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Attacks of *Apate monachus* Fabricius 1775 (Coleoptera: Bostrichidae) on date palm (*Phoenix dactylifera* Linnaeus 1753) in the Souf region (northern-east Sahara, Algeria)

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Abstract

Apate monachus Fabricius 1775 (Coleoptera: Apatidae) is recognized as the second most significant pest affecting date palms in Algeria, primarily targeting the leaves of date palm trees. This study aims to assess the incidence of *Apate monachus* attacks based on the cultivar and the age of the date palms. Observations were conducted through direct field assessments at least once or twice weekly to gather comprehensive data. The study was conducted over a period from June 2021 to June 2022 across three date palm farms (Farm I with 650 date palms, Farm II with 1,708 date palms, and Farm III with 100 date palms). During each observation period, the number of date palm leaves exhibiting symptoms of *Apate monachus* infestation was recorded. Infested leaves were then cut to evaluate the extent and decrease of the infestations. Results indicated that younger date palms (10 to 15 years old) are more susceptible to attacks by *Apate monachus*, with attack rates ranging from 10% to 32.1%. The overall attack rate across the three farms was found to be 15.1%, with specific rates of 24.4% for Farm I, 13.13% for Farm II, and 15.56% for Farm III. The cultivar most adversely affected by *Apate monachus* was Ghars, exhibiting an attack rate of 84.27%, followed by Degla-Beida at 67.08%, and a minimal rate of 0.27% for Deglet-Nour.

Key words: *Apate monachus*, *date palm*, *Degla-Beida*, *Deglet Nour*, *Ghars*, *pest attacks*, *Souf*.

Introduction

“Date is the bread of the Saharians. We will never conduct enough studies to improve its production” (Chevalier, 1932). The date palm (*Phoenix dactylifera* L.) is a dioecious member of the Areaceae family that holds both economic and ecological significance. Consequently, in vitro micropropagation is essential for the renewal and expansion of palm groves (Djibril, 2013). The presence of date palms creates a microclimate that supports diverse animal and plant life, which is vital for the sustenance of desert populations (El Houmaizi, 2002). As such, the date palm serves as a biological model for promoting development in Saharan regions. Currently, dates are recognized as a strategic agricultural product (Saker, 2005). Algeria ranks as the third-largest producer of dates in the world, with an estimated production of 1,247,404 tons in 2022 (F.A.O, 2024) and approximately 20 million date palms, of which 17 million are productive (M.A.D.R, 2023). The Oued-Souf region is the second-largest date producer in the country, reaching an annual production of 1,223,200 quintals in 2022, with a total of 1,612,981 date palms (1,542,522 of which are productive) (M.A.D.R, 2023). Worldwide, around 3,000 date palm cultivars have been identified (Khierallah et al., 2015), with 490 cultivars recorded in Algeria (Hannachi et al., 1998). Algeria is particularly renowned for its ‘Deglet Nour’ variety, celebrated for its nutritional quality (Debabeche et al., 2021) and significant socio-economic impact, accounting for 54% of total production. This cultivar occupies the largest cultivated areas in Ziban, Oued-Souf, and Oued-Righ (Mardf, 2021). The Deglet Nour, Ghars, Degla-Beida, and Mech-Degla cultivars together make up about 70% of Algeria’s date heritage (Bensalah et al., 2015). To remain competitive in both national and international markets, the

expansion of areas planted with Deglet Nour must be accompanied by improvements in fruit quality, which appear to be influenced by ambient climatic conditions. However, pests can sometimes significantly affect production, primarily from the insect classes Lepidoptera and Coleoptera (Dhouibi, 2000). Indeed, Algeria's date palm heritage is subject to various constraints and bio-aggressors that hinder its development and valorization (Tirichine, 2010). Among the notable bio-aggressors affecting *Phoenix dactylifera* are the mite *Paratetranychus simplex* or *Oligonychus afrasiaticus* (McGregor, 1939), the white mealybug of palm, *Parlatoria blanchardi* (Targioni-Tozzetti, 1868), and the date pests *Ectomyelois ceratoniae* Zeller and *Apate monachus* (Fabricius, 1775) (Ould El Hadj & Abidi, 2003; Idder et al., 2015). The latter species, recognized as a secondary pest, has seen increasing populations in our palm groves (Balachowsky, 1962), causing significant damage in the southeastern palm groves of the country, particularly in the northeastern regions of the Algerian Sahara (Ouargla, Biskra, and El-Oued). Notably, this palm leaf borer also infests fruit trees; in a nursery in southern Italy, it attacks pomegranates (*Punica granatum* L.) and carob trees (*Ceratonia siliqua* L.) (Bonsignore, 2012). Furthermore, Braham & Gahbiche (2016) reported on the presence of *Apate monachus* in the central-eastern region of Tunisia, where it causes considerable damage. According to Dakhia et al. (2013) and Bensalah & Saouli (1997), the palm borer, or Bougassass, is prevalent in Ziban (Bordj Ben Azzouz/Tolga) and Ouargla, damaging Deglet Nour due to its predominance. Meanwhile, in the Touggourt region, this pest targets Degla Beida. This study aims to assess the attack rate of *Apate monachus* on three cultivars in the Oued-Souf region.

Material and methods

Study Area

The Oued-Souf region is administered by the wilaya of El-Oued and is situated in the southeastern part of Algeria (33° 12' to 33° 35' N; 6° 50' to 6° 51' E), on the northern borders of the Eastern Erg (Voisin, 2004). This region is characterized by a vast array of palm trees surrounded by sand dunes, located at an altitude of 70 meters above sea level (Beggas, 1992). The climate is hyper-arid, and the oases of Souf extend over an area of 11,738.4 km² (Khezzani & Bouchemal, 2018). The Souf region is also referred to as the country of Ghouts (Côte, 2006). According to Voisin (2004), this area is bounded to the north by the Chotts zone (Melghir and Merouane) and to the south by the expanse of the Eastern Erg, while the Oued Righ valley extends to the west. The eastern boundary of this study region is marked by the Tunisian Chott El-Djerid (Figure 1). For this study, the focus is on the Reguiba sub-region (33° 56' N; 6° 71' E), chosen for its significant agricultural activity and cultural diversity. The territory of the commune of Reguiba is located in the northwest of the wilaya, approximately 30 kilometers from the center of El-Oued. It covers an area of 1,966 km² (Figure 1).

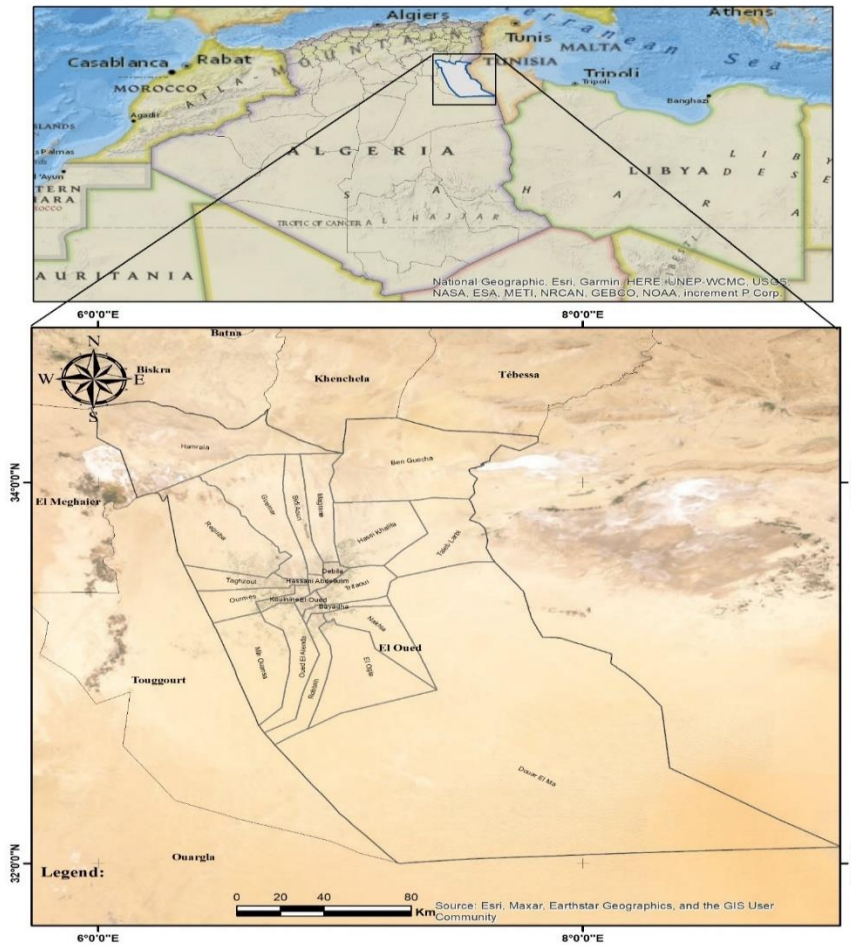


Figure 1. Location map of the region of Oued Souf (study area) in the Sahara Desert of Algeria, the black circle indicates the study location

Black giant Bostrychid collection and processing

To conduct this study, three types of palm groves were selected: Palm Grove I, Palm Grove II, and Palm Grove III. The details of these palm groves are as follows:

Palm Grove I has a population of 650 date palms, with the dominant cultivar being Deglet-Nour, which constitutes 72.3% of the grove (≥ 2 m; $m = 25\%$). This is a modern-type palm grove characterized by plantations that maintain an average spacing of 10 m by 10 m (Figure 2 A).

Palm Grove II contains 1,708 date palms, with the Deglet-Nour cultivar also dominant at 75.4% (≥ 2 m; $m = 25\%$). This palm grove is similarly modern, featuring an average plantation spacing of 8 m by 8 m (Figure 2 B).

Palm Grove III has a smaller population of 100 date palms and is classified as a semi-modern type. This grove is characterized by a plantation with an average spacing of both 8 m by 8 m

and 5 m by 6 m (Figure 2 C). The dominant cultivar is Deglet-Nour, accounting for 77% of the palms (≥ 2 m; $m = 25\%$).

The overall attack rate of *Apate monachus* across the three studied palm groves was assessed based on several criteria:

Attack Rate According to Cultivars: The cultivars examined include Degla-Beida, Ghars, and Deglet-Nour.

Attack Rate According to Cultivars and Tree Location: This analysis includes the cultivars Degla-Beida, Ghars, and Deglet-Nour, while also considering the specific location of each date palm within the grove.

Attack Rate According to Plantation Age: The date palms were categorized into four age groups for this analysis:

Class I: Plantations that are 10 years old

Class II: Plantations that are 15 years old

Class III: Plantations that are 25 years old

Class IV: Plantations that are 30 years old

Data analyses

The attack rate is expressed as a percentage and is calculated based on the number of attacked date palms compared to the total number of date palms. The rates for the three farms are obtained using the following formula:

$$Ra = \frac{n \times 100}{N}$$

Where:

R_a \): Attack rate (%)

n \): Number of attacked date palms

To perform an ANOVA followed by Tukey's post-hoc test, the data will be normalized using a square root transformation. The analysis of variance (ANOVA) is used to compare the means across different groups (Dagnelie, 1975).

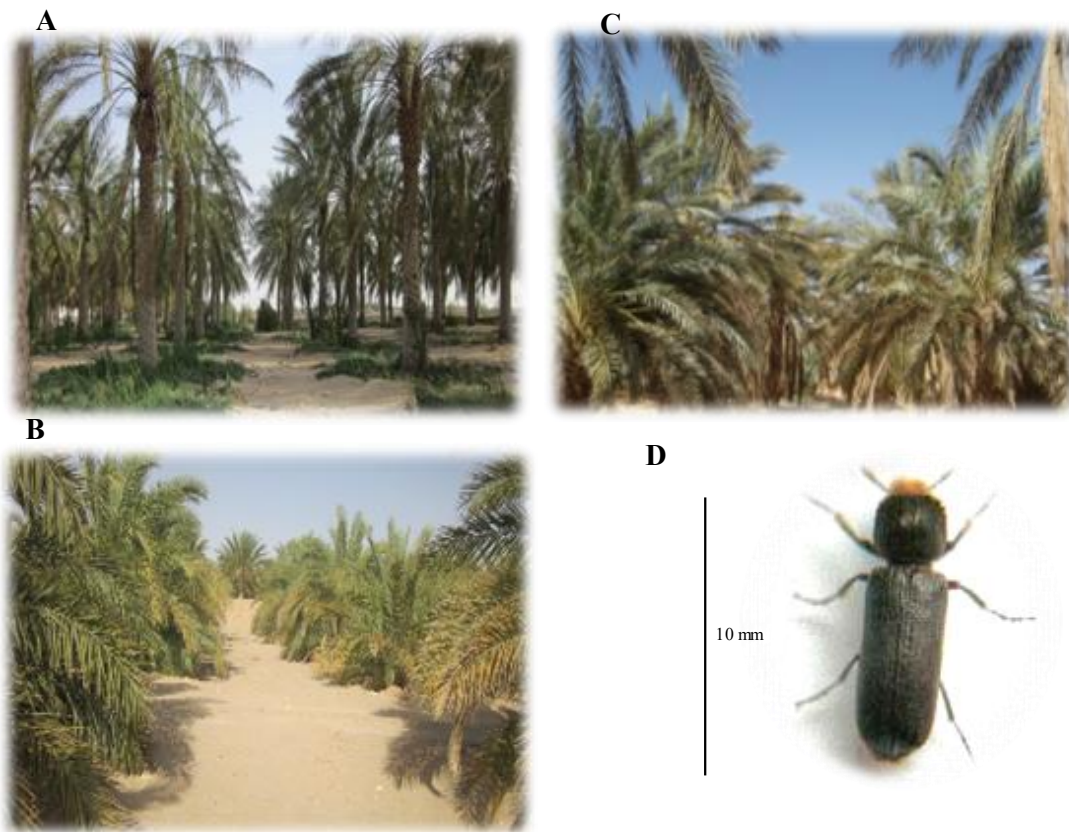


Figure 2. General view of the study stations A; palm grove I; B: palm grove II; D: palm grove III; F: *Apatе monachus* (D: ACHOUR,2003)

Results and discussions

Global Apatе monachus attacks rate

The attack rate of *Apatе monachus* reveals an overall incidence of 15.1%. Among the cultivars studied, the Ghars cultivar is the most affected, exhibiting an attack rate of 84.3%. This is followed by the Degla-Beida cultivar, which has an attack rate of 67.1%, while the Deglet Nour cultivar shows a significantly lower attack rate of only 0.27% (Figure 3). Previous studies have indicated that *Apatе monachus* tends to attack Deglet Nour more frequently than other varieties. Specifically, Ben Khalifa (1991), Bouktir (1999), and Sakhri (2000) documented these trends. Sakhri (2000) reported a low overall attack rate of 5.24% in date palm farms in the Ouargla region. Conversely, Bouktir (1999) found the attack rate to be higher, at 18.7%, while Tirichine (1993) estimated it to be around 20%.

Ben Khalifa (1991) also noted that the rate of *Apate monachus* attack in date palm farms in Mekhadma, Ouargla, reached approximately 30%.

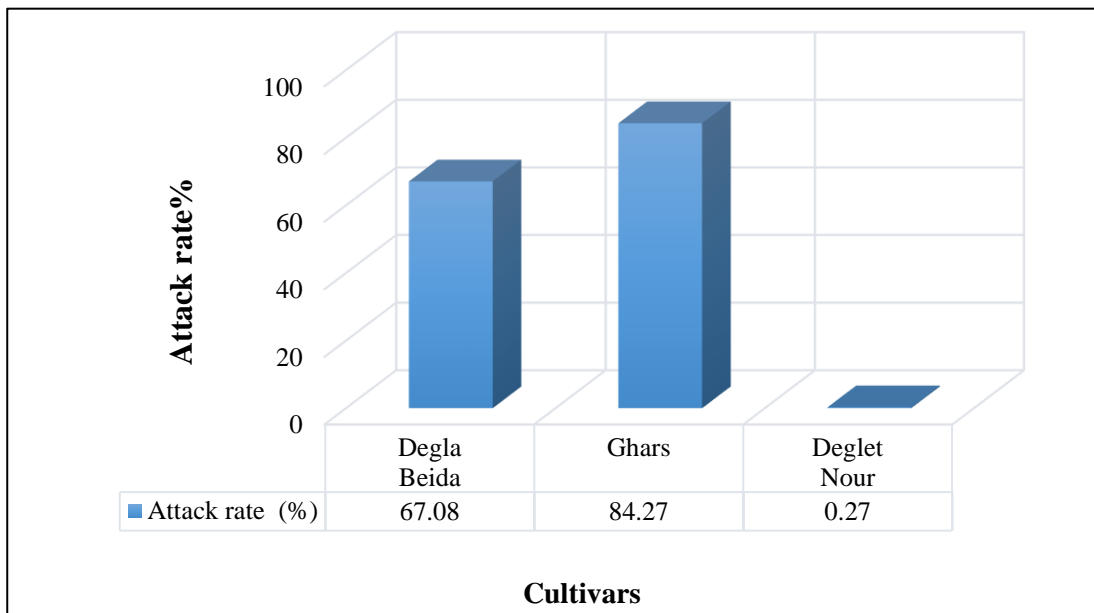


Figure 3. Overall Attack Rate of *Apate monachus* on Different Cultivars

Attack rate according to cultivars

In the three palm groves studied, the cultivar most affected by *Apate monachus* is Degla-Beida. In Palm Grove I, a total of 96 date palms were affected, resulting in an attack rate of 96%. In Palm Grove II, there were 171 affected date palms, yielding an attack rate of 57% (Figure 4).

In Palm Grove III, the Ghars cultivar was the most impacted by *Apate monachus*, with 9 date palms affected, which corresponds to an attack rate of 100%. Additionally, Ghars ranked second in terms of affected date palms in Palm Grove I, where 26 date palms were affected, leading to an attack rate of 86.7%. In Palm Grove II, the Ghars cultivar also had 40 affected date palms, resulting in an attack rate of 80%.

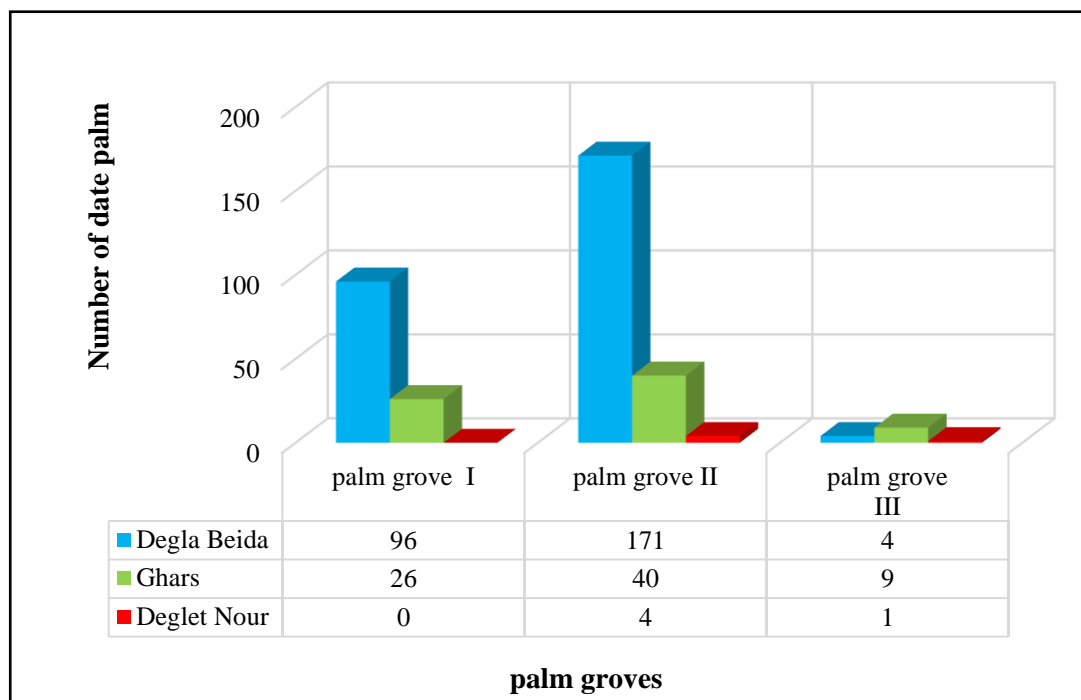


Figure 4. Number of Date Palms Affected by *Apate monachus* Across Three Cultivars in the Three Studied Palm Groves

Conversely, in Palm Grove III, the Degla-Beida cultivar ranked second with 4 affected date palms, achieving an attack rate of 100%. In Palm Grove II, the Deglet Nour cultivar was affected, albeit minimally, with 4 date palms showing an attack rate of 0.3%. In Palm Grove III, only one date palm was affected by *Apate monachus*, reflecting an attack rate of 1.3%, and no date palms in Palm Grove I were affected at all (Figure 6). According to Achour (2003), the Degla-Beida cultivar is the most frequently attacked by *Apate monachus*, with an attack rate varying from 57% to 100% compared to other cultivars. The attack rates for Deglet Nour range from 4% to 63%, for Ghars from 2% to 9%, and for common dates from 1% to 5%. Conversely, Sakhri (2000) reported that the most affected cultivar was Deglet Nour, with an attack rate of 57%, followed by Ghars at 30% and other cultivars such as Dokkar and Takermoust with an attack rate of 13%.

Attack rate according to location of date palms (periphery, center, and mixed)

The results presented in Figures 5 and 6 indicate that attacks by *Apate monachus* are localized primarily in the periphery of the palm groves. The number of date palms affected in the periphery ranks higher compared to those in the center and mixed areas. The attack pattern reveals that incidents begin at the periphery and progressively move toward the center and mixed areas of the palm groves. Notably, the total number of affected plants in Palm Grove II is greater than that in the other two palm groves (I and III) (Figures 5 and 6).

According to Achour (2003), the Degla-Beida cultivar is the most frequently attacked by *Apate monachus*, with an attack rate ranging from 57% to 100% compared to other cultivars. The attack

rates for Deglet Nour average between 4% and 63%, for Ghars between 2% and 9%, and for common dates between 1% and 5%. Sakhri (2000) identified Deglet Nour as the most affected cultivar, with an attack rate of 57%, followed by Ghars at 30%, and other cultivars like Dokkar (male date palm) and Takermoust, which have an attack rate of 13%.

Furthermore, research by Ben Khalifa (1991), Bouktir (1999), Sakhri (2000), and Tirichine (1993) consistently found that Deglet Nour is more frequently attacked by *Apate monachus* than Ghars and other cultivars. These studies also noted that date palms situated on the periphery are more susceptible to attacks than those located in the heart of the farms. This heightened vulnerability may be attributed to specific environmental conditions, such as the presence of dry palm leaf belts around the farms (acting as windbreaks), which could serve as overwintering sites for the insect.

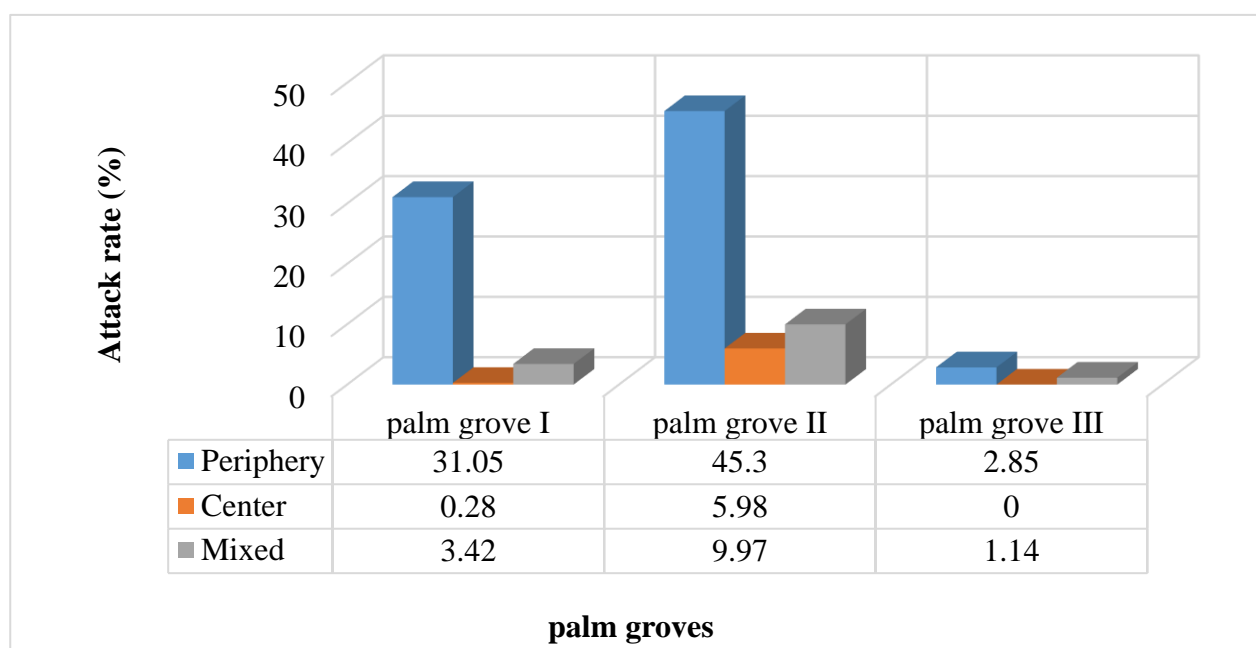


Figure 5. Attack Rates of *Apate monachus* According to Date Palm Location in Three Studied Palm Groves

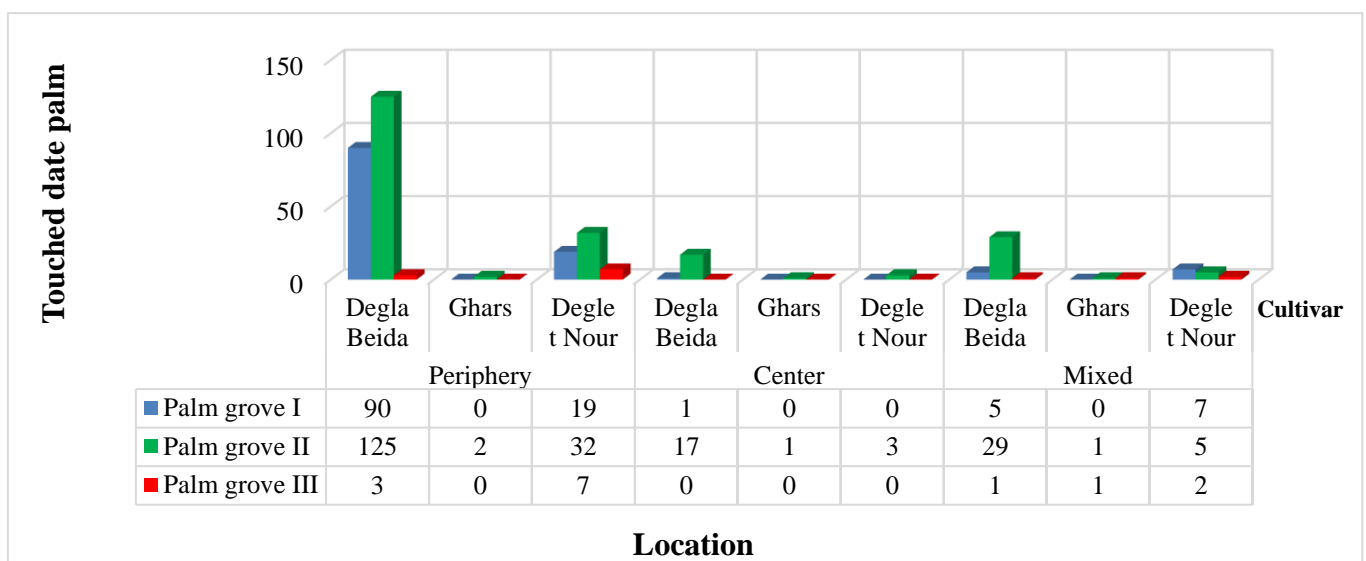


Figure 6. Attack Rates of *Apate monachus* According to the Three Cultivars Studied

Attack rate according to date palm age

Table 01 presents the attack rates across four age categories for the three date palm farms studied, with attack rates ranging from 0% to 32.11%. In both Date Palm Farms I and II, the attack rates are consistent within the age categories of 15 and 30 years. In the 15-year-old category, Date Palm Farm II shows an attack rate of 32.11%, while Date Palm Farm I shows a lower rate of 17.64%. Notably, in the 30-year-old category, no date palms exhibit symptoms of attack by *Apate monachus*. In contrast, Date Palm Farm III displays varying attack rates between 10% and 20% across three age categories specifically, 10, 15, and 25 years old. The attack rates for the 10-year and 25-year-old palms are both recorded at 10%, while the 15-year-old palms show a higher attack rate of 20%. Sakhri (2000) indicated that the highest attack rate of *Apate monachus* occurs in date palms aged between 25 and 50 years, with an attack rate of 33%. In addition, Achour (2003) suggested that the attack rates of *Apate monachus* are lower in older and taller date palms, indicating that the attack rate is not solely dependent on the age of the date palms.

Table 01. Attack rate according to date palm age in the 03 palm groves

Palm groves (years old)	Age and quantity of date palm				Attacks rate			
	≥ 10	≥ 15	≥ 25	≥ 30	≥ 10	≥ 15	≥ 25	≥ 30
Palm grove I	0	380	0	270	/	32,11	/	0
Palm grove II	0	1196	0	512	/	17,64	/	0
Palm grove III	10	40	50	0	10	20,00	10	/

Rate attack related to total number of plants per cultivar, using comparison between the 03 palm groves by statistical analysis

Variance analysis indicates a very highly significant difference associated with the type of palm grove, with an F value of 27.6 and a probability of 1.75×10^{-12} (Table 02).

Table 02 One-way ANOVA: Rate attack related to total number of date palm per cultivar, by comparison between the 03 palm groves

	Df	Sum Sq	Mean Sq	F Value	Pr (>F)
Palm groves	2	53.5	26.77	27.6	1.75e-12 ***
Residuals	1401	1358.7	0.97		

Subsequent comparisons of the palm groves using Tukey’s multiple comparisons of means (Table 03) reveal a very highly significant difference among the date palm farms ($P < 0.001$). The analysis

identifies two distinct groups: Group A, which includes Palm Groves I and II, and Group B, which includes Palm Grove III. The most affected groups by *Apate monachus* are Palm Groves I and II.

Further comparisons between the palm groves show a non-significant difference between Palm Groves II and I ($P > 0.05$), while there is a very highly significant difference between Palm Grove III and Palm Grove I, as well as between Palm Grove III and Palm Grove II ($P < 0.001$) (Table 03).

Table 03: Tukey multiple comparisons of means test: Rate attack related to total number of date palm per cultivar, by comparison between the 03 palm groves

95% family-wise confidence level				
Fit: aov (formula = plm ~palm grove)				
Palm grove	difference	lower	upper	p Value
Palm grove II-Palm grove I	-0.1465812	-0.2976245	0.004462107	0.0594067
Palm grove III-Palm grove I	0.3210043	0.1699610	0.472047577	0.0000021
Palm grove III-Palm grove II	0.4675855	0.3165422	0.618628773	0.0000000

Conclusion

The study of palm groves indicates that the extent of damage varies significantly from one farm to another, influenced by several parameters, particularly the date palm cultivar and its age. Throughout the study period, results demonstrate that the level of damage is dependent on the type of date palm cultivar, its height, and its position within the grove. Notably, taller date palms exhibit a lower degree of attack, suggesting that the flying height of *Apate monachus* is limited. The cultivars that are most susceptible to this wood-eating pest are primarily Degla-Beida and Ghars.

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