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Impact of Organic Fertilization on Population of Scale Insects and Mealybugs Infesting Sesame Plants, *Sesamum indicum* L. and its Role in Integrated Crop Management

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Abstract: Field experiments were conducted at Giza Governorate, Egypt, during two successive seasons (2024-2025 and 2025-2026) to survey sap-sucking pests infesting sesame, *Sesamum indicum* L. (cv. Giza 32). This presented work was carried out to survey of mealybugs and scale insects which attacked sesame plants and the associated natural enemies, as well as studied the population density, peaks and generations of brown scale insect, *C. hesperidum* and the associated natural enemies in addition to, evaluated the effects of some climatic factors on the *C. hesperidum*. Finally, to investigated the effect of mineral and organic fertilization on the dominant pest. Survey results revealed five species belonging to families Coccidae and Pseudococcidae: *Phenacoccus solenopsis, Ferrisia virgata, Planococcus citri, Pseudococcus longispinusand, Coccus hesperidum* were monitored. Also, we monitored various species of predators and parasitoids were associated with scale insects and mealybugs on sesame plants. *C. hesperidum* (Coccidae) was the most abundant and damaging species during vegetative stage (June-September). Seasonal abundance studies showed that *C. hesperidum* had two overlapping generations per year, with population gradually increasing from May to reach a maximum peak on 15th August (2473 and 3590 individuals /125 leaves) in first and second seasons, respectively. Four species of natural enemies were associated with *C. hesperidum*, *Scymnus* spp. (40%) and *Chrysoperla carnea* (32%) were the most dominant. Weather factors had highly significant positive correlation with pest population. Maximum temperature was the most effective factor (r=0.968 and 0.978) explaining 93.7% and 95.65% of population

variation, while combined weather factors explained 96.2%. Concerning fertilization, full mineral NPK (100% RD) recorded the highest infestation (82.5 individuals/125 leaves, 0% reduction). The lowest infestation was recorded in unfertilized control (18.75 individuals, 77.27% reduction) followed by compost at 2 ton/fed (25.75 individuals, 68.79% reduction). Increasing mineral proportion increased infestation: 75% compost+25% NPK (44.6 individuals, 45.94% reduction) and 50% compost+50% NPK (62.81 individuals, 23.87% reduction). It is concluded that organic fertilization at 2 ton/fed or integrated fertilization (75% compost + 25% NPK) can be recommended as sustainable, eco-friendly and cost-effective tactic for suppressing *C. hesperidum* within IPM programs in sesame fields.

Key words: Sesame; *Coccus hesperidum*; survey; population dynamics; natural enemies; organic compost; mineral fertilization; IPM.

1. Introduction

Sesame (*Sesamum indicum* L.) is an economically valuable oilseed crop that is grown under a wide range of environmental conditions. Its seeds are an important source of vegetable oil and are also incorporated into several food products. (**Ashri, 1998**). In Egypt, sesame is mainly cultivated as a summer crop and represents an important source of oilseed production. Cultivation is concentrated in several governorates of Upper Egypt, such as Minya, Qena, Assiut, Sohag, Fayoum, Aswan, and Beni Suef. Production has also expanded into some areas of Lower Egypt, notably Sharkia and Nubaria. Within these regions, important growing localities include Faqous, Abu Kebir, and Kafr Saqr in Sharkia, together with Girga and Dar El-Salam in Sohag. Because of its tolerance to heat and relatively dry conditions, sesame can also be grown successfully in newly reclaimed soils, making it a promising crop for the expansion of agricultural production in Egypt.



Fig. (1). Sesame cultivation Map of Egypt

The cultivation of sesame (*Sesamum indicum* L.) may be influenced by a diverse group of insect pests that occur throughout the crop growth cycle. Among the insects associated with sesame (**Alemu & Taye, 2022**). Depending on the species and its feeding behavior, infestation can occur on leaves, tender shoots, flowers, or other plant structures, leading to different forms of plant injury. The presence and development of these pests may consequently affect normal plant growth and productivity. Therefore, identifying the major insect pests associated with sesame and understanding their occurrence are essential steps for developing appropriate and sustainable pest-management programs.

Among the sap-sucking insects associated with agricultural crops, mealybugs belonging to the family Coccoidae: *Coccus hesperidum* L., are of particular importance. These insects have a broad host range and may colonize different plant parts, where their feeding can weaken plants and interfere with normal growth. In Egypt, a considerable diversity of mealybug species has been documented, highlighting the importance of this group within the country's agricultural entomofauna **(Evans & Abd-Rabou, 2023)**. Previous surveys have also demonstrated the occurrence of several economically important mealybug species on different plant hosts in Egypt **(Badr *et al.*, 2020; Abd-Rabou & Malausa, 2010)** & **(Peri and Kapranas, 2012)**.

Organic agriculture is an important approach to sustainable agricultural development in Egypt. It promotes the use of natural fertilizers, compost, and biological pest control while reducing dependence on synthetic chemicals. Organic farming contributes to improving soil fertility, protecting the environment, and producing safe, high-quality agricultural products. Organic agriculture may influence insect population dynamics through reduced use of synthetic pesticides and increased reliance on organic fertilizers and biological control. The absence of chemical pesticide applications may favor the survival and development of certain insect pests, potentially resulting in increased population densities. However, organic farming practices can also enhance biodiversity and support natural enemies, including predators and parasitoids, which may contribute to the regulation of pest populations, **(Bengtsson *et al.*, 2005; Zehnder *et al.*, 2007; Cloyd, 2020).** Therefore, the effect of organic agriculture on insect abundance depends on the balance between pest development and the activity of associated natural enemies, (**Crowder *et al.*, 2010).**

2. Material and methods

1. Experimental Location

The study was carried out at the Experimental Farm of the Central Laboratory of Organic Agriculture, Agricultural Research Center, Giza Governorate, and Egypt. Ten sesame plants were randomly selected, and 125 leaves were randomly examined/collected at each sampling date. Sampling covered the four cardinal directions of the plants as well as the inner parts of the plant canopy. Samples were collected at two-week intervals throughout the study period.

2. Field Survey and Ecological aspects on some mealybugs and scale insects and their associated natural enemies in Egypt

A field survey of mealybugs and scale insects was conducted on ten on sesame plants, *S. indicum* L., Sampling was carried out at monthly intervals over two successive seasons from 20-202424-2025 and 2025-2026. The selected sesame plants were maintained under normal agricultural practices without application of any chemical pesticides throughout the survey period. Leaf samples were placed in polyethylene bags and immediately transferred to the laboratory for inspection. Scale insects and mealybugs were sorted into three developmental stages: crawlers, adult females, and gravid females, and their numbers were counted and recorded. Predators and parasitoids associated with these pests were also collected and recorded. Infested leaf samples were kept in carton boxes under controlled laboratory conditions (25-30°C and 65-70% R.H.) until emergence of natural enemies. Identification of all collected natural enemies was kindly confirmed by Prof. Dr. Angel R. Attia, Plant Protection Research Institute, Agricultural Research Center, Giza, Egypt.

Ecological aspects were studied to determine the population density, seasonal peaks, and number of generations of the brown soft scale, *Coccus hesperidum* L., and its associated natural enemies. The experiment was conducted in a pesticide-free orchard where ten trees were selected. Sampling was

carried out on a biweekly basis; ten leaves and five small twigs were randomly collected from different directions of each tree. The samples were enclosed in muslin bags and transferred to the laboratory for examination. Both upper and lower surfaces of leaves were inspected under a stereoscopic binocular microscope. All living developmental stages as well as parasitized individuals were counted and recorded. Predators observed in association were also recorded and identified. The number of annual generations, their peaks, and durations for *C. hesperidum* were estimated according to the formula proposed by **(Audemard and Milaire 1975**) and emended by (**Jacob, 1977**).

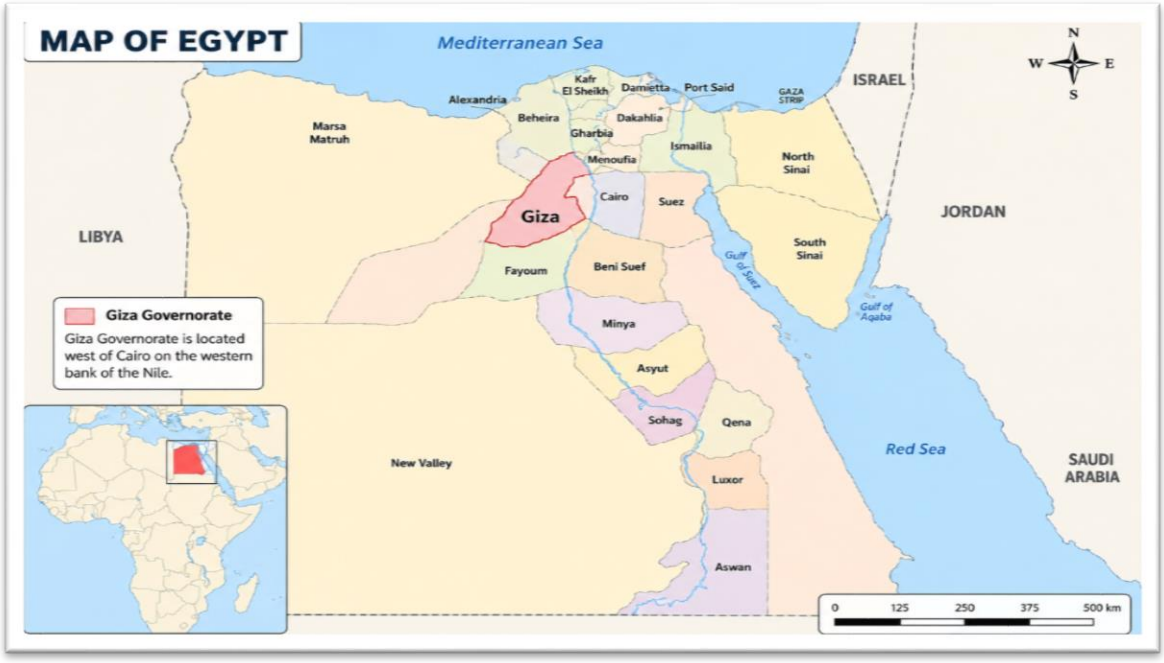


Fig. (2). Experimental Location and Map of Egypt

3. Influence of climatic factors on Population Dynamics of the brown soft scale, *C. hesperidum* L., and its natural enemies in Giza Governorate, during Two Seasons (2024–2025 and 2025–2026)

Climate change information system and renewable energy (**CCICRE**), Agricultural Research Center, Ministry of Agriculture provided us with data of maximum and minimum air temperature (°C) and relative humidity percentage (RH %) in Experimental farm of the Central Laboratory of Organic Agriculture, Agricultural Research Center, Giza Governorate, Egypt. The impact of these weather factors on the population fluctuations of the studied pests was evaluated.

4. Effect of some Bio fertilizers on population density of the brown soft scale, *C. hesperidum* L., on Sesame Plants during two Seasons (2024–2025 and 2025–2026)

Field experiments were conducted at the experimental farm of the Central Laboratory of Organic Agriculture (CLOA), Agricultural Research Center, Giza, Egypt, during two successive seasons (2024-2025 and 2025-2026) on Sesame plants variety (Giza 32) was grown on clay soil. The experimental area was divided into plots (5 × 6 m) arranged in a randomized complete block design (RCBD) with three replicates. Five treatments were applied as follows: Control (without fertilization), Full dose of compost (2 ton/ feddan), 75% compost + 25% recommended dose (RD) of NPK, 50% compost + 50% RD of NPK and Full RD of NPK (as chemical fertilizer check). All agricultural practices were carried out according to the recommendations of the Ministry of Agriculture.

4.1. Mineral fertilization

The recommended dose of mineral fertilization for sesame cv. Giza 32 in clay soil was applied at rate of 60 Kg N (ammonium nitrate 33.5%N) divided into two equal dose, the first after thinning (21

days after sowing) and the second before flowering. We put 30 Kg P_2o_5 (applied as single superphosphate 15.5 % P_2o_5 applied as basel dose during soil preparation. As well as, 24 kg K_2o per feddan of Potassium applied as (potassium sulphate 48% k2o) applied with the first N dose.

4.2. Organic fertilization

One type of compost was evaluated as organic sources: Plant Compost Produced from composted rice straw and maize stalks. + Animal Compost Produced from farmyard manure (cattle manure). Compost was obtained from [Beni-Suef Compost Company] and incorporated 2 weeks before sowing and incorporated into the soil two weeks before sowing during land preparation. The recommended dose was 3 ton fed for when applied at 100%.

Table (1). Physical and chemical analyses of the experimental soil

Sand %	Silt %	Clay %	Texture	pH	EC dS/m	Cations meq/l				Anions meq/l			
						Ca^{++}	Mg^{++}	K^{+}	Na^{+}	$Co_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$
23.7	36.8	39.5	Clay loam	7.62	2.45	3.20	2.80	0.80	2.35	1.22	2.37	3.23	3.80

Table (2). Analyses of Compost

PH 1:10	EC 1:10 ds/m	O.C (%)	O.M (%)	C/N Ratio	N	P	K	$N\text{-}NH_4$	$N\text{-}NO_3$
					%			ppm	
7.12	3.69	17.15	28.13	18.84	0.91	0.71	1.20	302.00	76.00

The experiment included the combination between rates:

T1: 100% Compost - 3 ton / fed

T2: 75% Compost + 25% NPK - (2.25 ton Compost + 25% NPK)

T3: 50% Compost + 50% NPK - (1.50 ton Compost + 50% NPK)

Compost (Plant and Animal) were applied two weeks (15 days) before sowing during final land preparation. The required quantity per plot was broadcasted manually and thoroughly mixed with the surface soil layer (20-30 cm) by plowing. This early application was done to allow decomposition of organic matter, avoid phytotoxicity to sesame seeds, and stimulate microbial activity.

5. statical analysis

An Analysis of Variance (ANOVA) for a Randomized Complete Block Design (RCBD) was applied to the data. At the 0.05 probability level, Duncan's Multiple Range Test (DMRT) was used to compare treatment means. Using MSTAT-C, all statistical analyses were conducted.

3. Results and Discussion

1. List Scale insects and mealybugs and associated natural enemies on sesame plants, *S. indicum* L. in Egypt

1.1. Scale insects and mealybugs on sesame plants, *S. indicum* L. in Egypt

The data presented in Fig. (3) indicate the presence of five species of scale insects and mealybugs were recorded on sesame plants, *Sesamum indicum* L., with noticeable differences in their infestation

levels, seasonal occurrence, and association with plant growth stages. *Ph. solenopsis* was among the most prevalent species, showing a high infestation level and occurring from May to October, mainly during the vegetative and flowering stages. Similarly, *F. virgata* Cockerell was classified as a highly infesting species and was detected from mid-May to October, extending from the flowering stage through pod formation and maturation. A moderate infestation level was observed for *P. citri* (Risso), which was recorded mainly during September and October in association with pod formation and maturation. In comparison, *P. longispinus* Targioni Tozzetti showed a low infestation level and was detected during August and September, particularly at the flowering stage. However, we found that the brown soft scale, *C. hesperidum* L., exhibited a high infestation level and occurred from June to September, mainly during the vegetative stage.

The observed differences in seasonal distribution and infestation severity suggest that each pest species has a distinct pattern of association with sesame growth and development. The prolonged occurrence and relatively high infestation levels of *P. solenopsis, F. virgata* and *C. hesperidum* indicate their greater importance among the recorded pests. Therefore, monitoring should receive particular attention during the vegetative and reproductive stages, when several of the recorded species were present.

1.2. Predators and parasitoids associated with scale insect and mealybug on sesame plants, *S. indicum* L.

Fig. (4) illustrated the relative occurrence of natural enemies associated with the principal scale insects and mealybug species observed on sesame plants. Both predatory and parasitoid species were detected, although their occurrence differed among the investigated pest species. In populations of *P. solenopsis*, *C. septempunctata* was the most frequently observed natural enemy (38%), followed by *C. carnea* (25%), *N. hiekei* (21%), and *A. kamali* (16%). For *F. virgata*, *Orius* spp. and *Scymnus* spp. represented the predominant associated natural enemies, accounting for 39% and 36%, respectively. In the case of *P. citri*, the highest occurrence was recorded for *Orius* spp. (40%), followed by *Scymnus* spp. (33%) and *N. hiekei* (27%). For *P. longispinus*, *Scymnus* spp. had the greatest occurrence (44%), while *C. carnea*, *Leptomastidea abnormis*, and *A. kamali* accounted for 26%, 20%, and 10%, respectively. Similarly, *Scymnus* spp. was the most frequently encountered natural enemy associated with *C. hesperidum* (40%), followed by *C. carnea* (32%), *C. scutellaris* (18%), and *M. helvolus* (10%). Overall, the observed variation in natural-enemy composition and occurrence among pest species suggests that different pest–natural enemy associations may occur within the sesame agroecosystem.

2.2. Seasonal abundance and peaks of *C. hesperidum* and associated natural enemies on sesame plants, *S. indicum* L.

Data on Fig. (5) illustrated that the Population dynamics of *C. hesperidum* on sesame plants during seasons 2024-2025 and 2025-2026 showed that the population started with low numbers at the beginning of May and then gradually increased to reach its peak in Mid- August, recording 2.473 individuals 125/ leaves in first season and 3.590 individuals 125/leaves during second season of study and continuous decline occurred until Mid- October. The peak of *C. hesperidum* on sesame plants is from Mid- June to Mid- August. Second season exhibited a significally higher population density than the first season. These results agreed with **(Mohamed & El- saied, 2018)** who reported that the highest population density of *C. hesperidum* occurs during August in Egypt. Decline occurred until Mid- October. The peak of *C. hesperidum* on sesame plants is from Mid- June to Mid- August. Second season exhibited a significally higher population density than the first season. These results agreed with **(Mohamed & El-saied, 2018)** who reported that the highest population density of *C. hesperidum* occurs during August in Egypt.

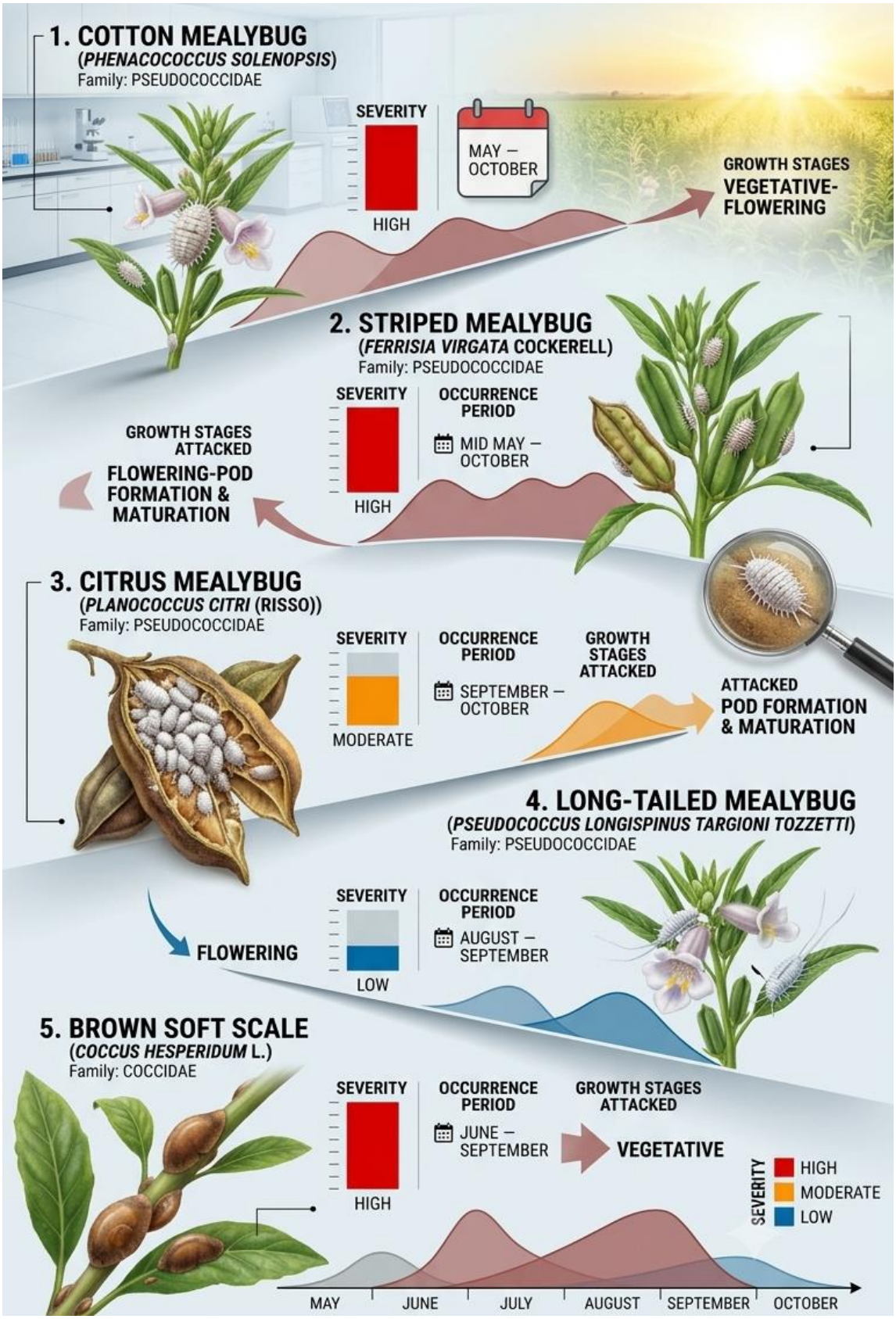


Fig. (3). Infestation severity level and occurrence period of scale insects and mealybugs on sesame plants, *S. indicum* L.

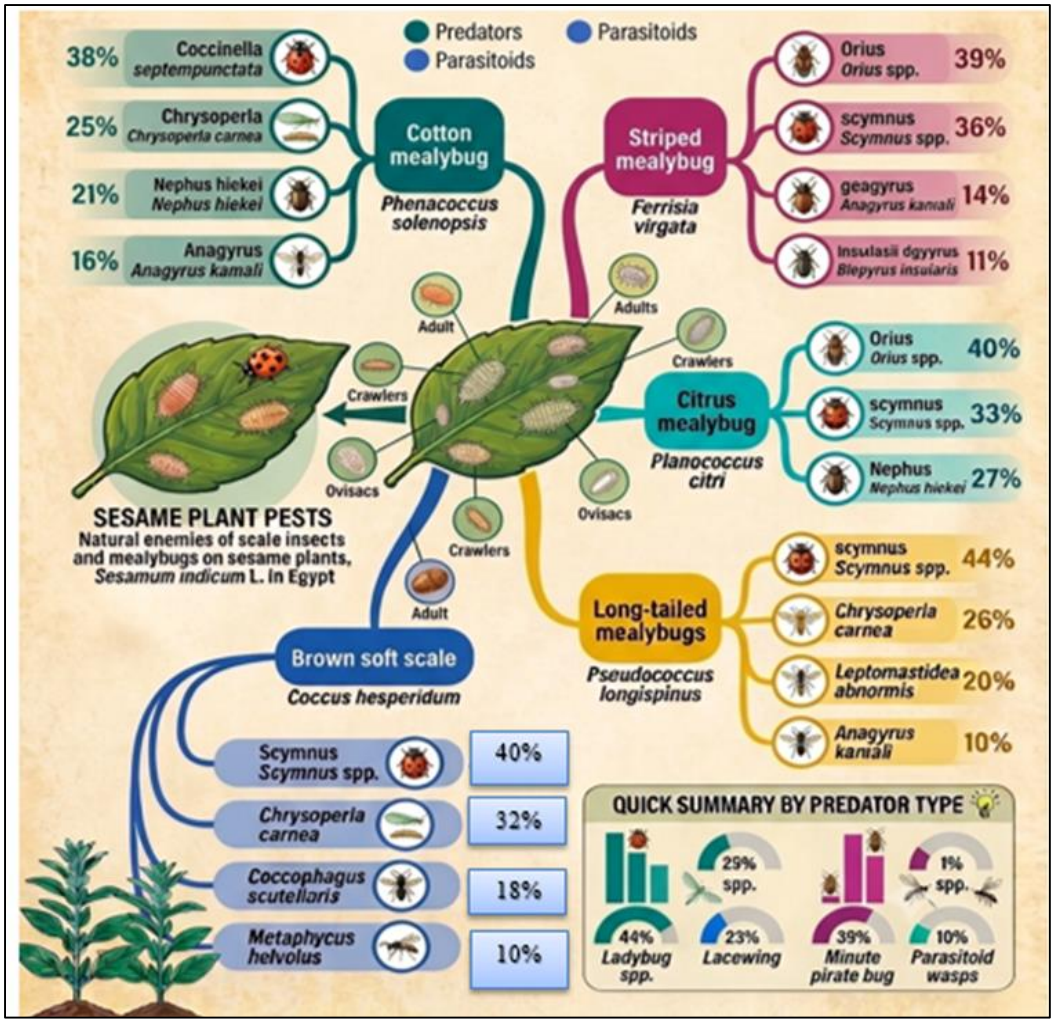


Fig. (4). Map of Occurrence Percentage of Natural enemies of scale insects and mealybugs on sesame plants, *S. indicum* L.

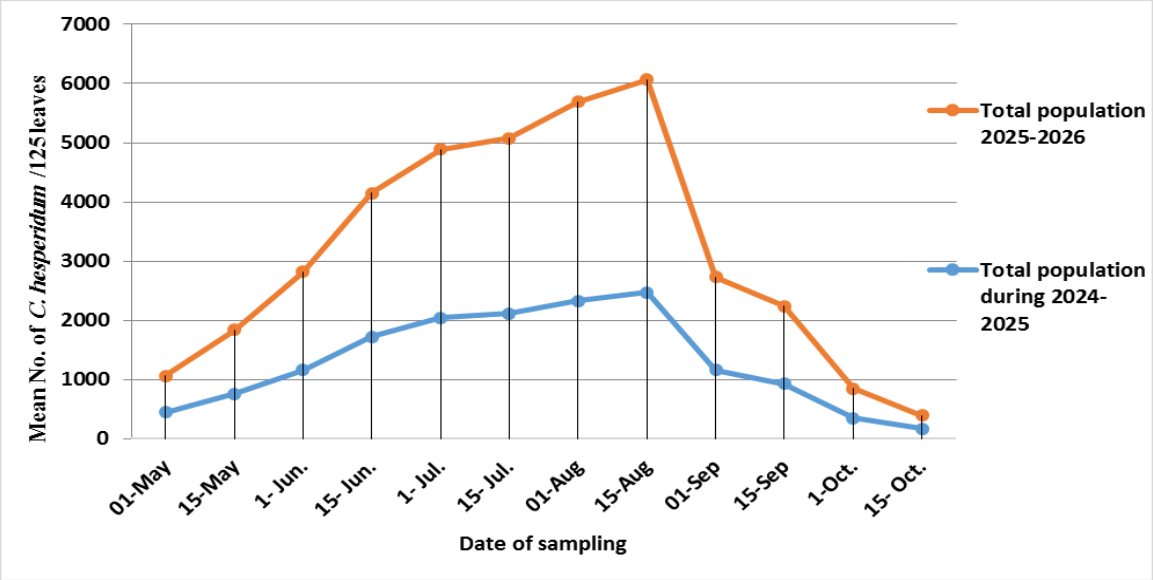


Fig. (5). Population fluctuations of *C. hesperidum* on/ 125 leaves of sesame plants, *S. indicum* L. in Egypt during seasons 2024-2025 and 2025-2026

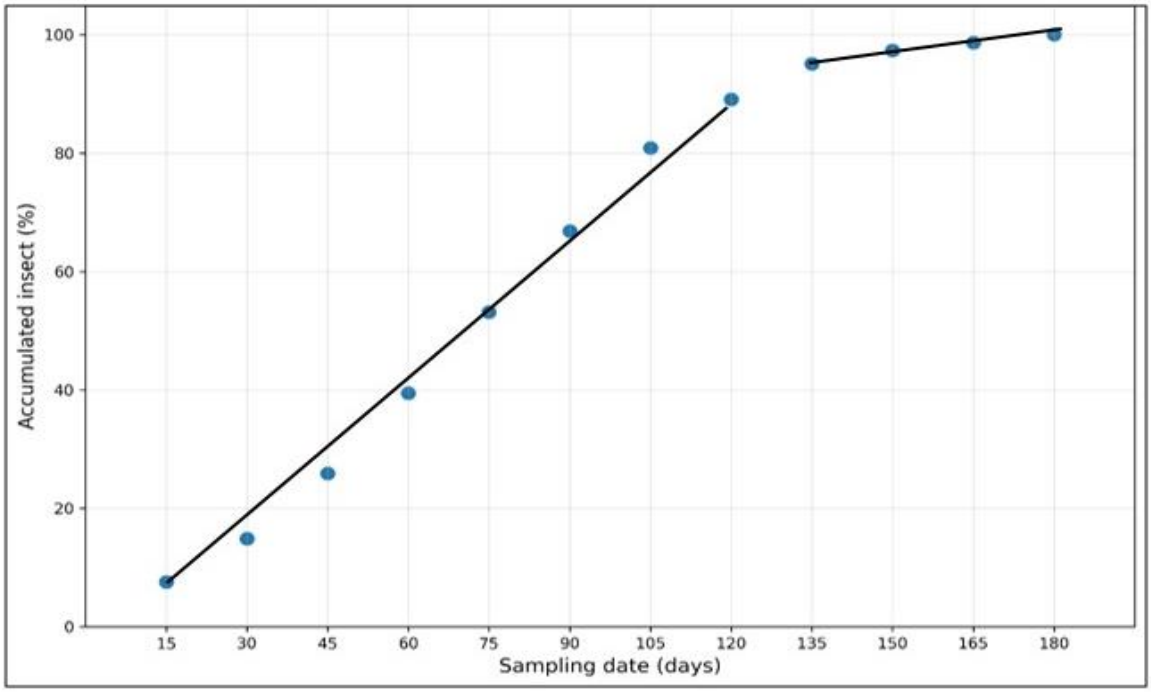


Fig. (6). Generations of *C. hesperidum* on sesame plants, *S. indicum* L. during season 2024-2025

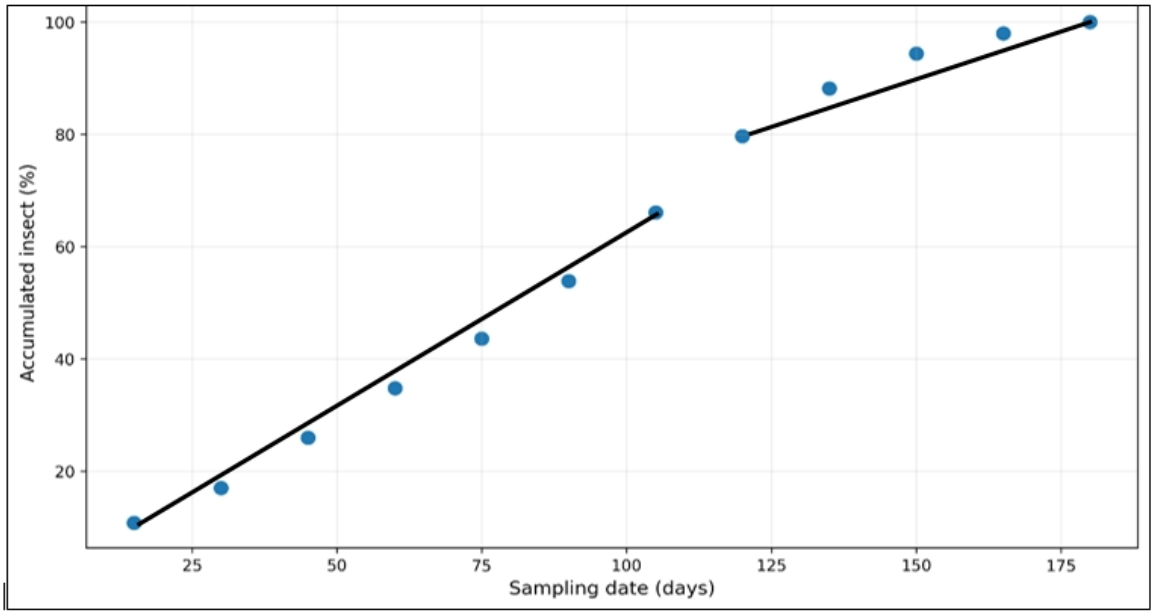


Fig. (7). Generations of *C. hesperidum* on sesame plants, *S. indicum* L. during season 2025-2026

Data in Fig. (6 &7) showed the number and duration of generations of the brown soft scale, *C. hesperidum* L., on sesame plants were estimated by using the formula of **(Audemard & Milaire, 1975 and Jacob, 1977)**. The results indicated that *C. hesperidum* had two overlapping generations per season on sesame in Egypt .The first generation was the longest and most dominant. It started in mid-May and extended to late August (118 days), with a duration of approximately 103 days. About 90% of the total insect population was recorded during this generation. The second generation was short and occurred from early September to the end of the season (from 135 to 180 day, during season 2024-2025 (Fig. 5).

During second season 2025-2026, the insect also exhibited two generations. The first generation was relatively shorter, lasting from the beginning of sampling until 100 days, while the second generation started earlier, at 125 days, and continued until 175 days. The shortening of the first generation in the second season suggests that higher temperatures accelerated the insect's development, which is consistent with the highly significant positive correlation found between maximum temperature and insect population (r = 0.968 and r = 0.978) (Fig. 5). In general, the first generation is considered the main generation responsible for the damage to the sesame crop.

Data presented in Fig. (8 & 9) revealed clear seasonal fluctuations in the abundance of the recorded natural enemies associated with insect pests. In both seasons, the populations of *Scymnus* spp., *C. carnea*, *C.scutellaris*, and *M. helvolus* generally increased from May and reached their highest levels during August, followed by a progressive decline during September and October. The population density of four species of natural enemies were associated with *C. hesperidum* on sesame plants during seasons 2024-2025 and 2025-2026: two predators, *Scymnus spp.* and *C. carnea* (Steph.) and two parasitoids were *C. scutellaris* (dalman) and *M. helvolus* (Compere). Data showed that the both of *Scymnus spp.* and *C. carnea* (Steph.) recorded their highest population on mid of August in both seasons. *Scymnus spp.* recorded 133 and 155 individuals/ *C. hesperidum*. Whereas, *C. carnea* (Steph.) recorded 125 and 122 individuals/ *C. hesperidum*. In contrast, the parasitoids *C. scutellaris* and *M. helvolus* occurred at comparatively lower densities, although both showed a noticeable increase during the summer period. The highest abundance of most natural enemies coincided with the period of maximum pest population, particularly during August. The highest abundance of most natural enemies coincided with the period of maximum pest population, particularly during August. This temporal synchrony suggests that the availability of insect prey or hosts may have contributed to the increase in natural enemy populations. The subsequent decline in their abundance from September onwards was consistent with the reduction in pest populations. Overall, the results indicate that the recorded predators and parasitoids were present throughout the crop season and may have contributed to the natural suppression of the associated insect pests.

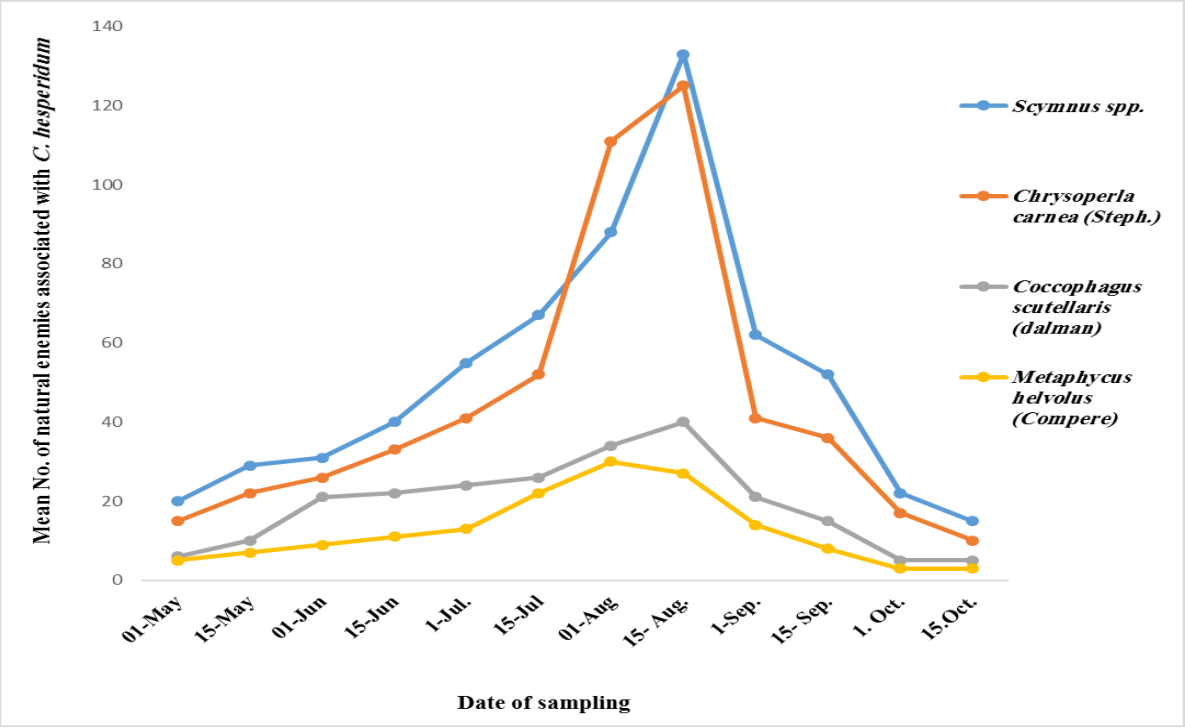


Fig. (8). Population density of natural enemies associated with *C. hesperidum* on sesame plants, *S. indicum* L. during season 2024-2025

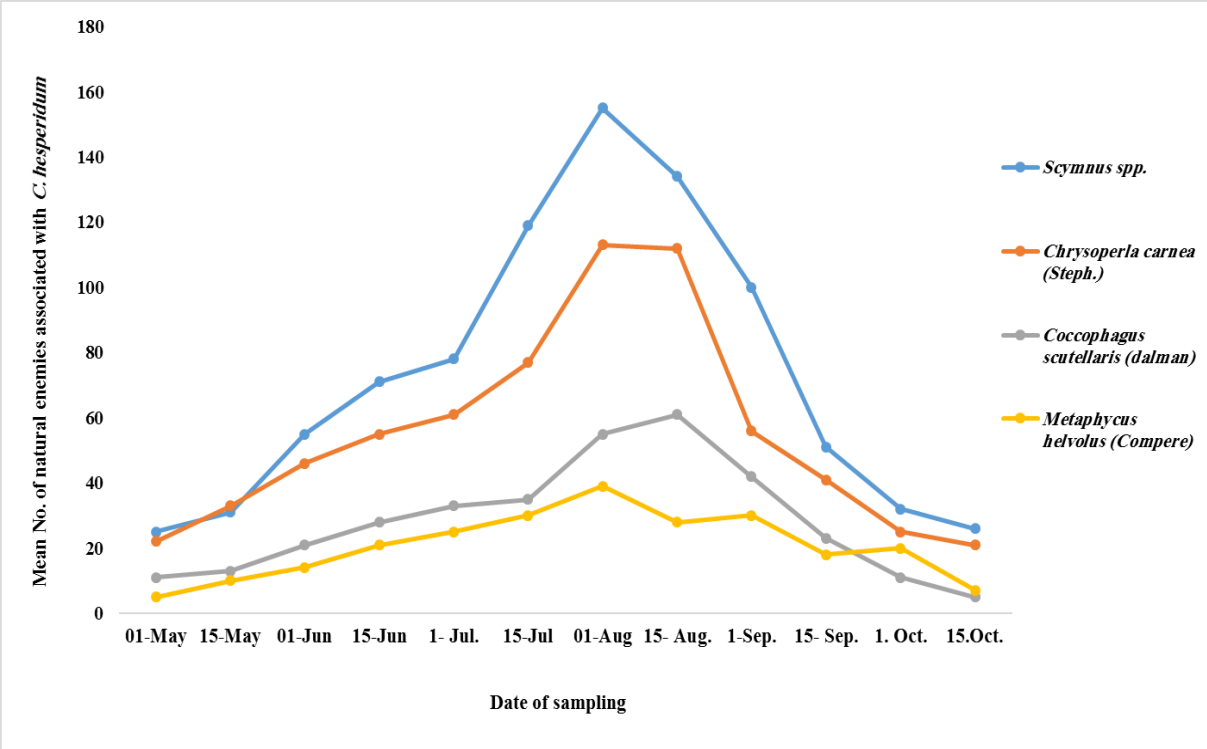


Fig. (9). Population density of natural enemies associated with *C. hesperidum* on sesame plants, *S. indicum* L. during season 2025-2026.

2. Effect of some weather factor on population density of *C. hesperidum* on sesame plants, *S. indicum* L.

The data presented in Fig. (10& 11) revealed clear seasonal fluctuations in the population density of *C. hesperidum* in relation to the prevailing climatic conditions. In both seasons, the insect population increased gradually from May and reached its highest level during August, followed by a pronounced decline during September and October. The highest population density was recorded on 15 August, reaching 2,473 individuals in the first season and 3,590 individuals in the second season. The increase in population occurred under relatively high temperature conditions and moderate to high relative humidity, suggesting that the prevailing summer conditions were favorable for population development. The subsequent decline in insect abundance during September and October coincided with a gradual decrease in both maximum and minimum temperatures and relative humidity. Comparison between the two seasons showed that the population density of *C. hesperidum* was consistently higher during the second season than during the first season. These results indicate that seasonal climatic conditions, particularly temperature and relative humidity, may have influenced the population dynamics of *C. hesperidum*. However, the response of the insect was not necessarily directly proportional to any single climatic factor, indicating that population development was probably affected by the combined effect of the prevailing environmental conditions.

As well as, data revealed a highly significant positive correlation (r) between all tested weather factors and total population of *C. hesperidum.* Maximum temperature was the most effective factor in both seasons (r=0.968& 0.978- E.V. %= 93.7&95.65) followed by R.H. % (r=0.905& 0.911- E.V. %= 81.0 &82.98) and minimum temperature (r=0.808& 0.813- E.V. %= 65.29&66.10). F values was significant for all factors during two seasons of study (F value= 82.15 and 67), (P values =<0.0001).

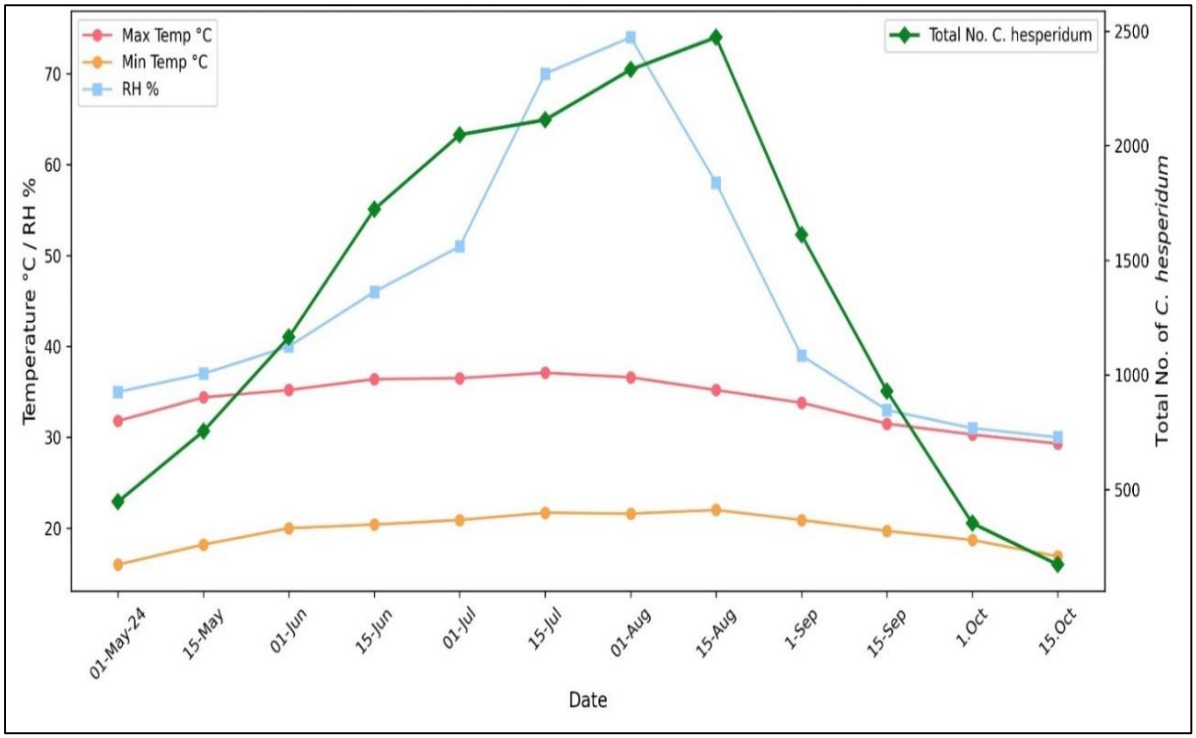


Fig. (10). Effect of weather factor on population of *C. hesperidum* during season 2024-2025 on sesame plants, *S. indicum* L.

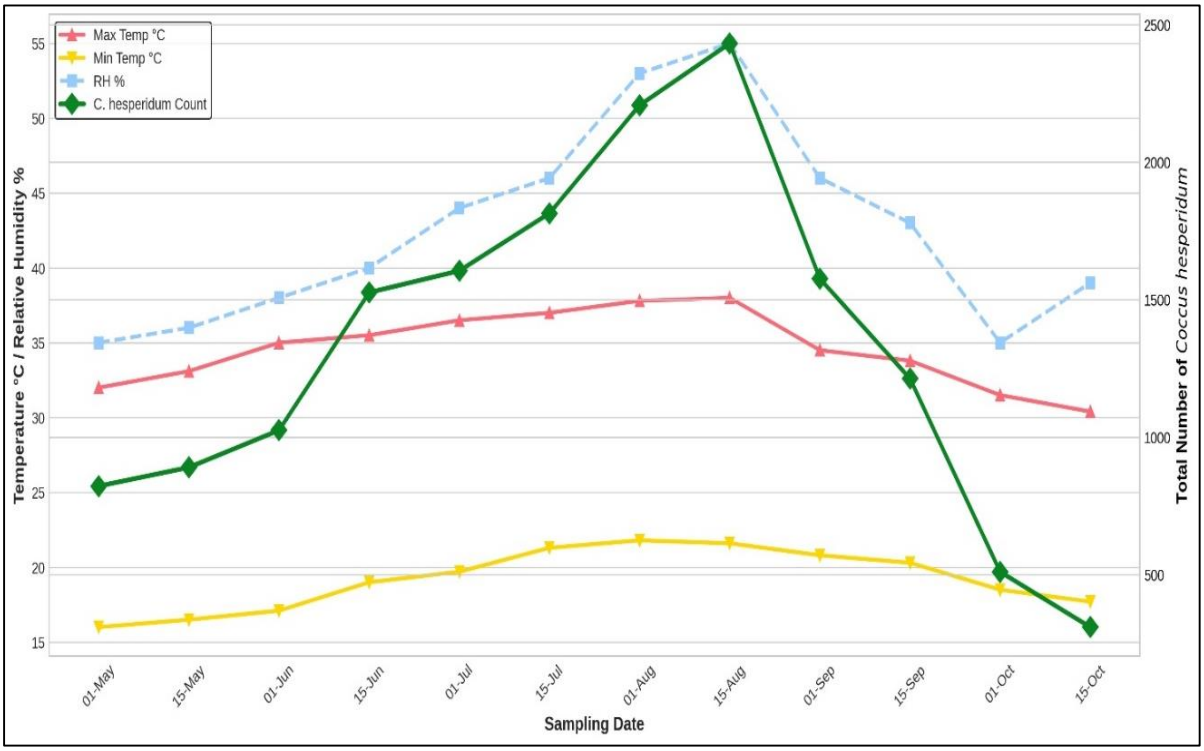


Fig. (11). Effect of weather factor on population of *C. hesperidum* during season 2025-2026 on sesame plants, *S. indicum* L.

3. Effect of organic and in organic fertilization on population of *C. hesperidum* L. during seasons 2024-2025 and 2025-2026 on sesame plants.

The data presented in Fig (12) demonstrate that the different fertilization treatments had a noticeable effect on the population density of *C. hesperidum* L. on sesame plants. The organic fertilization treatment (without and Compost) recorded the lowest mean of number of 18.75 and 25.80 individuals of *C. hesperidum*, respectively achieving the highest reduction % of 77.27 and 68.79%. The inclusion of mineral NPK fertilizer led to a significant increase in population and increase plant susceptibility to infestation due to high nitrogen content in sap.

Application of the treatment of 75% compost + 25% NPK and 50% compost + 50% NPK treatment recorded mean numbers of 44.6 and 62.81 individuals and recorded 23.87 and 45.94% reduction in population of *C. hesperidum.* The highest infestation was observing in the full mineral treatment (100% RD of NPK), which recorded the highest mean number of insect pest of 82.5 individuals and the recorded the lowest reduction 0 %. The results revealed that organic fertilization with compost significantly suppressed the population of the brown soft scale, *C. hesperidum*. Increasing the proportion of mineral fertilizer led to an increase in infestation. Therefore, the use of compost at 2 ton/fed or 75% compost + 25% NPK is recommended as an eco-friendly approach within IPM programs to control. These finding are in agreement with (**Garratt *et al*., 2011& Rowen *et al*., 2019) & (Ram *et al*., 2024), (Aly *et al*., 2018)** who mentioned that the organic fertilization with compost significantly suppressed the population of *C. hesperidum* this suggests that the proportion of organic fertilizer in the fertilization program may influence the population level of this scale insect on sesame plants.

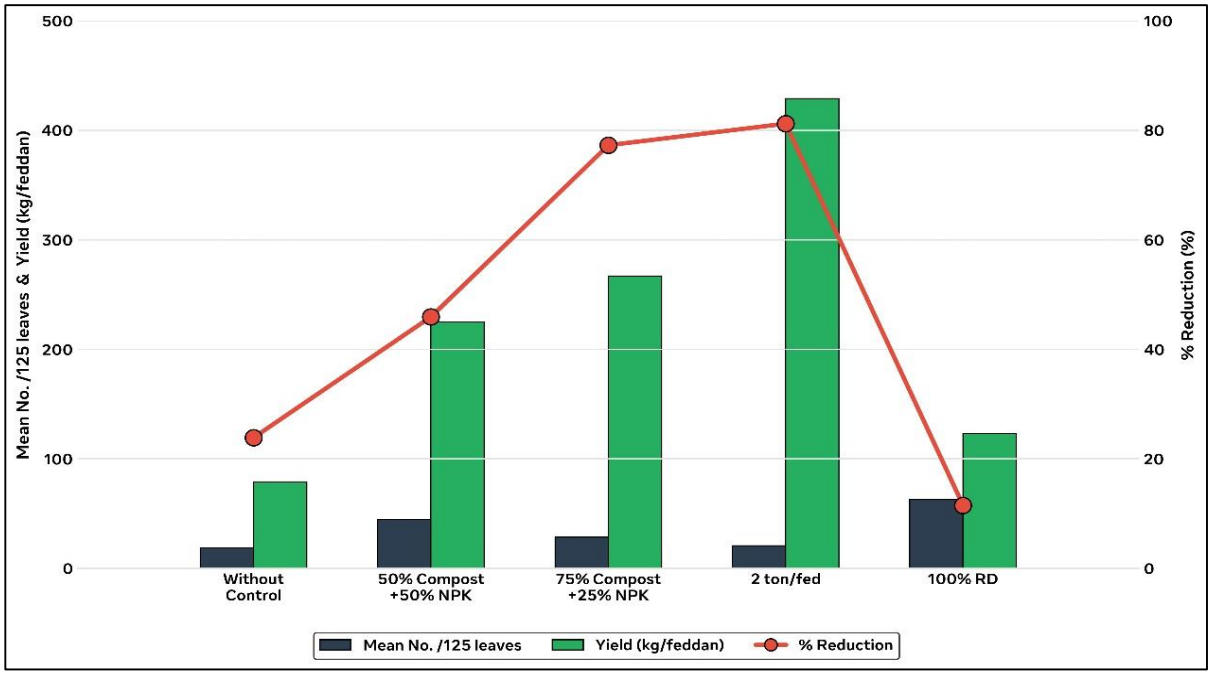


Fig. (12). Effect of organic and in-organic fertilization on population of *C. hesperidum* during seasons 2024- 2025 and 2025-2026 on sesame plants, *S. indicum* L.

Finally, Organic fertilization significantly reduced the population of *C. hesperidum*, while high doses of inorganic nitrogen (urea) increased it. High nitrogen produces soft, succulent leaves rich in free amino acids which are more attractive for feeding and oviposition **(Bala *et al*., 2018 & Ram *et al*., 2024)** found that sucking pests on sesame increased with higher nitrogen and decreased with lower nitrogen combined with higher phosphorus. Similarly, excessive use of inorganic fertilizers lowers pest resistance **(Ebrahem *et al*., 2021)**, while organic matter enhances plant resistance and natural enemies **(Skelly, 2014)**. Therefore, organic compost is recommended as a tool in IPM to reduce pest incidence.

The results indicated significant differences among treatments regarding final yield. The treatment of compost achieved the highest yield of 429 kg/feddan, with an increase of and the treatment of 100% RD was (123 kg) and Without (control) was (79 kg), followed by 75% Compost + 25% NPK was (267 kg/feddan) and the treatment of 50% Compost + 50% NPK was (225 kg/feddan). Conversely, the 100% RD treatment recorded a notably low yield of 123 kg/feddan despite full mineral fertilization, while the (Without) control recorded the lowest yield of 79 kg/feddan. This demonstrates that organic amendments, particularly improved plant health and tolerance to *C. hesperidum* infestation, leading to a direct and substantial increase in yield, these results are in agreement with **El-Borollosy *et al*. (1990) and Mangoud (2000)** who reported that organic fertilization reduces infestation by scale insects and improves plant vigor. As well as, **Adekiya *et al.* (2020)** confirmed that compost improve soil fertility and increased yield. Moreover, **Golan *et al.* (2017)** mentioned that nitrogen fertilization increases the population density of *C. hesperidum* leading to yield reduction, which explains the low yield in 100%RD treatment.

4. Conclusion

The present survey confirmed that sesame plants are attacked by a complex of soft scales and mealybugs, with *C. hesperidum* as the dominant pest. Similar findings were reported by several authors in Egypt and other countries, indicating that *C. hesperidum* is a polyphagous species with wide host range. The seasonal abundance of C. *hesperidum* revealed two overlapping generations, with peak activity during hot months (June-August). This trend is in agreement with (**El-Said 2018**) and **(Hassan *et al.*, 2020)** who recorded maximum population of soft scales in summer. The sharp decline during autumn may be attributed to lower temperature, senescence of host leaves, and increased activity of natural enemies.

Based on the ecological data, spraying should be conducted upon monitoring the first generation of *C. hesperidum during* early infestation on June. Therefore, the occurrence of scale insects and mealybugs emphasizes the need for regular field inspection and early detection of infestations. Monitoring their population levels and distribution can contribute to developing effective management strategies aimed at protecting sesame plants and minimizing potential losses in crop productivity.Four predators were recorded in association with *C. hesperidum*, *Scymnus* spp. and *Chrysoperla carnea* being the most abundant. Their population synchronization with the pest during August indicates their important role as bio-control agents. This supports the findings of (**Mangoud, 2019**) that coccinellid predators are key mortality factors for soft scales.

Weather factors, particularly maximum temperature, showed highly significant positive correlation with pest density, explaining more than 93% of population variation. This confirms that temperature is the main driver for *C. hesperidum* multiplication, as reported by (**Amin *et al.*, 2021**). Relative humidity also had a significant positive effect, while the combined effect of all-weather factors accounted for 96.2% of variability, indicating that climatic conditions are crucial for forecasting pest outbreaks.

The effect of fertilization type on infestation level was clearly demonstrated. Plants receiving full mineral NPK recorded the highest infestation, while unfertilized plants and those receiving organic compost at 2 ton/fed had the lowest infestation with reduction of 77.27% and 68.79%, respectively. The increase in infestation with increasing mineral nitrogen can be explained by higher nitrogen content in plant sap, increased free amino acids, and enhanced succulence, which makes plants more attractive and suitable for sap-sucking insects. Similar results were obtained by (**Hashem *et al*., 2017**) and (**Ali *et al.*, 2022**) on different crops. Organic compost improves soil structure, enhances beneficial microorganisms, and induces systemic resistance in plants through phenolic compounds, which may explain the suppression of *C. hesperidum*. The integrated treatment (75% compost + 25% NPK) achieved moderate suppression (45.94% reduction) with maintaining soil fertility, making it a practical option for farmers who cannot completely avoid mineral fertilization. Accordingly, organic fertilization at 2 ton/feddan or the integrated rate 75% organic + 25% mineral can be recommended as a sustainable and eco-friendly tactic within integrated pest management (IPM) for sesame, as it significantly suppressed *C. hesperidum* conserved its natural enemies, and minimized environmental pollution. Therefore, it is recommended to avoid excessive use of mineral NPK in sesame cultivation and to adopt organic compost (2 ton/fed) or

integrated fertilization (75% compost +25% NPK) as an eco- friendly cultural control method within IPM program to suppress *C. hesperidum* infestation. There is a strong positive correlation between balanced Organic fertilization and crop yield, as it improves nutrient availability, soil health leading to a significance increase in seed yield and quality.

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