Annual occurrence of the wax scale insect *Ceroplastis rusci* (Linna) on Fig trees in the Al-Haidariya District of Najaf Governorate

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https://doi.org/ 10.59658/jkas.v12i4.5115

Received: May 25, 2025

Accepted: June 30, 2025

Published: Dec. 25, 2025

Abstract

A study was conducted during the 2024/2025 season to determine the annual presence and population density of the wax-scale insect *Ceroplastis rusci*. The population density of non-Ovipositing adults was studied from September 1, 2024, to April 1, 2025, in a Fig orchard in Al-Haidariya District of Najaf Governorate. The field survey on Black Diyala Fig trees showed a clear variation in the population density of the insect throughout the year, with a sharp decline during the winter months (from the beginning of December to mid of February), where the lowest rate was recorded in December 2024 (0.54 insects/tree). The peak population density of the adult insect reached 6.98 insects/tree in September, while the numbers gradually declined as winter approached. The results showed significant differences between the different months of the year. The insect density peaked at the beginning of the first week of October 2024, when it began a continuous relative decline. The distribution of insect numbers across different tree levels and directions was also studied. The results showed that the insect is widely distributed in the surveyed areas. It was found that non- Ovipositing adults infest the upper surface of the leaf in the lower and middle levels of the tree in the first generation and they prefer the middle level only in the second generation. The survey results showed that the insect prefers the upper part in the third generation and the winter hibernation stage. The study also indicated that the insect's spread depends on the location of the trees, wind direction, and surrounding environmental conditions, which significantly impact insect spread. The possibility of utilizing these results in designing a pest control program in the area where it is widespread was discussed.

Keywords: Wax scale insect, Fig trees *Ceroplastes rusci*, Iraq.

Introduction

The fig tree is one of the blessed trees mentioned by God Almighty, and he swore by it in the Holy Quran (Surat At-Tin, verse 1). Fig trees are one of the largest genera of angiosperms, with over 800 species of trees, epiphytes, and shrubs belonging to the

Moraceae family. Figs are cultivated in tropical, subtropical, and temperate regions worldwide. They are considered one of the most diverse plant genera in terms of their growth habits, with deciduous and evergreen trees, as well as stranglers, climbers, and small shrubs [1, 2]. The Asian and Australian regions are considered the richest and most diverse, containing approximately 500 fig species. Half of the fig species are monoecious, while the remainder are dioecious. Members of the genus Fig share an obligate symbiotic relationship with wasps of the Agaonidae family, which pollinate figs [3]. The Mediterranean coast and south-eastern Anatolia are suitable for producing fresh figs [4]. also indicated that the most important fig producers are Turkey, Egypt, Morocco, Algeria, Iran, Spain, and Syria, and Turkey is the leading fig-producing country[5]. Due to the economic importance of fig trees, interest in caring for and serving them has increased. Thus, we ought to determine the annual presence of the insect in central Iraq, specifically in the Al-Haidariya district of Najaf Governorate, and to identify periods of activity and weak links in its life cycle to develop an effective and comprehensive program to combat the insect in its areas of spread as it could cause great economic losses and other harmful effects [6].

A number of studies have been conducted on the biology and ecology of this insect, and various methods and means have been used to combat it [7, 8, 9, 10]. Given the importance of this insect and the damage it causes to fig trees in many regions, the current study was conducted to mitigate and kill the insect. Agriculturally, it is important to protect it from agricultural pests and diseases that cause economic losses and damage it. Figs are exposed to many pests that reduce their productivity and nutritional value [11]. The Fig wax scale insect *Ceroplastes rusci*, is one of the most important agricultural pests that infect fig trees. Due to its economic importance and the way it feeds on the tree's vegetative system, nymphs and adult females feed by sucking plant sap.

The effects are further enhanced by the secretion of honeydew, which leads to the growth of sooty fungi, the accumulation of dust, and the prevention of sunlight, which reduces photosynthesis. Due to its feeding on the tree, it weakens it and is therefore susceptible to infestation by stem borers [12]. The non-egg-laying adult stage is one of the most important sources of insect spread from one orchard to another and from one region to another, and it is also considered a source of infestation in the following season [13]. The infection rate and the number of generations of the insect present on its hosts vary according to the seasons, the region, and the prevailing environmental conditions [14].

Materials and Methods

Survey and distribution of the wax-scale insect *Ceroplastes rusci*

This study was conducted over two years (September 2024 to April 2025) in a Fig field in the Al-Haidariya District of Najaf Governorate (32.611910"E north latitude and 44.4026372"E east longitude). An orchard with an area of approximately 4 dunums (Photo (1)) was selected, planted with fig trees (*Ficus carica*), and infested with the fig wax scale insect *C. rusci*, to study the population density and annual presence of the insect's dormant adult stage. The orchard had not been subjected to any chemical treatment for more than a year before the study. A survey was conducted in fields infested with *C. rusci* and planted with fig trees in the district. Trees were randomly selected from each orchard, where ten random samples were taken for each part of the tree (stems, leaves, fruits, branches) from the top, middle, and bottom of the tree. The trees were at least 10-12 years old. The dormant adult insects of the insect, were observed and recorded on each branch and twig from the upper and lower surfaces of the tree using a hand magnifying lens.

Al-Haidariya/Najaf Al-Ashraf is a region famous for fig cultivation, especially the lands extending alongside the Euphrates River. Areas infested with the wax scale insect were selected, and the area planted with figs was divided into three regions from North to South (Northern, Central, and Southern regions). The survey process was conducted by visiting three orchards from each region. These orchards were chosen randomly, with the distance between one orchard and the next between 1 and 2 km. After confirming the infestation of the visited orchards, two orchards were chosen for the study in the middle of the region (Figure (3-1) to conduct control.

In contrast, the other orchard south of Al-Haidariya District, beside the Euphrates River, was used to study the annual presence of the wax scale insect (Figure (3-1).With a magnification of (6X) and a microscope with a magnification of up to (1000X). Visits were made to each orchard weekly, and the temperature and humidity rates were recorded (Table (3-2)). The infection rate for each part (leaves, branches, fruits, branches) was calculated, as well as the infection percentage for the field according to the following equation:
The results determined the infection rate on a single infected tree according to the equation adopted [15]

$$\text{Tree infection rate} = \frac{\text{Infection rate of stems + leaves + branches + fruits}}{4}$$

The percentage of infestation with wax scale insects was calculated using the following equation [16]

$$\%\ \text{incidence} = \frac{\text{Number of infected trees}}{\text{Total number of trees}} * 100$$

To identify the insect, samples were collected from Fig orchards and morphologically identified using the book "Basics of Insect Taxonomy" and the taxonomic keys of the Coccidae family, provided by Professor Ali Abdul-Hussein Al-Rubaie. The insect was identified as a Fig scale *Ceroplastis rusci* Linnus (Hemiptera, Coccidae).

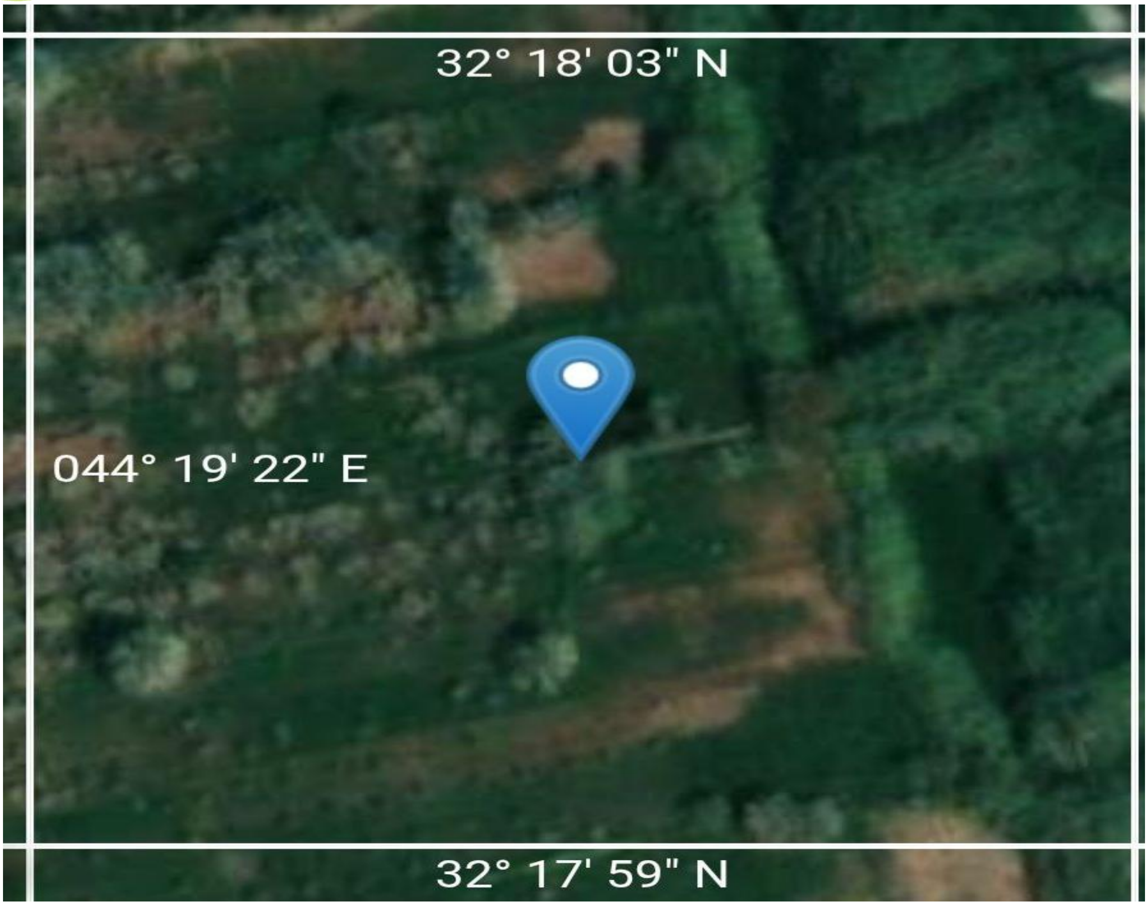

Figure (1): Field study site for the annual presence of the insect (The image was taken from the USGS website)

A study of insect population density at three levels of tree height.

The study was conducted in a Fig orchard during the autumn season from September 15, 2024, to the spring season on April 15, 2025. Trees with a height of 3-2.5 m were selected, and each tree was divided into three approximately equal sections: the lower level, one meter above the soil surface; the middle level, 1-2 m high; and the upper level, over 2 m. Live adult insect numbers were counted at each of the three levels. Five random locations were selected inside, outside, and around the trees for each level to count insects present on the surfaces of the leaf blade and leaf stalk, as well as the branches. The total number of insects at each level was calculated, followed by the average for each level, and then the infestation rate for the tree was calculated. Sampling continued every (5) days for the autumn and spring seasons. For the overwintering phase, the number of insects was counted. The remaining living insects were randomly selected from ten branches per tree. The numbers of adult insects were counted. Their number fluctuations and activity peaks were monitored, and changes in their numbers and density were recorded. This experiment was conducted in the same orchard in the Al-Haidariya District from September 15, 2024, to April 15, 2025, and planted with Fig trees. Five trees were selected from the orchard, and five leaves were taken from each direction (North, East, South, and West) using the same method mentioned above. The adult stage of the insect present on both surfaces of the leaves was counted, with an average of four readings, with an interval of five days between each reading. The readings were recorded, and the results were extracted.

Population density of insects in the four directions

October 2024, when the population density began to decline (Figure 4-1). Their numbers were very low during the period extending from the beginning of December until the end of January of the following year. These results are consistent with a previous study indicating that the insect overwinters on Fig trees as second nymphs and adults [17]. In terms of distribution across plant parts, the presence of the insect on leaves was associated with the period of active growth (until September), where the highest density was recorded (14.79 insects/leaf), while its presence disappeared with the fall of leaves in autumn and winter. As for the fruits, they witnessed a seasonal presence that ended with the end of the season, while branches and trunks hosted continuous numbers throughout the year, with a peak on branches in March (17.10 insects/branch) and on stems in February (7.05 insects/stem). This seasonal and distributional variation reflects the insect's interaction with biotic (such as predators) and abiotic (such as temperature, humidity, and leaf fall) factors, emphasizing the importance of appropriate timing for pest control according to its annual dynamics and sensitive stages.

Statistical analysis

GenStat analysis of data was performed using GenStat (Analysis System). Anova table. And Least significant differences (LSD) post hoc test were performed to assess significant differences among means. $P < 0.05$ is considered GenStatcally significant.

Results and Discussion

Field Survey and Annual Insect Presence (Number Density) on Fig Trees

A field survey and annual presence of the wax scale insect, *Ceroplastes rusci*, on Black Diyala Fig trees showed a clear variation in the insect's population density throughout the year, with a sharp decline during the winter months (from early December to mid-February). The lowest rate was recorded in December 2024 (0.54 insects/tree). This is attributed to harsh climatic conditions (cold, rain, wind), which lead to leaf fall and the death of live stages on them. Second-stage nymphs and some adults survive, clinging to the ground and taking refuge on the underside of the branches from environmental factors [18]. Starting with the improvement in conditions in the spring season (April 2025) (Table (1)), the activity of natural enemies (predators) was observed as a factor contributing to the decline in population density, while the remaining overwintering insects (distinguished by their pink colour) showed a transition to the third nymph instar and then adults, which constitute a source of reproduction and increase in numbers with the onset of the new generation. This study is consistent with previous studies that confirmed the overwintering of the insect in the second nymph instar and adults on fig trees. This insect can overwinter throughout all life stages in relatively warm coastal areas, depending on the prevailing environmental conditions [19, 20]. The peak population density of the insect, supported by high temperatures (34.7°C) and low relative humidity (37.5%), led to an increase in the average number of adults to 0.98 insects/tree in September, while numbers gradually declined as winter approached. The remaining individuals from the winter could be distinguished by their pink colour on the infected branches as they begin to moult and transform into the third nymph stage when environmental conditions improve. They then transform into adult insects (males and females), which are considered a source of producing large numbers of eggs and the beginning of a new generation (continuous increase in population density in the field). The results showed significant differences between the different months of the year, reaching their peak at the beginning of the first week of the month.

Table (1): The infection rate of tree parts with the wax scale insect *Ceroplastes rusci* on Figs according to the months of the year.

Date of Sampling (2024-2025)	Mean infestation rate of tree parts by the waxy scale insect				
	Leaves	Branches	Fruits	Stems	Mean Tree Infestation Rate
September	14.79	10.05	2.19	0.90	6.98
October	14.17	4.88	0.83	1.67	5.39
November	4.71	6.52	0	1.64	3.22
December	0	1.50	0	0.67	0.54
January	0	8.39	0	1.38	2.44
February	0	13.13	0	7.05	5.04
March	0	17.10	0	3.42	5.13
April	7.7	14.4	0	3.1	6.3
Infestation Rate	5.17	9.50	0.38	2.48	4.38
LSD 0.05	3.59	4.32	0.82	2.15	2.47

This is consistent with previous studies that found the highest density of wax scale insects at all life stages on Fig trees: Sultani, followed by Aswad Diyala, then Turki, with the lowest density on Waziri [21]. also indicated that the Aswad Diyala variety was more susceptible to *C. rusci* infestation than Waziri [22]. A study of the percentage of insect presence on trees showed that the insect is present in fields year-round but at varying rates depending on the month and season. The highest percentage of wax scale insects was recorded in the field selected for this study in October, reaching 98.3% in 2024. This is consistent with a study conducted by [23]. The infection gradually decreased in the following months, reaching its lowest infection rate in January, with an infection rate of 11.6%. After that, the infection gradually increased until the study ended at the end of the fourth month (April) of 2025. Figure (2) shows the infection rates with the waxy scale insect.

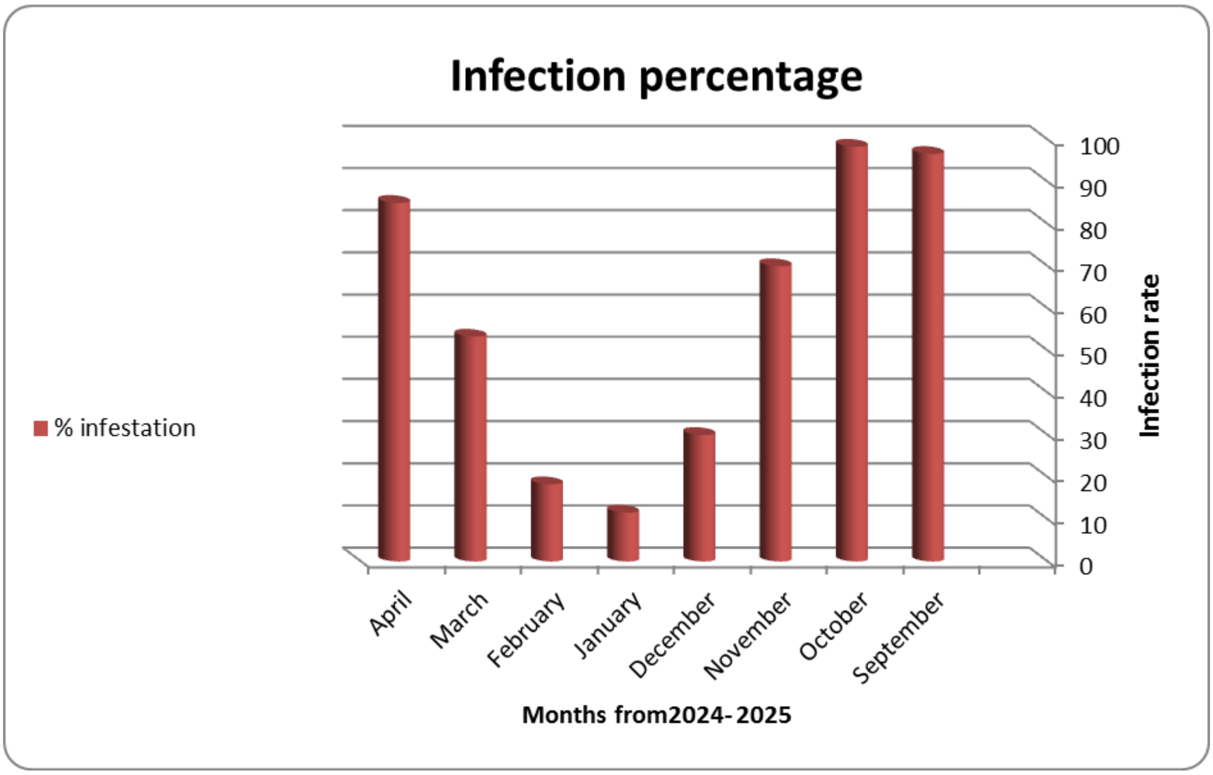

Figure (2): The percentage of infestation with the wax scale insect *Ceroplastes rusci* in Al-Haidariya District/Najaf Al-Ashraf for the year 2024-2025

The results in Table (2) also indicated the existence of a relationship between the temperatures and humidity recorded throughout the field survey of Fig orchards in the fig cultivation area in Bani Muslim - Al-Haidariya District - Najaf Governorate and the infection rate of the scale insect *C. rusci*, where an increase in infection rates is observed in September (with an infection rate of 96.6%) until it reaches its first peak in October with a rate of (98.3%). Temperature moderation accompanies this increase, as the average temperature reached 34.7°C. An average humidity rate of 37.5% for September and a temperature of 27.4°C for October this falls within the thermal range for the insect's activity and spread. This is consistent with a study by [24] on the thermal range that suits the insect's activity. The infection rate began to decline until it reached 11.6%. This decrease was accom pained by a temperature decrease that reached an average of 12.3°C. The infection rates began to rise gradually in February and with the beginning of the spring season, Table (2).

Table (2): The percentage of infection with the scale insect *C. rusci* with the temperatures and humidity recorded in the Bani Muslim area - Al-Haidariya District - Najaf Governorate

No.	Month	Percentage of insect infestation (%)	Average Temperature (°C)	Average Relative Humidity (%)
1	September	96.6	34.7	37.5
2	October	98.3	27.4	43.6
3	November	70	18.3	51
4	December	30	13.6	44
5	January	11.6	12.3	55
6	February	18.3	12	39.3
7	March	53.3	19.79	38.00
8	April	85	27.21	25.71

The field survey conducted during this study provided a clear idea about the spread of the scale insect and its interaction with environmental factors, especially temperature and humidity. It was observed that the two peaks of the insect's population increase occurred in May and October due to temperatures being within the range preferred by this insect for reproduction and spread, 25-32°C [25]. indicated in their study on the life cycle and biological control methods of *C. rusci* in Vietnam that the growth rate of this insect was high when the temperature ranged between 27-28°C [26]. Meanwhile, the study conducted by [27], which focused on studying the effect of temperature on the development of the soft brown scale insect *Coccus hesperidum*, showed that the percentage of live insects increased when the temperature ranged between 24-30°C. In addition, [28] reported that the average number of eggs per female and the average percentage of egg hatching of the fig scale insect *C. rusci* increased at 25°C, reaching 1795.73 eggs and 90%, respectively, in 29 days compared to 35°C, which reached 1189 eggs and 40.5%, respectively, in 36 days.

A study of population density at three levels of tree height.

Table (3) shows that in October, the highest rate of adult insect infestation on the lower leaves was 14.3 during the season. The average rate of adult insect infestation on the lower leaves was 12.4 and 6.7, respectively, insects per leaf or twig per orchard. Meanwhile, the average rate at the middle level was 16.16 and 13.29 insects per leaf, and the average rate was 11.13 insects per leaf.

Field observations revealed that eggs that fall from under the shell of the ovipositor do not hatch into nymphs upon exit by any means. The eggs hatch into nymphs only when under the insect's shell in a transparent white sac and emerge from under the shell as first-stage crawling nymphs. This is what [29] concluded. The eggs hatch into crawling nymphs, the first-stage nymphs that crawl toward different parts of the tree. Most of them settle at the beginning of the season on the lower leaves, while other numbers reach the middle level, and very few reach the upper level of the trees.
Meanwhile, the infestation increased in the upper level of the tree compared to the middle and lower levels in mid-January, where the infestation rate reached 5.8 insects per plant part or infected sample taken from the tree, while the middle and lower levels reached (2.9, 1.3), respectively. This increase continued on the trees until the leaves appeared and temperatures rose in the spring. The statistical analysis results showed significant differences between tree levels in terms of insect density due to the influence of prevailing environmental conditions and the consistency of the infestation trend.

There is also a significant difference according to date, as the study showed significant differences in insect infestation on fig trees between months of the year. The value of 3.9% represents the lowest significant difference between levels. There is a significant difference between levels due to the difference between any two average levels being greater than the number above. The upper level recorded the highest average infestation (8.85%), while the lower level showed the greatest variation in infestation rates. The population density study results at three tree height levels showed that the non-Ovipositing wax scale insect prefers the lower and middle parts of Fig trees in the fall, while it prefers the upper part in the winter and spring (Table (3)).

Table (3): Population density at three levels of infestation by the insect *Ceroplastes rusci* on Fig trees with temperature and humidity rates

Date	Infestation Levels of Fig Trees by Month			Mean	Avg. Temp (°C)	Avg. Relative Humidity (%)
	Lower Level	Middle Level	Upper Level			
1/9/2024	14.3	12.4	6.7	11.13	34.7	37.5
1/10/2024	13.8	11.8	8.1	11.23	27.4	43.6
1/11/2024	11.2	13.1	7.2	10.50	18.3	51.4
1/12/2024	2.1	4.6	4.6	3.77	13.6	44.1
1/1/2025	1.3	2.9	5.8	3.33	12.3	55.32
1/2/2025	2.7	3.9	10.5	5.70	12	39.2

1/3/2025	3.1	6.4	14.7	8.07	19.79	37.57
1/4/2025	3.8	9.1	17.6	10.17	22.9	41.3
Mean	**6.54**	**8.03**	**9.40**			
LSD 0.05	**Date**	**Level**	**Temperature**	**Humidity**		
	***3.81**	***3.9**	***6.73**	***7.85**		

Insect population density in the four directions

The results indicated that the average number of insects was 1.85, 7.74, 9.31, and 3.75 per tree for the north, south, east, and west directions, respectively (Table (4)). This indicates that insect numbers increase on the vegetative parts of the tree in the east and south directions more than in the other directions. The study results indicated that, from the beginning of the season to its end, the distribution line is in the southeast direction, facing the sun, and fewer in the north and west directions due to the cold winds coming from the north and west. This is consistent with what [30] reported, which stated that the highest population density of non-egg-laying adults was in the south and east directions, and the lowest was in the north and west directions. The results of the statistical analysis indicated statistically significant differences in the insect population density between the four directions: east-west, east-north, south-west, and South-north. However, there were no significant differences in the east-south and west-north directions. This indicates that the insect density in the eastern and southern directions is statistically close, although the eastern direction recorded a higher average. The eastern direction provides a much better environment for insect reproduction than the western direction, as there is a significant difference. The eastern direction was more suitable for insect growth than the northern direction. The southern direction provides better conditions for insect reproduction than the western direction. The southern direction is much more favourable for insect growth than the northern direction. The difference between the averages of the western and northern directions is less than the overall significant difference, so there are no significant differences due to their relative proximity. This explains why the eastern and southern directions receive more sunlight, providing higher temperatures suitable for the activity and reproduction of the wax scale insect. The northern directions receive less sunlight, resulting in a less suitable environment for insect reproduction, especially in winter. The prevailing winds in the region may influence insect dispersal in different directions.

These results are similar to those of other researchers who have indicated that insect numbers affect their hosts depending on the region and prevailing environmental conditions [31, 32]. The north-westerly wind movement affects insect behaviour, causing them to move away from the site to the most protected and warmest location as far as possible.

Table (4): The effect of the four trends on the population density of *Ceroplastes rusci* on Fig trees in Al-Haidariya District.

Density of *C. rusci* Insect According to Directions on Fig Tree					
Date	**North**	**South**	**East**	**West**	**Mean**
1/9/2024	3.1	9.5	15.3	2.6	7.63
1/10/2024	2.9	11.4	13.1	4.2	7.90
1/11/2024	3	11.2	13.6	5.1	8.23
1/12/2024	0	3.3	5.2	2.3	2.70
1/1/2025	0	3.1	4.6	2.1	2.45
1/2/2025	0	3.7	5.5	2.5	2.93
1/3/2025	2.1	7.6	5.9	3.4	4.75
1/4/2025	3.7	12.14	11.3	7.8	8.74
Mean	1.85	7.74	9.31	3.75	5.66
LSD 0.05	****for Directions**				
	2.14				

The results revealed that the wax scale insect infestation is widespread on Fig trees in the fig fields of Al-Haidariya district, Najaf, Iraq, and that the insect is more prevalent in the middle and lower levels of the tree during the autumn months. While the insect population density increases in the winter and spring months at the upper level, its density increases in September and October and begins to increase after the winter hibernation period in March. It was also found that the insect spends the winter on Fig branches in all its stages and regains its activity to grow and reproduce in the following spring. It was noted that its distribution on the tree is in the southern direction, towards the sun, and the east. In contrast, the northern and western directions are not preferred due to the influence of cold winds and other environmental conditions [33]. Knowing the periods of activity and areas of pest spread will help lay the appropriate foundations for a control program and reduce its damage as much as possible. Therefore, the control program must consider the overwintering stage, which is the weak link in the life cycle and, at the same time, the source of infection for the following season. Confronting the pest in severely infested areas will limit its spread and reduce the incidence and damage it causes.

Table (5): Average temperatures and humidity in Fig orchards in Al-Haidariya district for the period from September 2024 to April 2025

No.	Month	Average Temperature (°C)	Average Relative Humidity(%)
1	**September**	34.7	37.5
2	**October**	27.4	43.6
3	**November**	18.3	51
4	**December**	13.6	44

5	**January**	12.3	55
6	**February**	12	39.3
7	**March**	19.79	38.00
8	**April**	27.21	25.71

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