Seasonal dynamics and spatial distribution of black scale insect, *Saissetia oleae* (Olivier) on olive trees, and role of associated predators

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Abstract

Olive (*Olea europaea*) is an ancient, drought-resistant tree cultivated for several thousands of years, primarily in the Mediterranean region, for oil and table fruit. The olive black scale insect, *Saissetia oleae* (Olivier) (Coccidae: Hemiptera), is one of the key pests of olive. The seasonal abundance and spatial distribution of *S. oleae* were investigated over two consecutive seasons; from October 2023 to September 2024 and from October 2024 to Septemb er 2025. Populations exhibited clear annual fluctuations, with winter declines followed by pronounced spring and summer peaks. Immatures dominated throughout both seasons, reflecting continuous recruitment and extended crawler activity. Horizontal distribution showed higher insect densities on south and west directions of the canopy, while the lowest numbers were detected on north direction. Vertical distribution revealed that the middle level of the canopy harbored the highest populations of both immatures and adult females, whereas the lower level contained the fewest individuals. Two coccinellid predators; *Coccinella undecimpunctata* L. and *Exochomus flavipes* (Thunberg, 1781) (Coleoptera: coccinellidae), were recorded associated with *S. oleae* during both seasons. Their populations showed significant positive correlations with the total scale population, indicating a numerical response of the predators to host abundance. Spring and early summer peaks indicate critical windows for targeted management. Overall, the findings highlight the nearly year-round activity of *S. oleae*, and the influence of canopy microhabitats on population distribution.

Keywords: *Saissetia oleae*, Seasonal abundance, Horizontal distribution, Vertical distribution

Introduction

Olive (*Olea europaea* L.) is one of the most economically and culturally significant crops in Egypt, forming a cornerstone of both the agricultural sector and the national economy. The country ranks among the top producers of olive oil and table olives in the Mediterranean region, with olive cultivation extending across diverse agro-ecological zones, from the Nile Delta to Upper Egypt (FAO, 2022).

Given the long lifespan of olive trees and the perennial nature of cultivation, the health and productivity of these orchards are directly linked to the effective management of insect pests that can severely compromise yield and fruit quality (Abd-Rabou and Abbassi, 2009).

Among the most destructive insect pests, negatively affect olive trees, is the black wax scale, *Saissetia oleae* (Olivier) (Hemiptera: Coccidae). This soft-scale insect is widely distributed throughout Mediterranean olive-growing regions and has been identified as a key limiting factor in olive productivity worldwide (González *et al*., 2018). Adult females are sessile, exhibiting an oval body covered with a thick, protective wax layer that shields the insects from environmental stress and predation, whereas males are smaller, winged, and short-lived. Both nymphal and adult stages feed on the phloem sap of leaves, stems, and fruits, causing significant physiological stress. Infestations can lead to yellowing of leaves, defoliation, reduced fruit size and low oil content, and in severe cases, the trees are too much declined. Moreover, the honeydew excreted by *S. oleae* promotes the growth of sooty mold fungi, further diminishing photosynthetic efficiency of leaves and marketability of fruits (Tena *et al*., 2007). In olive ecosystems, populations of scale insects are often influenced by the activity of natural enemies, including predatory coccinellids and parasitoids, which contribute to the natural regulation of pest populations under field conditions.

Understanding the seasonal abundance and population dynamics of *S. oleae* is essential for implementing effective management strategies. Knowledge of the temporal patterns of population buildup enables growers to anticipate peak infestations and apply interventions at the most vulnerable stages of the insect's life cycle, thereby optimizing control efficacy and minimizing environmental impact (Soulsby and Thomas, 2012). Seasonal monitoring also provides insight into the phenology of the pest, including periods of crawler emergence, oviposition, and adult maturation, which are critical for synchronizing both chemical and biological control measures. Equally important is the study of the spatial distribution of *S. oleae* within the orchard and along the vertical gradient of the tree canopy. Horizontal distribution patterns across cardinal directions may reflect microclimatic conditions, sunlight exposure, and wind effects, which influence colonization and dispersal behaviors (Darwish, 2016). Vertical stratification, on the other hand, can reveal preferences for specific canopy levels; upper, middle, and lower strata, where variations in leaf density, temperature, and humidity affect inset survival, feeding, and reproduction (مرجع). Detailed knowledge of these spatial patterns is fundamental for designing targeted pest monitoring and localized management interventions, which can reduce the need for blanket insecticide applications and enhance the efficiency of integrated pest management (IPM) programs (مرجع). In addition, documenting the occurrence and seasonal abundance of associated natural enemies can provide useful information for strengthening biological control components within IPM strategies.

The present study aims to develop a comprehensive understanding of the seasonal abundance and population dynamics of *S. oleae*, and additionally to investigate its spatial distribution by examining both the horizontal distribution across the four cardinal directions and the vertical distribution among the upper, middle, and lower canopy strata.

Material and Methods

a) Study site and experimental trees

The study was carried out at a private olive (*Olea europaea* L.) farm located at the El Hammam district, Matrouh Governorate, Egypt, with a total cultivated area of approximately 10 feddans (about 4 hectares). All experimental trees were of 15- year old (about 3 m height) and maintained under uniform agricultural practices. Standard cultural operations were followed throughout the study, except for the exclusion of insecticidal applications, while irrigation was conducted using a drip irrigation system. Observations and treatments were conducted over two consecutive seasons: the first from October 2023 to September 2024, and the second from October 2024 to September 2025.

b) Ecological study of the olive black scale insect

To investigate the seasonal dynamics of the olive black scale, *Saissetia oleae* (Olivier) (Coccidae: Hemiptera), sampling was conducted every two weeks throughout each season. The study was carried out on five olive trees, and from each tree, twelve branches (20 cm each) with their leaves were collected randomly, giving a total of 60 branches per sampling date. The 60 branches represented four main cardinal directions (north, south, east, and west) and three vertical canopy levels (upper, middle, and lower), and five olive trees (as five replicates). The lower canopy level corresponded to branches located at approximately 1 m above ground level, the middle canopy around 2 m, and the upper canopy around 3 m above the ground level. Immature stages (including crawlers and nymphal instars) were counted collectively, whereas adult females were recorded separately as the mature stage, as the females are stable on the canopy, while the females are flying and could not be easily captured. Data were expressed as the number of individuals per branch to describe population fluctuations throughout the season. For seasonal analysis, the biweekly population records were pooled and classified into four main seasons (autumn, winter, spring, and summer). Mean population densities of immature stages, adult females, and total population were then calculated for each season to describe the seasonal abundance of *S. oleae* on olive trees.

c) Predatory coccinellid sampling

The abundance of predatory coccinellids associated with the black olive scale was assessed during the sampling program. Two predators were recorded: *Exochomus flavipes* and *Coccinella undecimpunctata*. Observations were conducted on the same sampled units used for scale insect assessment, consisting of 60 olive branches (each approximately 20 cm in length). All immature and adult stages of both predators present on the sampled branches were counted during each inspection. The results were expressed as the total number of predators (larvae + adults) per sample.

d) Statistical analysis

All collected data ere subjected to analysis of variance (ANOVA) using CoStat software. Mean differences among treatments were separated by the Least Significant Difference (LSD) test at a probability level of $P \leq 0.05$ to detect statistically significant differences in pest reduction among treatments.

Results and discussion

Seasonal abundance of *Saissetia oleae*

The population of *S. oleae* on olive trees exhibited clear seasonal fluctuations across the two studied seasons, with notable variation in both immature stages and adult females. Immature individuals predominated most of the year, indicating continuous recruitment and extended crawler activity (Tables 1 and 2 and Figs. 1 and 2).

First season (October, 2023 to September, 2024)

By early October, insect populations began at moderate levels (370 immatures and 145 adult females/ 60 branches) and declined through late November to 145 immatures and 110 adults, reflecting the effect of low temperatures and reduced metabolic activity (Table 1). Recovery started in December, with a pronounced increase from mid-February to early March, peaking at 430 immatures and 235 adults (total 665) on 3rd of March. A temporary decline occurred by late March as immatures transitioned to adults. Populations rose again in April–May (280–405 immatures), reaching the season's highest peak on 9th of June with 490 immatures and 210 adults (total 700). This early-summer maximum represented the primary generational culmination, with concurrent crawler and nymph activity. A minor decline was observed by late June, while July witnessed a gradual reduction in immatures and a drop in adults to 115 by 21 July, likely due to natural mortality, may be due to heat stress. Recovery occurred in August, reaching 240 adults and 335 immatures, before declining again in September (315–325 immatures, 155–160 adults). Overall, two major peaks were evident: early spring (March) and early summer (June), with a secondary rise in August, highlighting optimal timing for control during high population density of crawlers.

The 2nd season (October, 2024 to September, 2025)

Population dynamics in the second season showed similar patterns but with higher peaks (Table 2 and Fig. 2). Numbers started high by late September (395 immatures and 220 adults, total 615) and slightly declined through November. Winter minima occurred in mid-January (130 immatures and 90 adults, total 220), as reflected by lower temperatures, reduced metabolic activity, and limited sap flow. Recovery began in February, reaching 425 by early March. Populations continued rising through April, peaking with 590 by month-end. A sharp early-summer peak occurred in June (440 immatures, total 680), followed by stable high numbers in July. The highest population of the season was recorded in early August (485 immatures, 270 adults, total 755), demonstrating successful overlapping generations. Counts declined moderately by mid-August and September, remaining relatively high (540 total) before the following winter.

Both seasons had a consistent annual cycle: winter suppression followed by spring and summer population build-up. The first season had a moderate winter decline with a single major summer peak, while the second season had a stronger, earlier June peak and the highest late-summer peak in August. Winter reductions in December–January were evident in both seasons, reflecting sensitivity to low temperatures and limited sap availability, consistent with wax scale biology (Darwish, 2021). The dominance of immatures in total population trends was clear, with high nymphal counts during peak months serving as reliable indicators of population build-up and economic risk Ilias, and Hammadi, 2017; Mesbah, *et al*., 2020;). Differences between seasons likely reflect environmental variations, including warmer summer conditions and improved host plant quality during the second season (Bakry, *et al.* 2015). In summary, *S. oleae* maintains nearly year-round activity, with mid-winter reductions and major summer peaks. Temperature-driven developmental rhythms govern seasonal abundance, and the summer generations represent the critical period for effective chemical or natural management interventions (Souza *et al*. 2015; Abou-Ghadir, 2025).

Table 1: Seasonal abundance of immature stages, adult females, and total population (per 60 olive branches) of *Saissetia oleae* and its predators on olive trees during the 1st season (October 2023 – September 2024)

Investigation date	*S. oleae*			Predators	
	Immature stages	Adult females	Total population	*Coccinella undecimpunctata*	*Exochomus flavipes*
01-Oct	370	145	515	2	0
15-Oct	305	155	460	4	1
29-Oct	280	160	440	5	0
12-Nov	190	115	305	6	0
26-Nov	145	110	255	3	0
10-Dec	180	160	340	4	0
24-Dec	230	155	385	3	0
07-Jan	245	150	395	2	0
21-Jan	310	170	480	3	3
04-Feb	265	205	470	7	4
18-Feb	265	225	490	9	5
03-Mar	430	235	665	10	6
17-Mar	405	220	625	9	5
31-Mar	275	140	415	10	4
14-Apr	355	215	570	12	9
28-Apr	330	230	560	11	7
12-May	280	190	470	9	6
26-May	405	185	590	14	5
09-Jun	490	210	700	16	4
23-Jun	420	225	645	14	6
07-Jul	360	230	590	13	8
21-Jul	265	115	380	10	8
04-Aug	275	125	400	9	7
18-Aug	335	240	575	12	10
01-Sep	325	160	485	13	8
15-Sep	315	155	470	12	6
r				r= 0.668**	r=0.533**

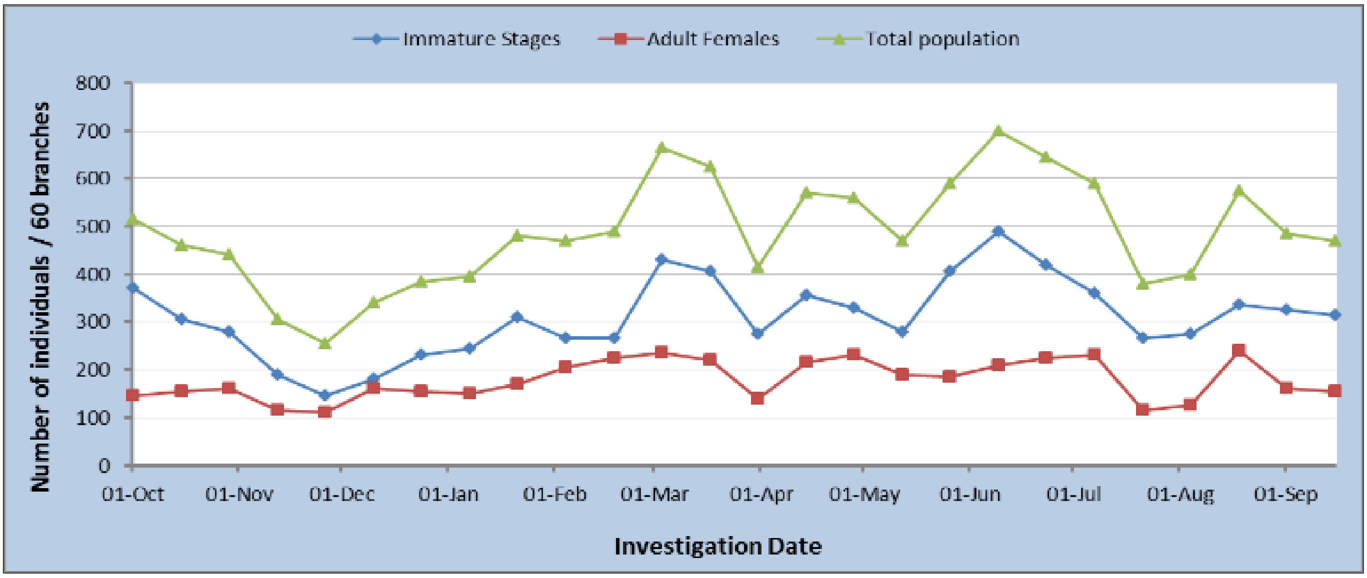

Fig 1: Seasonal abundance of immature stages, adult females, and total population of *Saissetia oleae* on olive trees during the 1st season (October 2023 – September 2024)

Table 2: Seasonal abundance of immature stages, adult females, and total population of *Saissetia oleae* (per 60 olive branches) and its predators on olive trees during the 2nd season (October 2024 – September 2025)

Investigation date	Immature stages	Adult females	Total population	*Coccinella undecimpunctata*	*Exochomus flavipes*
29-Sep	395	220	615	5	1
13-Oct	380	160	540	6	0
27-Oct	340	205	545	4	1
10-Nov	290	260	550	5	0
24-Nov	180	140	320	3	1
08-Dec	210	140	350	4	2
22-Dec	165	135	300	4	3
05-Jan	140	105	245	4	4
19-Jan	130	90	220	5	5
02-Feb	240	85	325	3	4
16-Feb	195	110	305	5	3
02-Mar	285	140	425	7	6
16-Mar	275	155	430	10	8
30-Mar	380	210	590	14	7
13-Apr	340	215	555	13	14
27-Apr	305	230	535	16	15
11-May	280	245	525	18	20
25-May	275	215	490	22	25
08-Jun	440	240	680	27	19
22-Jun	350	195	545	35	16
06-Jul	340	245	585	27	14
20-Jul	330	215	545	25	13
03-Aug	485	270	755	21	10
17-Aug	400	195	595	28	11
07-Sep	370	140	510	30	6
21-Sep	350	190	540	19	8
				r=0.607**	0.409*

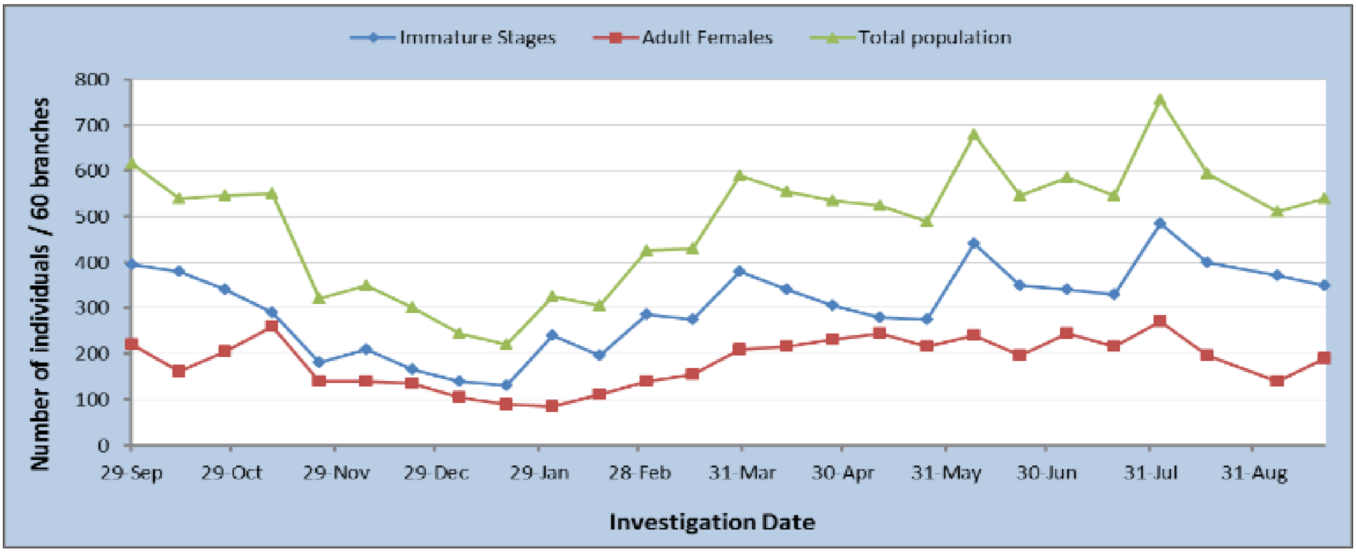

Fig 2: Seasonal abundance of immature stages, adult females, and total population of *Saissetia oleae* on olive trees during the 2nd season (October 2024 – September 2025)

Population abundance of *Saissetia oleae* during year seasons

In 2023–2024

During 2023–2024 season (Table 3), the seasonal abundance of *Saissetia oleae* exhibited significant variation among the four seasons for immature stages, adult females, and total population, as indicated by the ANOVA results (F = 2.867, 3.366, and 3.594, respectively). Spring recorded the highest mean densities of immature stages (365 ± 78.42 individuals), adult females (199.29 ± 31.01), and total population (564.29 ± 97.32), showing no significant difference from winter in adult females and total population, according to the LSD test at P ≤ 0.05. Winter also supported relatively high population levels, particularly for adult females and total population, reflecting favorable conditions for survival and development during this period. In contrast, autumn exhibited significantly lower population densities across all stages, especially for immature stages and adult females. Summer populations were intermediate, with no significant differences from winter or spring in most cases. Overall, immature stages consistently constituted the dominant portion of the population throughout all seasons, indicating continuous crawler emergence and sustained population recruitment during most of the year.

In 2024–2025

In 2024–2025 season (Table 4), highly significant seasonal differences were observed among seasons for immature stages, adult females, and total population (F = 8.046, 12.044, and 12.169, respectively). Spring and summer recorded the highest population densities, with immature stages reaching 336.67 ± 64.16 and 375 ± 53.62 individuals, respectively, and total populations exceeding 560 individuals per sampling unit, with no significant differences between these two seasons. Adult females followed a similar trend, peaking during spring and summer, reflecting enhanced population buildup under favorable environmental conditions. Autumn also supported relatively high population levels, but winter showed a marked and significant decline across all stages, recording the lowest means for immature stages (204.29 ± 63.34), adult females (117.14 ± 26.59), and total population (321.43 ± 81.02). As observed in the first season, immature stages dominated the population structure throughout the year, confirming the prolonged activity and continuous reproduction of *S. oleae*. These results emphasize that spring and summer represent the main periods of population increase and are critical seasons for implementing effective management strategies.

Table 3: Seasonal population abundance of *Saissetia oleae* (per 60 olive branches), during autumn, winter, spring, and summer in 2023–2024

Season	Immature stage	Adult female	Total population
Autumn	245±86.83b	140.83±22.67b	385.83±100.87b
Winter	307.14±79.63ab	194.29±35.29a	501.43±106.84a
Spring	365±78.42a	199.29±31.01a	564.29±97.32a
Summer	312.5±36.3ab	170.83±52.67ab	483.33±86.7ab
F	2.867	3.366	3.594
LSD	88.1462	43.982	118.0252

Means followed by the same letter are not significantly different at the 5% level

Table 4: Seasonal population abundance of *Saissetia oleae* (per 60 olive branches), during autumn, winter, spring, and summer in 2024–2025

Season	Immature stage	Adult female	Total population
Autumn	299.17±89.02a	187.5±48.76a	486.67±120.98a
Winter	204.29±63.34b	117.14±26.59b	321.43±81.02b
Spring	336.67±64.16a	225.83±14.63a	562.5±66.39a
Summer	375±53.62a	207.14±41.92a	582.14±81.44a
F	8.046	12.044	12.169
LSD	81.3388	42.52018	106.60625

Means followed by the same letter are not significantly different at the 5% level

Horizontal distribution of *Saissetia oleae* immature stages and adult females

The 1st season

The horizontal distribution of *S. oleae* immature stages and adult females on olive trees during the first season revealed significant directional differences (Table 5, Fig. 3). Immature stages were most abundant on the south (95 ± 22.45) and west (84.81 ± 26.89) orientations, while the north side supported the lowest numbers (57.69 ± 18.07), indicating a clear microhabitat preference (F = 14.146, $P < 0.05$). Adult females showed a similar pattern, with highest densities on the south (57.69 ± 13.21), followed by the west and east, and lowest on the north (34.04 ± 9.38; F = 20.076, $P < 0.05$). These findings suggest that the southern and western directions of trees, likely receiving higher sunlight and warmth, favor both immature development and adult survival. Conversely, northern branches, which may remain shaded, supported smaller populations. The consistent predominance of immatures on south-facing foliage during the first season aligns with the species' biology, as developing nymphs require optimal microclimatic conditions for feeding and growth. Such directional aggregation also highlights areas of the tree that are likely to contribute most to population buildup and subsequent crawler emergence.

The 2nd season

In the second season, similar directional trends were observed, although overall densities were slightly higher, than those of the first year, for both stages (Table 5, Fig. 4). Immature stages peaked on the south (92.62 ± 27.35) and west (78.96 ± 25.84), while the north again recorded the lowest counts (59.96 ± 20; F = 8.38, $P < 0.05$). Adult females were most abundant on the south (58.65 ± 17.24) and west (45.58 ± 12.75), with northern branches showing the lowest numbers (37.31 ± 10.7; F = 10.649, $P < 0.05$). The east side maintained intermediate densities for both stages.

The two seasons consistently indicated directional preference, with the south and west sides providing favorable conditions for immature and adult populations. These patterns likely result from microclimatic factors, including sunlight exposure, leaf temperature, and possibly wind protection, which enhance feeding efficiency and survival. Notably, adult females exhibited slightly less variation than immatures, reflecting their sessile nature. Understanding these directional trends can improve the timing and targeting of control measures, as chemical or biological interventions applied to the preferred orientations (south and west) could intercept the majority of the population during key developmental stages (Darwish, 2016). Asmaa and Mohamed (2020) reported that the black wax scale, *Saissetia oleae*, showed a clear preference and higher aggregation on the eastern and southern aspects of olive trees in two different regions of Algeria. Overall, the data demonstrate that *S. oleae* shows strong horizontal aggregation on tree sides that provide optimal microhabitats, with immatures consistently more abundant than adult females across all orientations. Management strategies should incorporate this knowledge to maximize insect control efficiency, particularly during spring and early-summer peaks when population pressure is highest.

Table 5: Seasonal distribution of *Saissetia oleae*/ 15 olive branches across the four cardinal directions

Cardinal directions	The 1st season		The 2nd season	
	Immature stage	Adult female	Immature stage	Adult female
East	72.12±18.98b	39.62±12.96c	71.15±22.82bc	41.15±16.39bc
West	84.81±26.89a	46.54±10.37b	78.96±25.84b	45.58±12.75b
South	95±22.45a	57.69±13.21a	92.62±27.35a	58.65±17.24a
North	57.69±18.07c	34.04±9.38c	59.96±20c	37.31±10.7c
F values	14.146	20.076	8.38	10.649
LSD	12.03589	6.3808	13.299	7.9874

Means followed by the same letter are not significantly different at the 5% level

Fig. 3. Seasonal distribution of *Saissetia oleae* across the four cardinal directions during the 1st season (Polygons marked with the same letter(s) are not significantly different from each other; small letters for immature stages, capital letters for adult females).

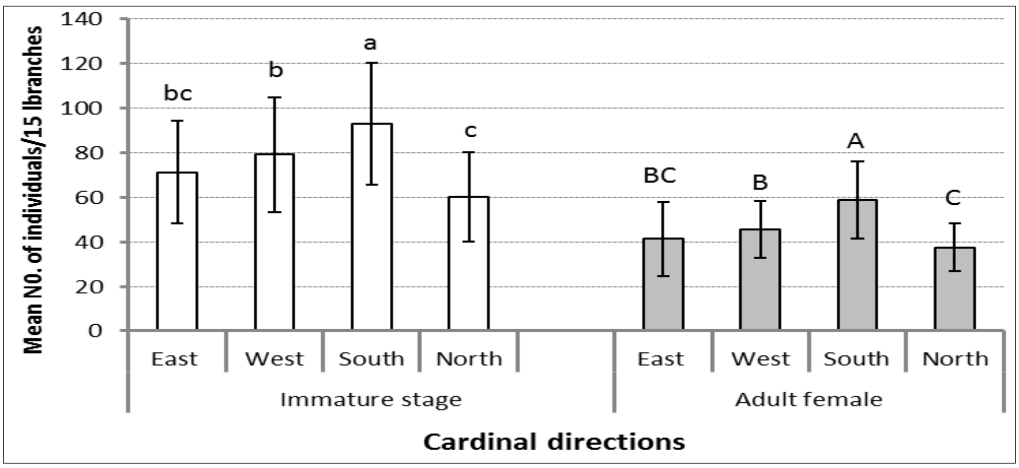

Fig 4: Seasonal distribution of ***Saissetia** oleae* across the four cardinal directions during the 2nd season (Polygons marked with the same letter are not significantly different from each other; small letters for immature stages, capital letters for adult females)

Vertical distribution of *Saissetia oleae* across canopy strata

The vertical distribution of *S. oleae* in the olive tree canopy is presented in Table 6 and Figs. 5 and 6. In both seasons, the middle stratum harbored the highest numbers of immature stages and adult females. Specifically, during the first season, the middle stratum contained 123.35±31.6 immatures and 72.54±16.76 adult females, significantly higher than the upper (95.65±26.45 immatures, 63.65±18.48 adult females) and the lower strata (90.62±24.72 immatures, 41.69±8.44 adult females). Similarly, in the second season, the middle stratum had 126.73±36.94 immatures and 78.81±21.21 adult females, compared to the upper (95.85±29.07 immatures, 67.96±23.45 adult females) and lower strata (80.12±27.27 immatures, 35.92±10.56 adult females). This pattern aligns with previous studies (e.g. Bakry, and Tolba, 2019; Bakry, *et al*., 2024), showing that scale insects preferentially occupy the middle canopy, likely due to optimal microclimatic conditions and availability of tender feeding sites. The lower stratum consistently harbored the fewest individuals, particularly adult females, which may be related to higher predation or less favorable feeding conditions. In contrast to the present findings, Youssef and Taksira (2023) reported that *S. oleae* showed a clear preference for the lower canopy level, followed by the middle level, while the lowest population densities were recorded in the upper canopy of olive trees. The stability of this vertical distribution, in the current stydy, across both seasons highlights its importance for monitoring and targeted pest management, ensuring interventions focus on the canopy strata most heavily infested by *S. oleae*.

Table 6: Vertical distribution of *Saissetia oleae* across olive tree strata

Stratum	The 1st season		The 2nd season	
	Immature stage	**Adult female**	**Immature stage**	**Adult female**
Upper	95.65±26.45b	63.65±18.48b	95.85±29.07b	67.96±23.45b
Middle	123.35±31.6a	72.54±16.76a	126.73±36.94a	78.81±21.21a
Lower	90.62±24.72b	41.69±8.44c	80.12±27.27b	35.92±10.56c
f vales	10.4915	28.34318	14.8495	34.8844
LSD	15.3285	8.40248	17.3375	10.6359

Means followed by the same letters are not significantly different (LSD, $p \leq 0.05$)

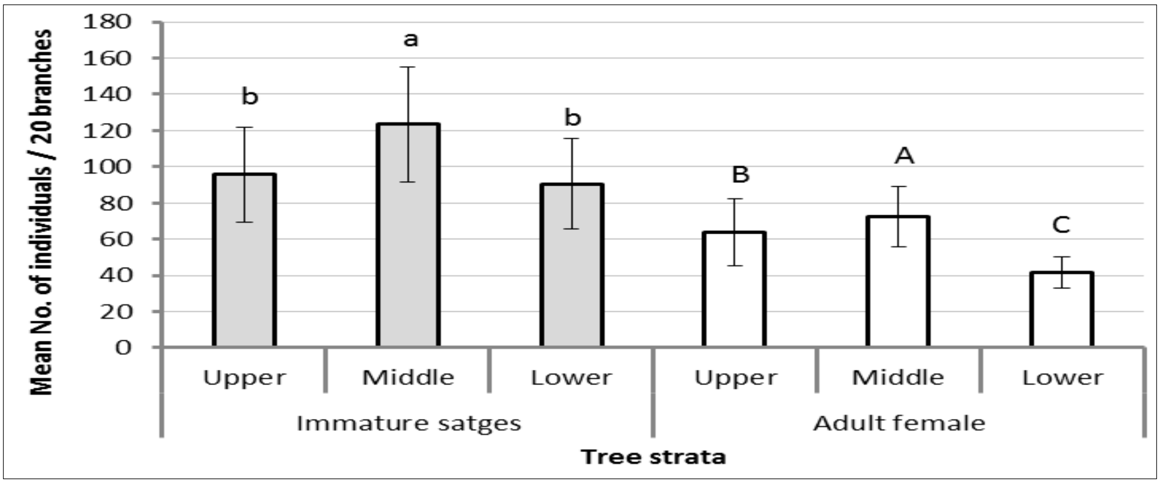

Fig 5: Vertical distribution of *Saissetia oleae* across olive tree strata in the 1st season (Polygons marked with the same letter are not significantly different from each other; small letters for immature stages, capital letters for adult females)

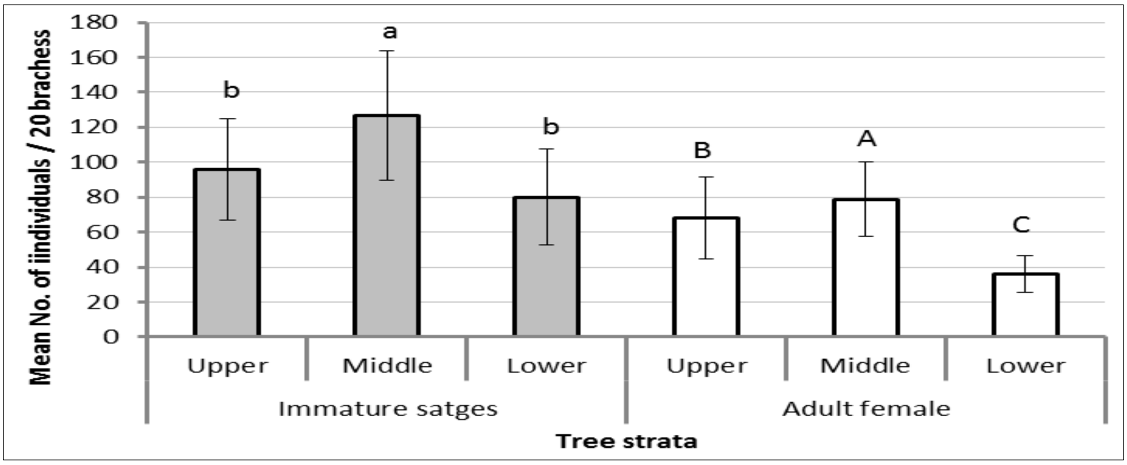

Fig 6: Vertical distribution of *Saissetia oleae* across olive tree strata in the 1st season (Polygons marked with the same letter are not significantly different from each other; small letters for immature stages, capital letters for adult females)

Population fluctuations of predatory coccinellids associated with the black olive scale insect, *Saissetia oleae*

During 2023–2024 season, two predatory coccinellids; *Coccinella undecimpunctata* and *Exochomus flavipes*, were recorded on olive branches infested with the black olive scale. The population of *C. undecimpunctata* appeared in low numbers at the beginning of October (2 individuals/60 branches), then gradually increased throughout the season, reaching its highest density during early summer with a peak of 16 individuals on 9 June. Afterwards, the population fluctuated moderately until the end of the season. A significant positive correlation was observed between the predator population and the total population of the scale insect (r = 0.668**), indicating that the predator density tended to increase with the increase of host abundance. In contrast, *E. flavipes* was recorded at lower densities during most of the season, appearing sporadically during autumn and winter, then gradually increasing from February onward and reaching a maximum of 10 individuals/60 branches during mid-August. The relationship between this predator and the scale population was also significantly positive (r = 0.533**), suggesting that the predator responded numerically to the availability of the prey.

In 2024–2025 season, similar predatory population densities were recorded, with generally higher densities compared with the previous season. *C. undecimpunctata* was detected from late September with 5 individuals and showed a gradual increase during spring and early summer, reaching the highest population level of 35 individuals on 22nd of June before declining slightly towards the end of the season. The correlation analysis revealed a significant positive relationship between the predator abundance and the total population of the scale insect (r = 0.607**). On the other hand, *E. flavipes* showed relatively low numbers during autumn and winter but increased markedly from April onwards, reaching its peak of 25 individuals on 25th of May. The predator population then fluctuated moderately during the remaining months of the season. The correlation coefficient between this predator and the scale insect population was positive and significant (r = 0.409*), indicating that its population dynamics were also associated with the abundance of the host insect.

Conclusion

The current study demonstrates that the black olive scale insect, *Saissetia oleae* (Olievier) maintains active populations throughout the year, with pronounced peaks during spring and early summer. South side of the trees harboured the highest population density of the insect individuals, while the north side received the lowest one. As for vertical directions, the middle level was more preferable to *S. oleae* to lower level. These clear directional and vertical preferences within the olive tree canopy highlight the importance of understanding pest micro-habitat behavior when designing monitoring and control programs. In addition, two predatory coccinellids; *Coccinella undecimpunctata* L. and *Exochomus flavipes* (Thunberg) were recorded in association with the pest and showed positive correlations with its population density, indicating their potential contribution to natural biological control.

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