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Population Dynamics and Control of White Date Palm Scale, *Parlatoria blanchardi* Using Synthetic Pesticides and Essential Oils at Nubaria Region, Egypt

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Abstract: This study investigated the seasonal population dynamics, natural parasitism, spatial distribution, and chemical control of white date palm scale, *Parlatoria blanchardi* (Targioni-Tozzetti) during 2024 and 2025 seasons in Nubaria region, Egypt. *P. blanchardi* exhibited three major peaks annually, with higher densities in spring and autumn, confirming its multivoltine nature. The insect pest parasitism remained relatively low (<25%), indicating limited regulatory potential. The distribution of *P. blanchardi* was significantly higher in the southern and western date palm directions compared with the northern direction. Chemical trials confirmed that imidacloprid was the most effective compound against the scale insect with sustained suppression exceeding 90%. Neem oil showed moderate efficacy, while clove and peppermint oils were less effective. These findings highlight the need for integrating chemical and biological measures within IPM programs to achieve sustainable management of date palm pests.

Key words: Date palm, *Parlatoria blanchardi*, parasitoids, essential oils, imidacloprid, abamectin, IPM.

1. Introduction

The date palm (*Phoenix dactylifera L.*) is one of the most ancient and economically significant fruit crops cultivated in arid and semi-arid regions, particularly in the Middle East and North Africa **(El-Juhany, 2010 and Zaid and de Wet, 2002)**. Egypt is currently among the leading date-producing countries worldwide, contributing more than 1.8 million tons annually, which represents nearly 18% of global production **(FAO, 2023)**. Beyond its economic value, the date palm has considerable cultural, nutritional, and ecological importance, as it provides high-energy fruits, supports traditional industries, and plays a role in stabilizing desert ecosystems **(Chao and Krueger, 2007)**.

Maintaining high productivity and healthy date palms is a strategic necessity for Egypt's agricultural sustainability and food security. Despite its resilience, several insect and mite pests threaten palm cultivation. More than 100 arthropod species have been reported worldwide on date palm, including borers, sap-sucking insects, and acarine pests **(Abdallah *et al*., 2012 annd El-Shafei, 2018).** These pests cause direct damage by feeding on leaves, trunks, inflorescences, and fruits, and indirect damage by predisposing palms to secondary infections. Heavy infestations can significantly reduce photosynthetic efficiency, weaken palms, reduce fruit set, and render fruits unmarketable **(Aldosari *et al*., 2018).**

In Egypt, several species are of major concern, particularly the red palm weevil (*Rhynchophorus ferrugineus*), scale insects, and eriophyid or tetranychid mites **(El-Safty *et al*., 2009).** Therefore, developing effective management strategies for these pests is essential to sustain the date palm industry. Among scale insects, the white date palm scale (*Parlatoria blanchardi* Targioni-Tozzetti; Hemiptera: Diaspididae) is one of the most destructive pests of date palm in Egypt and other date-growing regions **(Blumberg, 2008 and Awadalla *et al*., 2023).** The pest colonizes both leaf surfaces, covering fronds with dense populations that cause yellowing, premature drying, and reduction in photosynthetic activity **(Awadalla *et al*., 2023).** Severe infestations may lead to the decline of palm vigor and reduced yields. Additionally, the waxy covering of the insect provides protection against natural enemies and chemical sprays, complicating its management **(Abd-Rabou, 2006 and Darwish, 2016).**

Although natural enemies such as parasitoids and predators play a role in its suppression, outbreaks are frequent and require targeted intervention. Despite its economic significance, its population dynamics under Egyptian conditions remain insufficiently documented, especially across successive growing seasons.

Chemical pesticides remain one of the most widely used and rapid solutions for controlling date palm pests, owing to their fast action and broad efficacy **(Aldosari *et al*., 2018).** However, overreliance on synthetic chemicals has led to multiple challenges, including pesticide resistance, environmental contamination, disruption of natural enemies, and residues on fruits **(El-Safty *et al*., 2009).** In this context, essential oils derived from medicinal and aromatic plants are gaining attention as eco-friendly alternatives or complementary tools in integrated pest management (IPM) programs **(Isman, 2020 and Regnault-Roger *et al*., 2012).** Many essential oils, such as neem, clove, and peppermint exhibit insecticidal, acaricidal, and repellent activities with low mammalian toxicity and rapid degradation in the environment **(Koul, 2008 and Pavela and Benelli, 2016).** Incorporating essential oils with selective pesticides could reduce the reliance on synthetic chemicals, delay resistance development, and enhance sustainability of control programs against scale insects.

The present study was conducted to monitor the population dynamics of *Parlatoria blanchardi* infesting date palm in Nubaria region, Beheira Governorate, Egypt, over two successive seasons (2024 and 2025). The performances of two synthetic pesticides and two essential oils against *P. blanchardi* were evaluated individually and in combination to determine their potential roles in integrated pest management.

2. Materials and Methods

2.1. Study Site

The field experiment was carried out during two successive growing seasons: 2024 and 2025, in a commercial date palm (*P. dactylifera* L. cultivar Barhi (soft)) orchard located in the Nubaria region, Beheira Governorate, Egypt (Latitude 31.19 N and Longitude 29.89 E). The orchard had uniformly managed palms aged 8 years old, planted at 8 × 8 m spacing, under drip irrigation and standard horticultural practices. No pesticide applications were conducted in the experimental plots, except for targeted pesticide treatments.

2.2. Population fluctuations of white date palm scale, *Parlatoria blanchardi*

To monitor the seasonal fluctuations of the white date palm scale, bi-monthly samples were taken throughout the year from both leaf surfaces of five palm trees, approximately similar in size and height. Four leaflets (pinnae) were randomly selected, one per cardinal direction (20 leaflets from the five trees). The numbers of live scale insects (nymphs and adults) were counted using a stereomicroscope in the laboratory.

2.3. Chemical and botanical control of *Parlatoria blanchardi*

Two synthetic insecticides and two essential oils were selected for evaluation against *P. blanchardi*, based on their documented efficacy in controlling other sap-sucking pests. The insecticides included chlorpyrifos-ethyl (organophosphate) at a rate of 1.5 ml/L (Lirifos 48% EC) and imidacloprid (neonicotinoid) at a rate of 0.5 g/L (Sinodor 70% W.G), while the essential oils were neem oil (*Azadirachta indica*) at a rate of 5 ml/L and clove oil (*Syzygium aromaticum* (L) at a rate of 5 ml/L. The treatments were applied as foliar sprays using a 20-L knapsack sprayer. Each treatment was applied to four trees (four replicates), and untreated trees served as controls. Scale populations were assessed before spraying and 1, 4, 7, and 14 days after spraying, by counting the number of live scales per pinna under laboratory conditions.

2.4. Statistical analysis

Collected data were subjected to analysis of variance (ANOVA) using a randomized complete block design (RCBD). Means were compared by the least significant difference (LSD) test at the 0.05 probability level to separate treatment effects. The percentage reduction in pest populations were calculated relative to the control (using Henderson and Tilton formula, 1955). Data from both pests were analyzed separately. Data were statistically analyzed using CoStat software (CoHort Software, Monterey, CA, USA).

3. Results

3.1. Seasonal fluctuations of *Parlatoria blanchardi* in 2024

P. blanchardi densities were relatively high during spring (Table 1 and Fig 1) with a distinct peak in early May (379 nymphs/20 leaflets) followed by a second relatively higher peak in mid-July (399 nymphs). The population then gradually declined by late summer, recording its lowest density in February (98 nymphs). Such patterns suggest that the species develops multiple overlapping generations, with favorable weather in spring and early summer promoting crawler activity and successful establishment.

Adult female counts paralleled the immature stages, but generally lagged by 2–3 weeks, reflecting the development period from crawler settlement to maturation. Peaks were observed in mid-April (188 adults) and the first of October (317 adults), indicating that adult activity is strongly influenced by the preceding nymphal abundance. Lower densities were consistently recorded in winter (40–52 adults in February), suggesting unfavorable climatic conditions for survival and reproduction.

The overall population (nymphs + adults) exhibited three distinct peaks during 2024 season; the first occurred in early May (550 individuals), the second in mid-July (617), and the third one in early October (748). These results indicate that *P. blanchardi* is multivoltine under Nubaria conditions, producing at least three overlapping generations per year. The persistence of the insect populations throughout the season, despite and the fluctuating densities, highlights the continuous availability of palm tissues suitable for the insect rearing.

Table (1). Seasonal fluctuations of *Parlatoria blanchardi*, infesting 'Barhi' date palm cultivar throughout the 2024 season, with parasitism rates by *Aphytis mytilaspidis*, in Nubaria region, Beheira Governorate, Egypt

Inspection date	Per 20 leaflets			Parasitism %
	Nymph	Adult	Total	
01-Jan	225	100	325	4.31
15-Jan	151	122	273	4.03
01-Feb	126	52	178	6.74
15-Feb	98	40	138	6.52
01-Mar	116	105	221	7.24
15-Mar	120	119	239	5.44
01-Apr	199	119	318	4.4
15-Apr	290	188	478	5.86
01-May	379	171	550	6.73
15-May	279	110	389	10.8
01-Jun	164	80	244	18.85
15-Jun	353	117	470	11.49
01-Jul	384	128	512	7.42
15-Jul	399	218	617	9.4
01-Aug	285	128	413	9.69
15-Aug	202	104	306	14.38
01-Sep	201	188	389	14.65
15-Sep	241	173	414	11.59
01-Oct	431	317	748	6.42
15-Oct	435	218	653	6.13
01-Nov	404	155	559	7.87
15-Nov	315	113	428	9.58
01-Dec	244	173	417	9.35
15-Dec	178	112	290	11.38

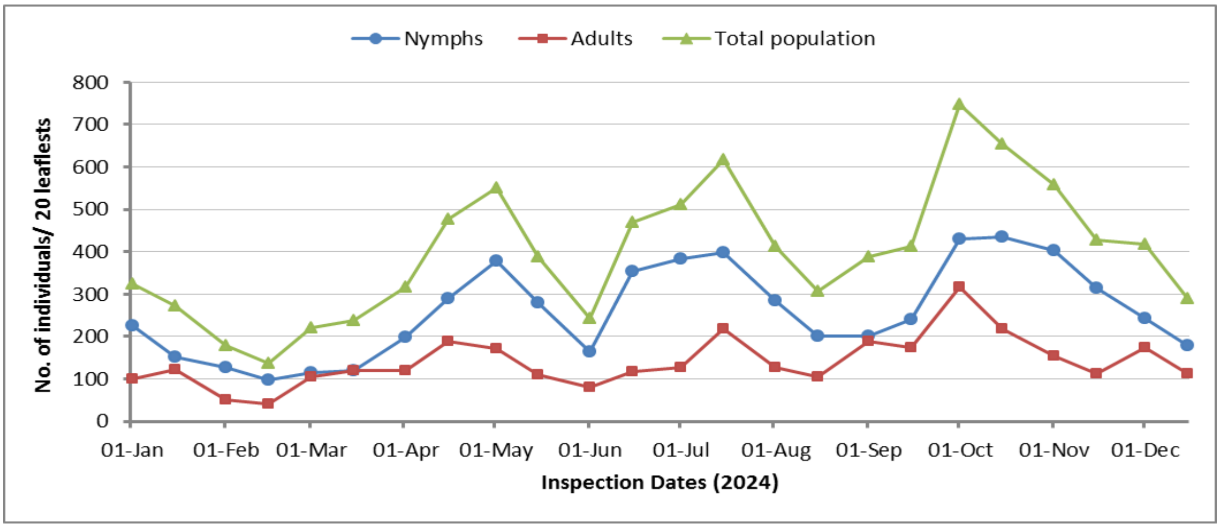

Figure (1). Seasonal fluctuations of *Parlatoria blanchardi*, infesting 'Barhi' date palm cultivar throughout 2024 season

3.2. Seasonal fluctuations of *Parlatoria blanchardi* parasitism by *Aphytis mytilaspidis*

Parlatoria blanchardi parasitism by *Aphytis mytilaspidis* followed a trend different from that of the host density (Table 1 and Fig. 2). The highest parasitism rates were detected in June (18.85%) and August (14.38%), coinciding with intermediate to declining pest densities. This suggests a density-dependent response of parasitoids, which may exert delayed suppression of the pest populations. However, parasitism levels remained generally low, indicating a limited regulatory capacity of natural enemies under field conditions.

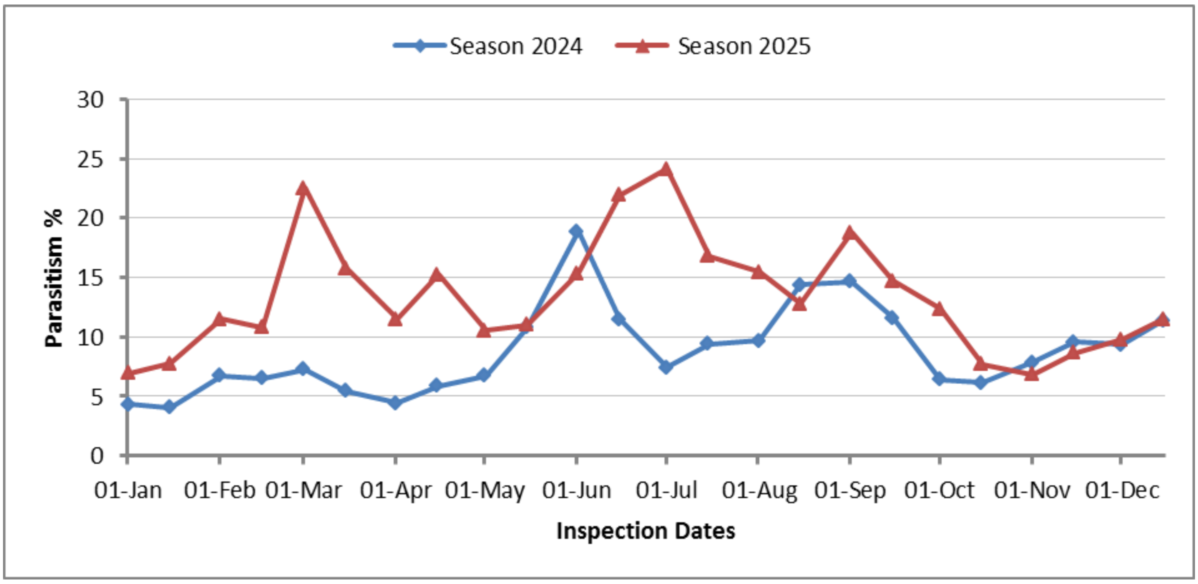

Figure (2). Trends of *Parlatoria blanchardi* parasitism on date palm during 2024 and 2025 seasons

3.3. Seasonal fluctuations of *Parlatoria blanchardi* in 2025

In 2025 season (Table 2 and Fig. 2), the nymphal density pattern was less pronounced compared to the previous year, with lower early-season counts in January–March. A sharp increase occurred by late spring and summer, peaking in November (437 nymphs). This shift suggests that environmental conditions during 2025, particularly cooler early spring temperatures, delayed crawler emergence and development.

The adult population also displayed delayed peaks relative to 2024, with the highest counts recorded in October (255 adults) and November (293 adults) and. Winter densities remained low between January and February), consistent with limited reproductive activity during cooler months.

During 2025 season, the total population (nymphs + adults) exhibited three pronounced peaks: the first in early June (456 individuals), second in early September (560 individuals), and third in early November (730 individuals), which represented the highest density recorded across both seasons (Table 2). This high late-autumn peak suggests that favorable climatic conditions, particularly moderate temperatures and relatively high humidity, enhanced survival and reproduction of the pest. The persistence of *P. blanchardi* throughout the year, without absence on any sampling date, indicates that the species may produce more than three generations annually, with overlapping cohorts contributing to its continuous field presence.

Table (2). Seasonal fluctuations of *Parlatoria blanchardi*, infesting 'Barhi' date palm cultivar throughout 2025 season, with parasitism rates by *Aphytis mytilaspidis*, in Nubaria region, Beheira Governorate, Egypt

Inspection dates	Per 20 leaflets			Parasitism percentages %
	Nymph	Adult	Total	
01-Jan	91	67	158	6.96
15-Jan	148	45	193	7.77
01-Feb	110	47	157	11.46
15-Feb	70	78	148	10.81
01-Mar	31	40	71	22.54
15-Mar	68	46	114	15.79
01-Apr	119	38	157	11.46
15-Apr	114	70	184	15.22
01-May	253	98	351	10.54
15-May	224	158	382	10.99
01-Jun	283	173	456	15.35
15-Jun	248	103	351	21.94
01-Jul	186	96	282	24.11
15-Jul	244	149	393	16.79
01-Aug	242	178	420	15.48
15-Aug	255	192	447	12.75
01-Sep	343	217	560	18.75
15-Sep	269	228	497	14.69
01-Oct	293	192	485	12.37
15-Oct	328	255	583	7.72
01-Nov	437	293	730	6.85
15-Nov	357	196	553	8.68
01-Dec	344	136	480	9.79
15-Dec	247	128	375	11.47

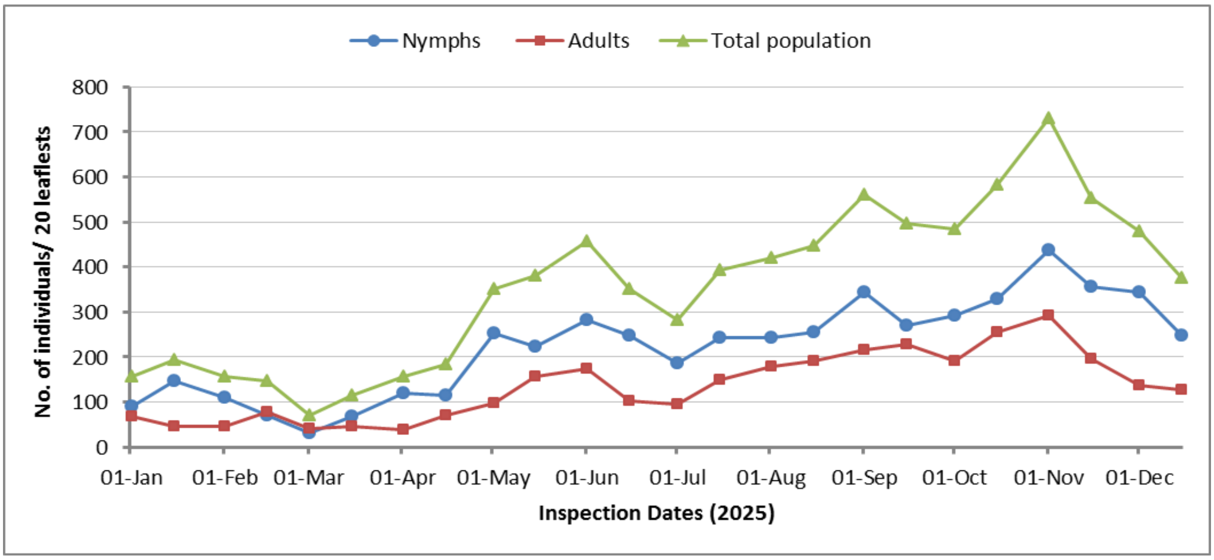

Figure (2). Seasonal fluctuations of *Parlatoria. blanchardi*, infesting 'Barhi' date palm cultivar throughout 2025 season.

3.4. Seasonal fluctuations of *Parlatoria blanchardi* parasitism by *Aphytis mytilaspidis* in 2025

As presented in Table 2 and Fig. 3, parasitism was generally higher in 2025 compared to 2024, with notable peaks in March (22.54%) and July (24.11%). Interestingly, these peaks occurred when host densities were relatively low to moderate, suggesting efficient host-searching behavior by parasitoids under such conditions.

3.5. Distribution of *Parlatoria blanchardi* on cardinal directions of date palm trees during 2024 and 2025

The obtained results (Table 3) indicated that the population density of the white date palm scale, *P. blanchardi*, varied significantly among the four cardinal directions of date palm trees. In both seasons, the southern direction harbored the highest infestation levels (124.83 ± 48.29 and 108.79 ± 56.23 individuals in 2024 and 2025, respectively), followed by the western and eastern directions. The northern side consistently recorded the lowest densities (71.38 ± 27.86 and 66.63 ± 33.62 in 2024 and 2025, respectively). The statistical analysis confirmed significant differences among directions with F = 7.26 (2024) and 3.74 (2025). These findings suggest that the southern and western orientations are more favorable for the scale insect development, most likely due to higher exposure to sunlight and warmer microclimatic conditions compared with the northern direction, which remains relatively cooler and shaded.

Table (3). Mean population density (mean ± SE) of *Parlatoria blanchardi* on cardinal directions of date palm trees in Nubaria region, Beheira Governorate, Egypt

Direction	2024	2025
North	71.38±27.86c	66.63±33.62b
East	95.83±34.22b	84.29±41.53ab
West	106.67±48.18ab	95.58±46.66a
South	124.83±48.29a	108.79±56.23a
F value	7.2598	3.74
LSD	23.28997	25.95041

Means within the same column sharing identical letter(s) do not differ significantly according to LSD test at the 0.05 probability level

3.6. Use of insecticides and essential oils for the management of the white date palm scale, *Paraltoria blanchardi*

First season, 2024

Reduction percentages of *P. blanchardi* population showed significant differences among the tested treatments. Imidacloprid was the most effective compound, achieving rapid and consistent suppression with reduction values of 86.06% one day after spraying and maintaining 87–88% up to two weeks post-treatment (Table 4). Chlorpyrifos-ethyl ranked second, with residual reductions ranging between 78.03% and 79.16%, indicating slower and less persistent activity compared to imidacloprid. Essential oils exhibited lower efficacy, with neem oil recording moderate suppression (60.11–65.70%), while clove oil achieved the least reduction (48.29–55.35%).

Second season, 2025

A similar trend was observed in the 2nd season (Table 5), though with generally higher reduction rates across treatments. Imidacloprid again provided the highest suppression, exceeding 90% throughout the assessment period, with a general mean of 90.6%. Chlorpyrifos-ethyl ranked second with reductions of 74.42–79.39%, closely resembling the 2024 results. Neem oil maintained moderate efficacy (62.6–68.9%), while clove oil again showed the lowest effect (53.70–60.87%). The superior consistency of imidacloprid across both years emphasizes its potential as a reliable control tool against *P. blanchardi*. The slight improvement in reduction values during 2025, especially for essential oils, may be attributed to differences in environmental conditions (temperature and relative humidity) that can influence both pest activity and product persistence.

Table (4). Reduction percentages of *Paraltoria blanchardi* infesting 'Barhi' date palm cultivar treated with different insecticides throughout 2024 season.

Treatments	Reduction residual %				General means
	1 day	4 days	7 days	Two weeks	
Imidacloprid	86.06±3.17a	87.35±0.59a	87.09±1.14a	88.03±1.28a	87.13±1.79a
Chlorpyrifos-ethyl	71.87±2.72b	78.03±2.32b	78.05±3.33b	79.16±3.38b	76.77±3.98b
Neem oil	60.82±6.61c	60.11±8.31c	63.38±3.24c	65.7±3.63c	62.5±5.7c
Clove oil	45.58±4.22d	48.29±2.46d	50.26±2.93d	55.35±3.15d	49.87±4.7d
F values	59.440	61.035	133.670	92.221	231.005
L. S. D.	6.84655	6.9256	4.3258	4.63127	3.034497

Means within the same column sharing identical letter(s) do not differ significantly according to LSD test at the 0.05 probability level

Overall, the two-year field trials clearly demonstrate that imidacloprid remains the most effective insecticide against *P. blanchardi*, followed by chlorpyrifos-ethyl, while neem and clove oils can provide supplementary or alternative eco-friendly approaches, particularly within integrated pest management (IPM) frameworks. However, reliance on a single chemical class (e.g., neonicotinoids) raises concerns about resistance, making rotation with organophosphates and integration with biological control agents (such as *Aphytis* parasitoids) crucial for long-term sustainability.

Table (5). Reduction percentages of the *Paraltoria blanchardi* infesting 'Barhi' date palm cultivar treated with different insecticides throughout 2024 season.

Treatments	Reduction residual %				General means
	1 day	4 days	7 days	Two weeks	
Imidacloprid	91.38±1.48a	89.43±2.9a	91.09±0.49a	90.5±2.29a	90.60±1.95a
Chlorpyrifos-ethyl	74.42±3.16b	76.9±3.93b	77.51±1.36b	79.39±2.75b	77.05±3.21b
Neem oil	62.6±5.98c	63.96±5.18c	66.86±2.88c	68.85±3.26c	65.57±4.76c
Clove oil	53.7±4.39d	53±6.78d	57.32±2.16d	60.87±2.12d	56.22±5.04d
F values	63.241	41.236	223.988	94.955	226.764
L. S. D.	6.311336	7.574549	2.9863	4.0696	2.78896

Means within the same column sharing identical letter(s) do not differ significantly according to LSD test at the 0.05 probability level

4. Discussion

The obtained results clearly demonstrate that *Paraltoria blanchardi* exhibits typical multivoltine behavior under Nubaria conditions, with overlapping generations and continuous presence throughout the year. The occurrence of multiple population peaks during spring, summer, and autumn agrees with the findings of **(Abd-Rabou, 2006)**, who reported similar seasonal dynamics for armored scale insects in Egypt, emphasizing the role of temperature and host plant phenology in regulating population development. The delayed population peaks observed in 2025 compared to 2024 may be attributed to variations in climatic conditions. Such seasonal shifts in population timing are commonly associated with environmental variability affecting insect life cycles and reproductive rates.

Natural parasitism by hymenopterous parasitoids showed a relatively low impact on *P. blanchardi* populations, with parasitism levels remaining generally below 25% in both seasons. These findings are in line with **(Awadalla *et al.*, 2023)** and **(Abd-Rabou and Moustafa, 2006)**, it was reported that natural enemies alone are insufficient to suppress outbreaks of date palm scale insects under field conditions in Egypt. The observed peaks in parasitism during periods of moderate host density suggest a density-dependent response; however, this response appears delayed and inadequate to prevent pest outbreaks.

The significant variation in the distribution of *P. blanchardi* among the four cardinal directions, with higher infestations on the southern and western sides, supports previous observations by Darwish (2016), who attributed such patterns to increased exposure to sunlight and higher temperatures. Similar findings were also reported by **(Awadalla *et al*., 2023)**, confirming that microclimatic factors play a crucial role in determining infestation levels on different parts of the tree canopy.

The evaluation of control treatments revealed superior efficacy of chemical compounds compared with botanical oils. Imidacloprid consistently achieved the highest reduction percentages against *P. blanchardi*, confirming its strong systemic and residual activity. These findings are in agreement with **(Abdulwahid and Mohammadali, 2021),** who reported high effectiveness of imidacloprid against armored scale insects under field conditions. Chlorpyrifos-ethyl showed moderate efficacy, which may be influenced by environmental degradation or the development of resistance, as commonly reported for organophosphate compounds. Botanical oils, particularly neem oil, exhibited moderate levels of control, which is consistent with the findings of **(Isman, 2020) and (Abdallah *et al*., 2022),** who highlighted the role of plant-derived products as eco-friendly alternatives with multiple modes of action, including antifeedant and growth-regulating effects. The relatively higher efficacy of neem oil compared to clove oil also supports the observations of **(Pavela and Benelli, 2019),** who emphasized the bioactivity of azadirachtin-based products against a wide range of insect pests. In addition, the results align with those of (**Hadi, 2024)** and **(Ibrahim and Mansor, 2025),** who demonstrated the effectiveness of plant-derived extracts and oils against *P. blanchardi*, supporting their potential inclusion in integrated pest management programs.

5. Conclusion

The present study demonstrated that *Parlatoria blanchardi* exhibited clear seasonal fluctuations under Nubaria conditions, with multiple population peaks and continuous presence throughout the year. Parasitoids showed a response to pest density but were insufficient to suppress high infestations. The distribution of *P. blanchardi* was significantly affected by cardinal directions, with higher infestations on the southern and western sides of date palm trees. Chemical treatments, particularly imidacloprid and chlorpyrifos-ethyl, provided the highest and most consistent levels of control across both seasons. In contrast, essential oils showed moderate effectiveness, supporting their role as supplementary tools within integrated pest management programs.

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التقلبات العددية ومكافحة الحشرة القشرية البيضاء *Parlatoria blanchardi* باستخدام المبيدات الكيماوية والزيوت العطرية في منطقة النوبارية، جمهورية مصر العربية

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الموجز

تمت دراسة ديناميكية التعداد الموسمي، ونسب التطفل الطبيعي، والتوزيع المكاني، وفعالية المكافحة الكيميائية للحشرة القشرية البيضاء *Parlatoria blanchardi* ، خلال موسمي 2024 و2025 في منطقة النوبارية بجمهورية مصر العربية. أظهرت نتائج التتبع الحقلي أن *P. blanchardi* سجلت ثلاث ذروات رئيسية سنويًا، خاصة في الربيع والخريف، مما يؤكد طبيعتها متعددة الأجيال. بلغت نسب التطفل بواسطة الطفيليات غشائية الأجنحة أقل من 20%، مما يوضح محدودية دورها في ضبط التعداد. كما تبين أن التوزيع المكاني للحشرة القشرية كان أعلى بوضوح على الاتجاهين الجنوبي والغربي مقارنة بالاتجاه الشمالي. أما تجارب المكافحة الكيميائية فقد أثبتت أن الإيميداكلوبريد هوالأكثر فعالية ضد الحشرة القشرية ، مع نسب خفض تجاوزت 90%. وسجل زيت النيم فعالية متوسطة، في حين كان زيت القرنفل والنعناع الأقل تأثيرًا. تؤكد هذه النتائج ضرورة الدمج بين وسائل المكافحة الكيميائية والحيوية ضمن برامج الإدارة المتكاملة للآفات لتحقيق استدامة المكافحة.