1608	0.7444

Mean in each column followed by different letter are significantly different at 5 % level

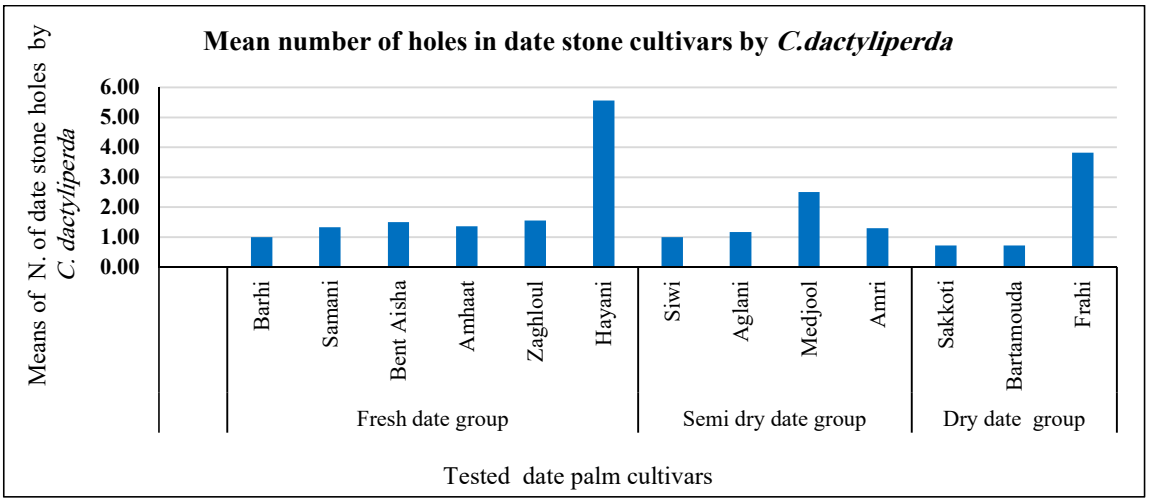

Fig. 8: Means number of holes in date stone cultivars by *C. dactyliperda* infesting different Egyptian cultivars

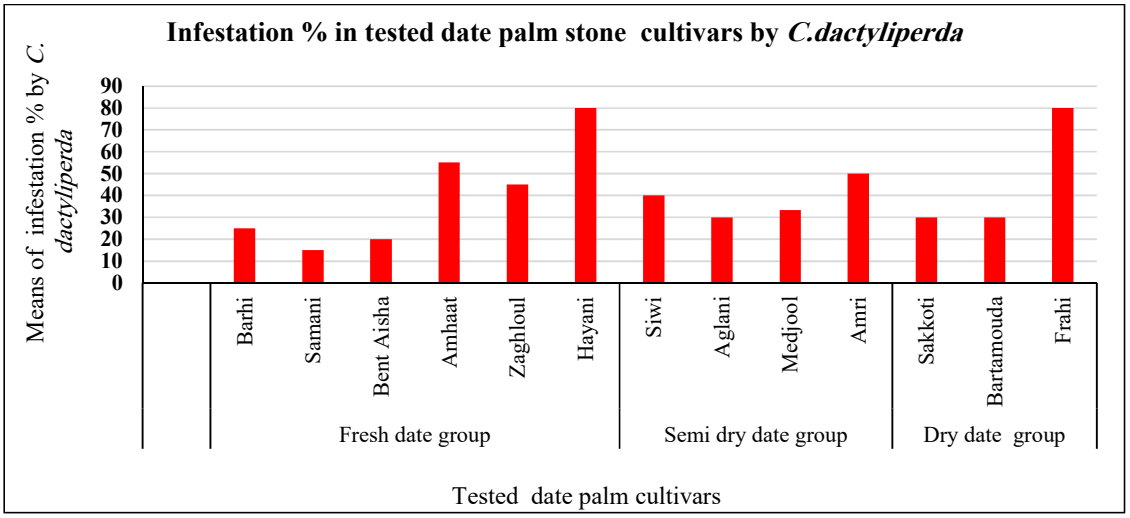

Fig. 9: Infestation percentages of *C. dactyliperda* in the date stones of 13 date palm cultivars.

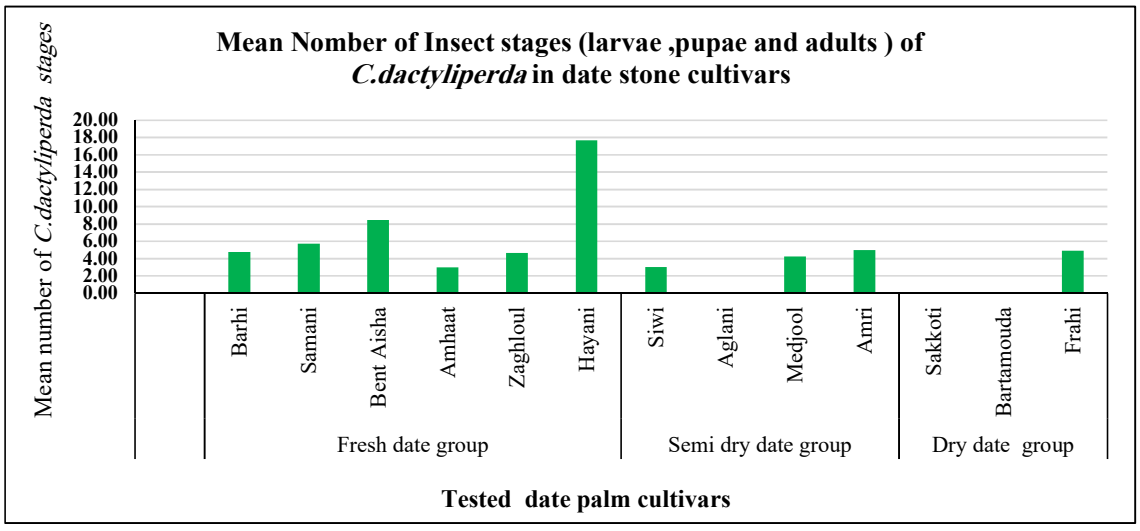

Fig. 10: Means numbers of *C. dactyliperda.* stages in date stone cultivars.

3.6. Biochemical contents of date stone of tested cultivars:

The results obtained from the analysis of some chemical components of the date stones of some of the tested cultivars in Table (4) indicated that its content for both total carbohydrates and total proteins recorded the highest values in the Hayani cultivar, followed by the Medjool cultivar, then Barhi, while the lowest value was in the Bartamouda cultivar with values of (931.55 , 854.11 ,839.48 and 697.62 mg /g dwt) and (18.63 , 15.45 , 16.91 and 9.77 %) for total carbohydrates and total proteins, respectively. While, on the contrary, it was found that in the case of both total phenols and flavonoids, the lowest values in the Hayani cultivar, followed by the Medjool cultivar, then Al Barhi, while the highest value was in the Bartamouda cultivar with values of (19, 27,24 and 31 mgcaticole /100gdwt.) and (24, 25, 33 and 36 mgcaticole /100gdwt.) were recorded for both total phenols and flavonoids, respectively. As for the acidity numbers, no significant differences were recorded between the tested palm cultivars, and they were all around the normal range. Considering the results obtained from the analysis of the components of the date stones to explain the results of host preference for the DSB over the different palm cultivars, we find that the values of total carbohydrates and total proteins were highly significant in Hayani cultivar , which belongs to the group of fresh cultivars, high-infestation and was the most preferred by the DSB, and the average value is in the Medjool cultivar, which belongs to the semi-dry group cultivars, and their value was low in the Bartamouda cultivar, which belongs to the dry cultivars group, which was less insect-preferable. While the values of both total phenols and flavonoids, in contrast, were lower in the Hayani cultivar, which was the most insect-preferable, and their value was medium in the Medjool cultivar, which belongs to the semi-dry varieties, and their values were higher in the dry cultivar Bartamouda has low insect preference and low infestation rates. From the above, we can conclude that the greater amount of total carbohydrates and total proteins in the date stone of a cultivar, as well as the lower the amount of phenols and flavonoids, the more sensitive the cultivar will be to DSB infestation and will be more preferable to DSB. The opposite is true: the lower the amount of total carbohydrates and total proteins and the greater the amount of phenols and flavonoids in a cultivar, the more resistant the cultivar is to infestation and less favorable to DSB insects. These results was in agreement with these of El-Shafei and Attia (2023) who reported that the quantity of total protein was higher in the leaves of the fresh cultivar, Samani (0.837 mg/g f.w.) than its quantity in the dry cultivar Bartamouda (0.717 mg/g f.w.). Batt *et al.* (2019) mentioned that the average amount of phytochemical components total carbohydrates and total protein were higher in the leaves of Cycas palms which was highly infested by butterfly, *Chilades pandava* than its amount in the leaves of zamia palms which recorded less infestation level of this butterfly. Batt and Swelam (2022) explained that the greater percentage of total carbohydrates and the lower percentage of total phenols in the tissues of the tested woody trees (*Cassia fistula, Poinciana regia, Cassia renigera, Ficus sycomorus, Morus alba, Mangifera indica, Sailxae gyptiace, Casuarina equisetifolia* and *Eucalyptus citriodora*), this results in an increase in the number of insect *Sinoxylon sudanicum* (Lesne Beetle) holes for enter and exits, the infestation rate increases, and the generation period decreases.

Table 4: Chemical content of some tested date stones cultivars.

Cultivars	Total carbohyrates (mg /g dwt)	Total protein %	Total Phenols (mgcaticole /100gdwt.)	Flavonoids (mg /g fwt)	pH
Bartamouda	697.62 ±3.47 D	9.77 ± 0.95 C	31.00 ± 0.98 A	36.00 ±0.82 A	7.4 ± 0.22 A
Barhi	839.48 ± 4.23C	16.91 ±1.20 AB	24.00 ± 0.38 C	33.00 ± 0.38 B	7.00 ± 0.15A
Medjool	854.11 ±7.56 B	15.45± 2.10B	27.00 ± 32B	25.00 ±0.32 C	6.9 ± 0.15 A
Hayani	931.55 ± 3.54A	18.63 ±1.84 A	19.00 ± 0.15 D	24.00 ± 0.15 C	7.1 ± 0.31 A
Pr	<.0001	<.0001	<.0001	<.0001	0.0745
LSD	1.8828	1.678	1.472	1.396	1.235

Means in column or row followed by different letter are significantly different at 5% level

7. Evaluation of some semiochemical attractants in the field trap of *C. dactyliperda*.

The control trap without any attractant just water was used to study the effect of attractants on DSB trap captures. All attractants significantly increased the trap catches compared with the control in Table (5) and illustrated in Fig. (11). The highest total mean number of DSB adults were caught in traps

baited with Ethyl acetate and date stone with means, 212.33 and 199.33 adults / trap respectively, without significant difference between them. Followed by the traps contained attractants, Vinegar and Ethyl Estate + date stone which were recorded 168.33 and 162.33 adults / trap respectively, without a significant difference between them. Then, a moderate effect was found on the collection of insects collected by the trap containing, Acetone + date stone and Ethyl alcohol (144.67 and 103.33 adults / trap) respectively. Both ethyl alcohol and acetone also recorded a small average number of insects (95.00 and 81 adults / trap) collected in the trap containing any one of them respectively. It was clear from the results that adding date fruits to volatile attractants such as acetone + dates, ethyl acetate + dates, and alcohol + dates had a negative effect, as it reduced their efficiency in attracting insects to the traps, recording the lowest averages of DSB insects collected in the traps (14.00 ,12.00 and 4.33 adults / trap) respectively. All these treatments was compare to the control of water which recorded 1 adults / trap. Our results obtained in the current research regarding the use of ethyl acetate or date stone as an attractant in field traps are consistent with De Souza *et al.* (2018) who assessed using baited traps in coffee farms, how *Hypothenemus hampei* (Coleoptera: Curculionidae) responded to semiochemicals and blends. It was discovered that ethyl acetate-baited traps caught more *H. hampei* than control traps, indicating that the substance may have an attractant effect. Date fruit extracts were not as effective as date stone extracts in luring adult date stone beetles, according to El-Barbary *et al.* (2002) in date palm farms in Egypt. Additionally, Lindmark *et al.* (2023) reported that in comparison to traps containing 2-phenethyl acetate, geranyl acetone attracted less Bark beetles, or *Ips typographus.* While regarding the rest of the attractants, such as ethanol and acetone attracted more. Bunchanan (1941) found that injection of 50% ethanol into elm trees caused severe attack by the scolytid, *Xylosandrus germanus* , whereas untreated elm parts were not attacked. Several species of ambrosia beetles attacked trees treated with ethanol (by injecting the roots of a living tree and immersing the butt end of a recently cut sopling) with immediate and intense force, as reported by Browne (1952). Moeck (1970) noted that low concentrations of ethanol are attractive to both sexes of the scolytid, *Trypodendron lineaturn* (Olivier). Additionally, he discovered that, in field conditions, ethanol was appealing to other scolytids in addition to *T. lineaturn*. According to Cade *et al.* (1970) ethanol served as the main scolytid *Gnathotricus gulcatus* attractant. Window flight traps baited with ethanol attracted 15 taxa, or 25 species of scolytids, according to research by Ruling and Kearby (1975).

Table 5: Comparison of *C. dactyliperda* attractants in field traps.

Attractants types	**Mean number ± SE of *C. dactyliperda* Adults/ trap collected during a year**
Ethyl acetate	212.33 ± 0.32 a
date stone	199.33± 1.43 a
Vinegar	168.33 ± 0.08 ab
Ethyl acetate + date stone	162.33 ± 1.00 ab
Acetone + date stone	144.67 ± 0.52 abc
Alcohol + date stone	103.33± 0.32 bc
Ethyl alcohol	95.00 ± 0.14 c
Acetone	81.00 ± 0.15 cd
Acetone + date fruits	14.00 ± 0.06 d
Ethyl acetate + dates date fruits	12.00 ± 0.95 d
Ethyl alcohol + date fruits	4.33 ± 0.08 d
Date fruits	2.33 ± 0.03 d
Control (water only)	1.00 ± 0.02 d
Pr	<.0001
LSD	80.812

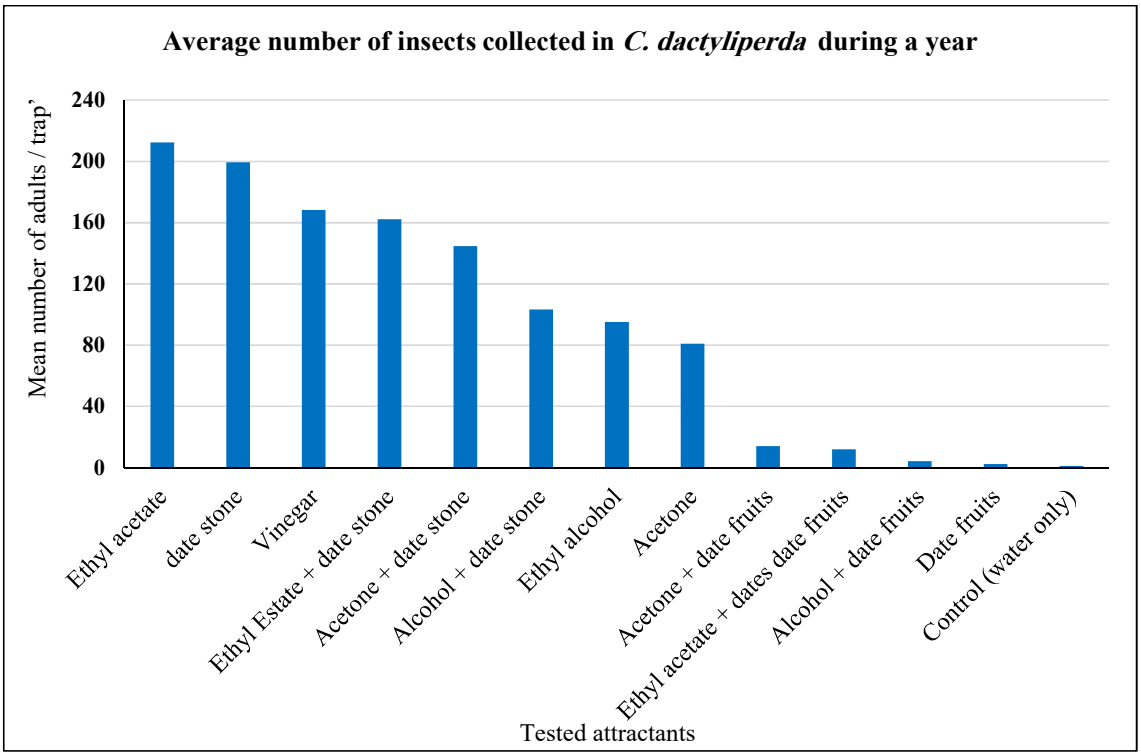

Fig. 11: Mean numbers of *C. dactyliperda a*dults collected in field traps during one year.

Ikeda *et al.* (1981) found that applying commercial grade ethanol (99.5 percent) or acetone (98 percent) to live Japanese red pine trees produced a strong attraction for the Japanese pine sawyer (*Monochamus alternatus* Hope) .More ceramoyeid, clerid, and scolytid beetles were captured with ethanol-containing vane traps than by unbaited traps, they also mentioned that none of the families they looked at found acetone to be appealing, according to research by Montgomery and Wargo (1983). A preliminary field test of chemical attractants for bark beetles was carried out by Girgis (1987).
The field test solutions containing ethanol either by itself or in conjunction with plum bark extract demonstrated a substantial attraction to bark beetles, and it was determined that this was the only attractant that would work in the field for scolytids. Nonetheless, sticky traps baited with 50% ethanol or ethanol-extracted plum bark were successful since a significant number of scolytid beetles, *Xyleborinus saxesenii* Ratzeburg and *Hypothenemus eruditus* Westwood were trapped despite the insects' frequent flight in the test area. Using trap logs of *Phloeotribus sylvestris* and *Pinus resinosa*, baited with 95% ethanol to trap *Pityogenes bidentatus*, *Hylastes opacus*, and *Tomicus piniperda*, Hoebeke (1994) conducted a survey study in the USA. According to Ranger *et al.* (2010) ethanol was found to be the most appealing substance to *Xylosandrus germanus* (Coleoptera: Curculionidae, Scolytinae) and other ambrosia beetles based on cumulative trap counts. However, no ambrosia beetle was drawn to traps baited with acetaldehyde and acetone. On the contrary, it was found that , the effects of ethanol concentration on the responses of scolytids, namely *Ips typographus*, *Xyleborinus saxe* seni, *Xyleborus dispar*, *Xylosandrus germanus*, *Hyburg opia* palliatus, and *Tomicus pinipeda*, were investigated by Klimetzek *et al.* (1986). They demonstrated how adding ethanol to the pheromons of *Ips typogrophus* reduced the reaction at all concentrations and how all Xyleborus and H. palliatus responded to increases in ethanol concentration.

4. Conclusion

Through the results of the current study, we can summarize that the date stone beetle infestation is present in the date stone under palm trees from the previous year, reaching the highest numbers in late October and December then its presence continues during the rest of the winter and spring periods, with a small population number in the date stone until it moves to infesting unripe green date fruits for the current year from late May until after the crop is collected in late October, and its highest infestation

rate in the fruits is in mid-July. Then the infestation spreads again to the fallen date stone from the previous year under the palm tree, repeating the same pattern. Therefore, we recommend removing and disposing of the fruits and date stone that have fallen on the ground under the palm trees after collecting the crop so that they are not a source of re-infestation by the date stone beetle in the following year and using of plastic trap with low cost and high attraction efficiency, date stone or finger as attractant to reduce DSB population in the field.

References

Abd El-Wahab, A.S., A.Y. Abd El-Fattah, W.K.M. El-Shafei, and A.A. El Helaly, 2020. Efficacy of aggregation nano gel pheromone traps on the catchability of *Rhynchophorus ferrugineus* (Olivier) in Egypt. Brazilian Journal of Biology, 81: 452-460.

Abou–Setta, M.M., 2020. Nutritional ecology bridges the gap between mites' biological and ecological research results under Mediterranean environment. Acarines*, 14:45-52.*

Assous, M.T.M., W.K.M. El-Shafei, L.M. Lewaa, and Salem, Rehab E.M.E., 2022. Efficiency of Carbone Dioxide and Aluminum Phosphide Gasses on *Ephestia cautella* and *Oryzaephilus surinamensis* Insects and Microbial Load on Stored Date Fruits. Egyptian Academic Journal of Biological Sciences. A, Entomology, 15(1): 81-89. doi: 10.21608/eajbsa.2022.225822

Batt, M.A. and Nehal O. Swelam, 2022. The Role of Some Factors Affecting Infestation of Certain Host Plants by Sinoxylon sudanicum Lesne Beetle (Coleoptera: Bostrichidae). J. of Plant Protection and Pathology, Mansoura Univ., 13 (1):7 – 12. DOI: 10.21608/JPPP.2022.222033

Batt, M.A., G.M. Hassan, and M.R. EL-Aassar, 2019. A study on infestation factors of cycas and zamia palms with butterfly, Chilades pandava and its control in Egypt. Pakistan Journal of Biological Sciences, 22(10): 477-485.
http://dx.doi. org/10.3923/pjbs.2019.477.485. PMid:31930837.

Bibars, E.E.D.A., E.M. Yassin, and A.R. Abdel Khalik, 2018. Survey of different mites and insect pests associated with date palm fruits in different locations of Egypt. Egyptian Journal of Agricultural Research, 96(3): 909-919.

Blumberg, D., 2008. Review: Date Palm Arthropod Pests and Their Management in Israel. Phytoparasitica, 36: 411–448. https://doi.org/10.1007/BF03020290

Boraei, H.A., I.A. Khodeir, and I.S. El-Hawary, 1994. On the biology, damage and food preference of the date-stone palm beetle, *Coccotrypes dactyliperda* F.(Coleoptera, Scolytidae), a newly serious pest of palm trees at the northern regions of the Nile Delta, Egypt. Journal of Agricultural Research, Tanta Univ.(Egypt).

Bradford, M.M., 1976. A rapid and sensitive method for the quantitation of microgram quantities of protein utilizing the principle of protein-dye binding. Anal. Biochem., 72: 248-254.

Browne, F.G., 1952. Suggestions for future research in the control of ambrosia beetles. Malay. Forester, 15: 197-206.

Buchanan, W.D., 1941. Experiments with an ambrosia beetle, *Xylosandrus germanus* (Blfd.). Journal of Economic Entomology, 34(3): 367 - 369.

Cade, S.C., B.F. Hrutfiord, and R.I. Gara, 1970. Identification of a primary attractant for Gnathotrichus sulcatus isolated from Western hemlock logs. Journal of Economic Entomology, 63(3): 1014-1015.

Crompton, M. and L.M. Birt, 1967. Changes in the amounts of carbohydrates, phosphagen and related compounds during the metamorphosis of the blowfly, *Lucilia cuprina*. J. Insect Physiol., 13: 1575-1592.

De Souza, M.S., J.N.M. Costa, M.C. Espindula, and A. de Almeida e Silva, 2018. Response of'Hypothenemus hampei'(Coleoptera: Curculionidae) to semiochemicals and blends using baited traps in coffee fields. Australian Journal of Crop Science, 12(6): 961-966.

Donia, A.R., N.S. El-Barbary, and A.M. Mostafa, 2002. The seasonal abundance of the date stone beetle, Coccotrypes dactyliperda Fabricius (Coleoptera, Scolyticdae). Alex. J. Agric. Res, 47: 93-102.

El Shafei, W.K.M., R.H. Mahmoud, and S.S.A. Mohamed, 2022. Efficacy of some entomopathogens against Ephestia cautella (Walker)(Lepidoptera: Pyralidae) in stored date fruits. Egyptian Journal of Biological Pest Control, 32(1): 1-7.

El-Barbary, N.S., Donia, A.R. and A.M. Mostafa, 2002. Effect of food preference and extracts of the date palm fruits and stones on the activity of the adult females of the date stone beetle, *Coccotrypes dactyliperda* Fabricius (Coleoptera, Scolytidae). Alexandria Journal of Agricultural Research; 2002. 47(2):103-107.

El-Lakwah, F.A., A.M.A. EL-Banna, R.A. El-Hosary and W.K. El-Shafei, 2011. Population dynamics of the Red Palm Weevil (*Rhynchophorus ferrugineus* (Oliv.) on date palm plantations in 6th October governorate. Egypt. J. Agric. Res., 89 (3):1105-1118. doi: 10.21608/ejar.2011.177676

El-Shafei, W.K.M., 2011. Ecological studies on the Red Palm Weevil, *Rhynchophorus ferrugineus* (Oliv). (Curculionidae: Coleoptera). M. Sc. Thesis, Fac. Agric., Benha Univ., Egypt, 180.

El-Shafei, W.K.M., 2015. Studies on efficiency of certain methyl bromide alternatives against *Ephestia cautella* (Walker) Lepidoptera: Pyralidae , Ph.D. Thesis, Benha Univ., Egypt, 195.

El-Shafei, W.K.M., 2018. Population Density of some Insect Pests Infesting Fallen Soft Dates and their Associated Natural Enemies in Giza governorate, Egypt, J. Plant Prot. and Path., Mansoura Univ., 9 (12): 815 – 821.

El-Shafei, W.K.M., 2020. Comparison between using phosphine and/or carbon dioxide for controlling *Plodia interpunctella* and *Oryzaephilus surinamensis* in stored date fruits. Middle East Journal of Applied Sciences, 10(4): 657-664.

El-Shafei, W.K.M. and S.A. Attia, 2023. Ecological and Toxicological Studies on Date Palm Scale *Fiorinia phoenicis* Balachowsky (Hemiptera-Diaspididae) Infesting Three Date Palm Cultivars with Reference to Anatomical and Chemical Analysis of Palm Cultivars Leaflets at Giza governorate, Egypt. Academic Journal of Entomology, 16(2): 70-83.

El-Shafei, W.K.M., R.H. Mahmoud, and S.E. El-Deeb, 2019. Impact of Controlled Atmosphere of different three gases for Controlling the stored dates mite, *Tyrophagus putrescentiae* (Schrank)(Acari: Acaridida), Acad. J. Entomol., 12(2): 49-56.

El-Shafei, W.K.M., R.A. Zinhoum, and H.B.H. Hussain, 2018. Biology and Control of Indian Meal Moth, *Plodia interpunctella* (Hubner) (Lepidoptera: Pyralidae) Infesting Stored Date, Almond and Peanut Fruits J. Plant Prot. and Path., Mansoura Univ., 9 (9): 595- 600.

El-Sherif, S.I., E.A. Elwan, and M.I.E. Abd-El-Razik, 1998. Insect pests of date palm trees in northern Sinai, Egypt. In *First International Conference on Date Palms (Al-Ain, UAE* (255-261).

Girgis, G.N., 1987. Studies on some Scolytids in Egypt (Coleoptera: Scolytidae). Ph.D. Thesis, Fac. Agric. Menoufia Univ., 144.

Hoebeke, E.R., 1994. New records of immigrant bark beetles (Coleoptera: Scolytidae) in New York: attraction of conifer- feeding species to ethanol-baited trap logs. Ent. News, 105 (5): 267-276.

Hussein, A.E., 1990. Date varieties and palm height in relation to infestation with date stone beetle, Coccotrypes dactyliperda F. (Coleoptera: Scolytidae).Annals of Agricultural Science, Moshtohor, 28(4):2613-2622.

Ikeda, T., A. Yamane, N. Enda, K. Matsuura, and K. Oda, 1981. Attractiveness of chemical-treated pine trees for Monochamus alternatus Hope (Coleoptera: Cerambycidae). Journal of the Japanese Forestry Society, 63(6): 201-207.

Kehat, M., D. Blumberg, and S. Greenberg, 1976. Fruit drop and damage in dates: the role of Coccotrypes dactyliperda F. & nitidulid beetles, and prevention by mechanical measures. Phytoparasitica, 4: 93–99. https://doi.org/10.1007/BF02980340

Klimetzek, D., J. Köhler, J.P. Vité, and U. Kohnle, 1986. Dosage response to ethanol mediates host selection by'secondary'bark beetles. Naturwissenschaften, 73(5): 270-272.

Lindmark, M., S. Ganji, E.A. Wallin, F. Schlyter, and C.R. Unelius, 2023. Semiochemicals produced by fungal bark beetle symbiont Endoconidiophora rufipennis and the discovery of an anti-attractant for Ips typographus. Plos one, 18(4): 1-15, e0283906.

Mahmoud, R., A.R. Abdel-Khalik, and W.K.M. El-Shafei, 2022. Comparison between Two Physical Methods to Control the Stored Dates Fruit Mites, *Tyrophagus putrescentiae* (Schrank) and *Rhizoglyphus robini* Claparede (Astigmata: Acaridae)". Egyptian Academic Journal of Biological Sciences, B. Zoology, 14(1): 149-158. doi: 10.21608/eajbsz.2022.228058.

Metwally, S.M., and A.E. Youssef, 2002. Some biological and ecological studies on the date-stone palm beetle, *Coccotrypes dactyliperda* F.(col., scolytidae). Journal of Plant Protection and Pathology, 27(2):1247-1253.

Moeck, H.A., 1970. Ethanol as the primary attractant for the ambrosia beetle *Trypodendron lineatum* (Coleoptera: Scolytidae). The Canadian Entomologist, 102(8):985-995.

Montgomery, M.E., and P.M. Wargo, 1983. Ethanol and other host-derived volatiles as attractants to beetles that bore into hardwoods. Journal of Chemical Ecology, 9:181-190.

Ranger, C.M., M.E. Reding, A.B. Persad, and D.A. Herms, 2010. Ability of stress-related volatiles to attract and induce attacks by Xylosandrus germanus (Coleoptera: Curculionidae, Scolytinae) and other ambrosia beetles. *Agric.* Forest Entomol, 12: 177-185.

Ruling, M.P., and W.H. Kearby, 1975. Seasonal flight and vertical distribution of Scolytidae attracted to ethanol in an oak-hickory forest in Missouri. The Canadian Entomologist, 107(12): 1315-1320.

Salim, A.F.A., 1999. Studies on the date stone beetle Coccotrypes dactyliperda (Fabricius) (Doctoral dissertation, Ph. D. Thesis, Zagazig Univ., Egypt,188.

Statistical Analysis System, 2003. SAS Statistics and graphics guide, release 9.1. SAS Institute, Cary, North Carolina 27513, USA.

Singleton, V.L. and J.A. Rossi, 1965. Colorimetry of total phenolics with phosphomolybdic-phosphotungstic acid reagents. Am. J. Enol. Viticult., 16: 144-158.

Spennemann, D.H.R., 2018. Global distribution of the date stone beetle, Coccotrypes dactyliperda (Coleoptera: Curculionidae, Scolytinae). Journal of Insect Biodiversity and Systematics, 4: 203–226.

Spennemann, D.H.R., 2019. Biology, ecology and distribution of the date stone beetle, Coccotrypes dactyliperda (Scolytinae, Coleoptera). Zoology in the Middle East, 65: 163–182. https://doi.org/10.1080/09397140.2019.1571743

Zhishen, J., T. Mengcheng and W. Jianming, 1999. The determination of flavonoid contents in mulberry and their scavenging effects on superoxide radicals. Food Chem., 64: 555-559.

Zinhoum R.A. and W.K.M. El-Shafei, 2019. Control of One of the Vital Stored Date Insects*, Plodia interpunctella* (Hübner) (Lepidoptera: Pyralidae), by Using Ozone Gas. Egypt. Acad. J. Biolog. Sci. (F. Toxicology & Pest control), 11(3): 149- 156 .