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ARTICLE

Seasonal Occurrence and Infestation Rates of *Tarucus theophrastus* (Lepidoptera: Lycaenidae) on Jujube Trees in some Regions of Maysan Governorate.

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ABSTRACT

The jujube tree (*Ziziphus spp*.) is considered one of the most vital multipurpose trees with significant economic and environmental value in arid and semi-arid regions. However, these trees are infested by a wide range of insect pests that lead to a decline in their productivity and the defoliation of their branches. The present study aimed to determine the seasonal occurrence of (*Tarucus theophrastus*), and calculate the infestation percentages on both trees and leaves, as well as to measure the average infestation severity rate in certain regions of Maysan Governorate. Two field stations were selected for the study: the College of Agriculture station at the University of Misan and the Al-Tabar station. Data were recorded on a bi-weekly basis starting from (1/9/2025), following the confirmation of the insect's morphological diagnosis using standard taxonomic keys). The results indicated that the insect appeared on (1/9/2025) and remained active until December 1, 2025. Following a period of winter dormancy, the insect reappeared on (15/2/2026) and was recorded until the end of the study period on (15/5/2026).The insect recorded the highest tree infestation rates during autumn and spring, whereas the infestation decreased significantly during the winter season, showing a clear similarity in infestation rates between both locations. Regarding leaf infestation, the insect reached its peak levels in October and early November at both stations, followed by a gradual decline until the infestation completely disappeared in early December. Furthermore, the findings demonstrated a clear impact of climatic variations on infestation severity at both study sites (College of Agriculture station and Al-Tabar station). The severity of the infestation began in early September with low rates (15% and 7%, respectively), then gradually escalated to record the autumn peak in early November at 53% at the University station and 34% at Al-Tabar. Following this peak, the infestation severity rates declined until reaching 0% in early December. This information provides a fundamental basis for developing an integrated pest management (IPM) program for this insect to minimize its damage to the lowest possible threshold.

Keywords: *Lycaenidae; Morphological Diagnosis; Molecular Identification; Climatic Factors.*

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INTRODUCTION

Ziziphus trees are recognized as vital botanical components in agricultural landscapes, particularly within arid and semi-arid environments, due to their significant environmental and economic roles." around the world, as it belongs to the Rhamnaceae family, which includes more than 100 plant species adapted to harsh environments (Ali *et al*, 2019). This tree is characterized by a superior biological and physiological capacity to withstand difficult climatic conditions, such as high temperatures, prolonged drought periods, and high salinity levels in soil and water, making it one of the primary plant components of vegetation cover in desert and semi-desert areas (Ibraheem, 2017). From an environmental perspective, jujube trees (*Ziziphus spp*.) play a significant role in mitigating land degradation through afforestation programs and efforts aimed at combating desertification, in addition to the role of their strong root system in stabilizing the soil and protecting it from wind and water erosion, and forming a natural habitat and vital environment for many organisms, such as pollinating insects, predators, and natural parasites that maintain ecological balance within agricultural systems (Khaleel *et al*., 2016). From a medical perspective, the jujube tree enjoys a prestigious status in folk medicine, and this status is attributed to the richness of plant tissues in many secondary metabolites, such as phenols, flavonoids, terpenes, and saponins (Hussein, 2019). Moreover, jujube fruits (Nabq) represent an important nutritional and consumer source due to their high content of essential vitamins and minerals, and it is one of the main trees on which honeybee colonies rely to collect nectar and pollen grains to produce jujube honey of high economic value (Hussien and Doosh, 2021). Jujube trees face significant challenges and obstacles that limit their growth and reduce their quantitative and qualitative productivity. They are also susceptible to a range of insect pests, such as Lepidoptera, most notably the jujube leaf moth, *Tarucus theophrastus* (Baz, 1988). The larvae of this insect feed directly on the cellular mesophyll tissue, resulting in the appearance of translucent spots. This damage to the green tissue hinders photosynthesis and causes the leaves to dry out and fall off (Reda *et al*., 2025). The damage caused by larval feeding extends to cause severe disruption in the plant's respiration process and an increase in transpiration rates, exposing the tree to severe water stress and negatively affecting other physiological and vital processes (Waqar *et al*., 2015). Open wounds and leaf scraping residues also provide an easy entry point for secondary infections, such as fungi and bacteria, causing rot and complex plant diseases that worsen the tree's health (Saied *et al*., 2008).

The successful confrontation of this pest and the reduction of its economic damage cannot be achieved without a comprehensive detailed understanding of the field dynamics of the insect, as the precise differentiation and robust scientific diagnosis of insect species distributed in the local environment represent the solid foundation for building Integrated Pest Management (IPM) strategies , The study of numerical density, infestation rates, and seasonal distribution of the insect across the months of the year acquires utmost practical importance for predicting the dates of appearance of harmful stages in the future based on changes in the prevailing climatic factors in the region (Youssef *et al*., 2011). The main objective of this study is to determine the seasonal occurrence and infestation rates of *Tarucus theophrastus* on *Ziziphus spina-christi* across different field sites. Furthermore, it aims to evaluate the effectiveness of plant extracts as natural control measures. This research promotes sustainable development by providing field-based data that supports eco-friendly pest management and reduces reliance on synthetic chemicals.

MATERIALS AND METHODS

Insect Identification

The insect was identified based on its external morphology using approved taxonomic keys (Tennent, 1996; Basu *et al*., 2019), and this morphological identification was confirmed by molecular diagnosis, as the genetic results showed a match with the species *Tarucus theophrastus*.

Study Sites

Two stations were selected for the study in Maysan Governorate:

First: The College of Agriculture Station (University of Misan)

This station is located within the building complex of the College of Agriculture at the University of Misan, specifically on the main road connecting Maysan and Basrah Governorates. The total area of the site is approximately (8.5 hectares) and includes the buildings of the College of Agriculture and the university's student dormitories. The site is characterized by plant diversity that includes date palm trees, jujube trees, *Eucalyptus*, *Conocarpus*, *Acacia* and *Oleander* trees, in addition to the presence of plastic greenhouses dedicated to protected agriculture. A group of wild plants and weeds is also distributed across the site, such as (*Imperata cylindrical*, *Phragmites australis*, *Malva parviflora, Euphorbia* *helioscopia*). The site is located at the geographical coordinates: (N 31° 43' 35.8", E 47° 10' 32.5") as shown in Figure (1).

Figure (1) The first site (the College of Agriculture Station)

Second: Al-Tabar Station

This station is located approximately (7 km) away from the center of Al-Amarah city, with an area of about (16 hectares). It is situated specifically on the main road connecting Misan and Basrah Governorates, and it is considered one of the newly reclaimed lands. Various crops are cultivated in this area, including faba beans, okra, and cowpeas, in addition to strategic crops such as wheat and barley. The site also features date palm trees, Jujube trees (*Ziziphus spina-christi*), Eucalyptus *(Eucalyptus camaldulensis*), bottlebrush (*Callistemon viminalis*), and Conocarpus (*Conocarpus lancifolius*), along with the presence of different types of seasonal weeds. The site is geographically located at the coordinates: (N 31° 49' 42.1", E 47° 04' 51.5") as shown in Figure (2).

Figure (2) The second site (Al-Tabar Station)

Study of Seasonal Occurrence

To study the seasonal occurrence of the jujube leaf butterfly *T. theophrastus*, the method of calculating the leaf infestation percentage was adopted. The sampling process began on (2025\9\1), on a bi-weekly basis at the College of Agriculture/University of Misan site, and continued regularly until the end of the season. The work mechanism included selecting five jujube trees of the (Fasami) cultivar at random, at a rate of 10 leaves per tree, to ensure data accuracy the samples were placed in polyethylene bags, and an identification card was attached to each bag containing (site name, collection date, and sample number). Then the samples were transferred directly to the laboratory for examination.

Calculation of Tree Infestation Percentage

To calculate the percentage of tree infestation at the study stations, which began on (2025/9/1), (5) jujube trees were randomly selected at each station. A tree was recorded as "infested" as soon as any trace of scraping or the presence of the insect's life stages (larvae) was observed on its leaves. The reading period was (bi-weekly) and ended on May 30, 2026. After completing the examination, the percentage of tree infestation was calculated according to the following formula**:**

$$\text{Percentage of tree infestation} = \frac{Number\ of\ infested\ trees}{Total\ number\ of\ trees} \times 100$$

Calculation of Leaf Infestation Percentage

To calculate the leaf infestation percentage of the jujube butterfly on the leaves, two stations were selected in Maysan Governorate. The field inspection method relied on selecting (5) trees randomly from each station. Regarding the sampling mechanism, 30 leaves were collected from each tree. In the data recording phase, the number of leaves showing symptoms of infestation was calculated and documented in tables designated for each site and inspection date. Subsequently, the infestation percentage was calculated based on the number of infested leaves compared to the total number of collected leaves, according to the following formula:

$$\text{Percentage of leaf infestation} = \frac{Number\ of\ infested\ leaves}{Total\ number\ of\ leaves} \times 100$$

Estimation of Infestation Severity

To calculate the infestation severity of leaf scrapers on jujube leaves, 30 leaves were examined from each tree and the leaves were classified according to the infestation categories shown in Table (1), which depends on the amount of damage percentage in a single leaf that was measured using the (ImageJ) program. Afterward, the infestation severity index was calculated by applying the McKinney formula (McKinney, 1923).

Table (1) Criterion for estimating infestation severity based on damage percentage per leaf

Infestation Level	Damage Percentage	Category (Grade)
Healthy / Uninfested	Healthy	0
Light infestation	Less than 10%	1
Moderate infestation	11 – 25 %	2
Severe infestation	26 – 50%	3
Very severe infestation	51 – 75 %	4

RESULTS AND DISCUSSION

Insect Identification

The insect specimens were collected and identified using approved taxonomic keys (Tennent, 1996; Basu *et al*., 2019). Given the occurrence of cryptic species within the genus Tarucus, morphological identification was further validated through molecular diagnosis as detailed by (Eidan *et al*., 2026). This molecular analysis involved DNA extraction and PCR amplification of the mitochondrial Cytochrome Oxidase I (COI) gene, which confirmed the species identity with a 100%

match in the GenBank database (Accession numbers: LC913553, LC913554, and LC913555) as shown in Figure (3).

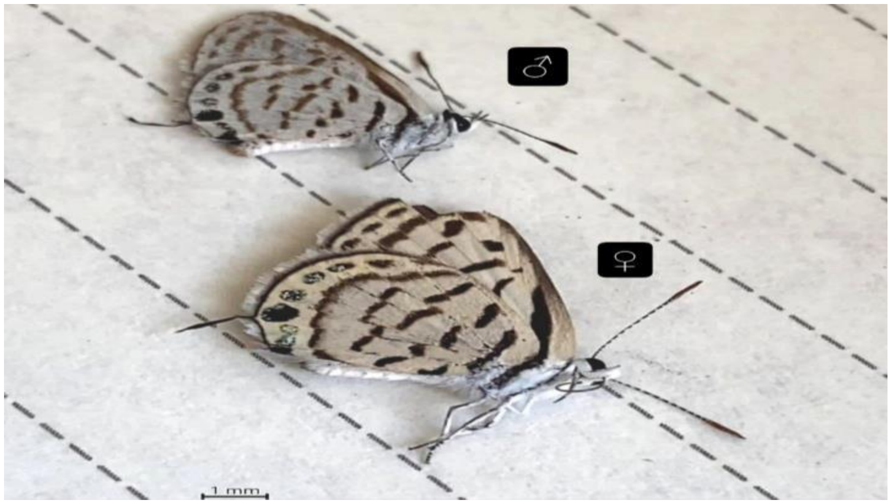

Figure (3) The insect of *Tarucus theophrastus*

Seasonal Occurrence of *Tarucus Theophrastus* at the (College of Agriculture) Site

As shown in Figure (4) that the seasonal occurrence, based on the infestation rate of the insect (*T. theophrastus)*, was directly affected by the continuous changes in average temperatures and average relative humidity throughout the study period. As observed from the chart, the infestation was recorded at the beginning of September (1/9/2025) at a rate of 12% at a temperature of 18 °C and a relative humidity of 9.9%. In the middle of September (15/9/2025), the infestation rate reached 14% at a temperature of 29.2 °C and a relative humidity of 9.4%, temperature of 23.4 °C and a relative humidity of 36.4%. Meanwhile, in the middle of November (15/11/2025), the infestation rate was recorded at 32% at a temperature of 20.1°C and a relative humidity of 45.7%. At the beginning of December (1/12/2025), the infestation rate dropped to zero at a temperature of 16.2 °C and a relative humidity of 41.7%, Subsequently, the infestation began to gradually rise due to the increase in the insect's population density and the suitability of environmental conditions, recording an infestation rate of 18% in October (1/10/2025) at a temperature of 29.2 °C and a relative humidity of 18.4%. This was followed by the first noticeable increase in the middle of October (15/10/2025), where the infestation rate reached 32% at a temperature of 27.45 °C and a relative humidity of 23.7%. After that, the clear activity of the insect continued at the beginning of November (1/11/2025) to record the autumnal peak at 34% at a temperature of 23.4°C and a relative humidity of 36.4%. Meanwhile, in the middle of November (15/11/2025), the infestation rate was recorded at 32% at a temperature of 20.1 °C and a relative humidity of 45.7%. At the beginning of December (December 1, 2025), the infestation rate dropped to zero at a temperature of 16.2 °C and a relative humidity of 41.7%. This decline continued throughout the winter, persisting until the beginning of February (February 1, 2026), when the infestation rate stabilized at zero at a temperature of 17.7 °C and a relative humidity of 56.3%. The graph (Figure 4) clearly shows that this complete disappearance and cessation of insect activity coincided directly with the arrival of the lowest average winter temperatures, accompanied by a significant and unprecedented increase in average relative humidity. This created an environmental stress that forced the insect into a state of complete hibernation, resulting in the complete cessation of larval activity (Alyousif *et al*., 2004).

Afterward, at the beginning of spring, an infestation was recorded in the middle of February (15/2/2026) reaching 8% as a result of the temperature is rising to 19.3 °C and relative humidity reaching 24.7%. Its percentage doubled at the beginning of March (1/3/2026), reaching 16% at a temperature of 15.8°C and a relative humidity of 25.4%. In the middle of March

(15/3/2026), the infestation rate reached 22% at a temperature of 19.7 °C and a relative humidity of 48%.

Subsequently, at the beginning of April (1/4/2026), an infestation rate of 32% was recorded at a temperature of 26.1 °C and a relative humidity of 27.4%. It rose in the middle of April (15/4/2026) to reach 34% at a temperature of 28.15 °C and a relative humidity of 36.4%. The infestation then reached its spring peak at the beginning of May (1/5/2026), registering 42% at a temperature of 29.7 °C and a relative humidity of 16.13%. Then, in the middle of May (15/5/2026), an infestation rate of 40% was recorded at a temperature of 29.5°C and a relative humidity of 16.06%.

The results of the study explained that the seasonal activity of the insect *T. theophrastus* is affected directly by the fluctuations in temperatures and relative humidity, as the highest infestation rates were recorded during the autumn and spring seasons, while these rates decreased or vanished completely during winter periods. It also agrees with the study conducted by (Al-Tamimi, 1999; AL-Yaqobi, 2002.). This correlation may be attributed to the direct physiological effect of heat on vital processes; this is what agrees with both (Al-Azzawi, 1980; Al-Derkazly, 1982; Daly *et al*., 1983). This aligns with scientific trends which indicate that climatic factors are considered a primary driver in determining the activity and diversity of insect communities, as climate fluctuations impose complex biological responses that directly affect their life cycle and seasonal presence (Forrest, 2016). When analyzing these responses, we find that the change in vegetation cover and the availability of food resources play a role, as climate variation affects significantly the composition and abundance of butterfly communities in arid environments (Checa *et al*., 2014). This supports the high infestation in the spring and autumn seasons as a result of the availability of tender vegetative growths on jujube trees, which provide an ideal nutritional environment, and this is what reinforces the hypothesis of insect attraction to plant hosts that provide suitable nutritional conditions (Bonebrake *et al*., 2010). This seasonal dynamic reflects the importance of studying butterflies as "bio-indicators" for the health of ecosystems (Freitas *et al*., 2006), especially that the fluctuation of their numbers is considered a direct response to seasonal and climatic variables which studies confirmed their essential role in determining the stability of butterfly communities (Castro and Espinosa, 2016).

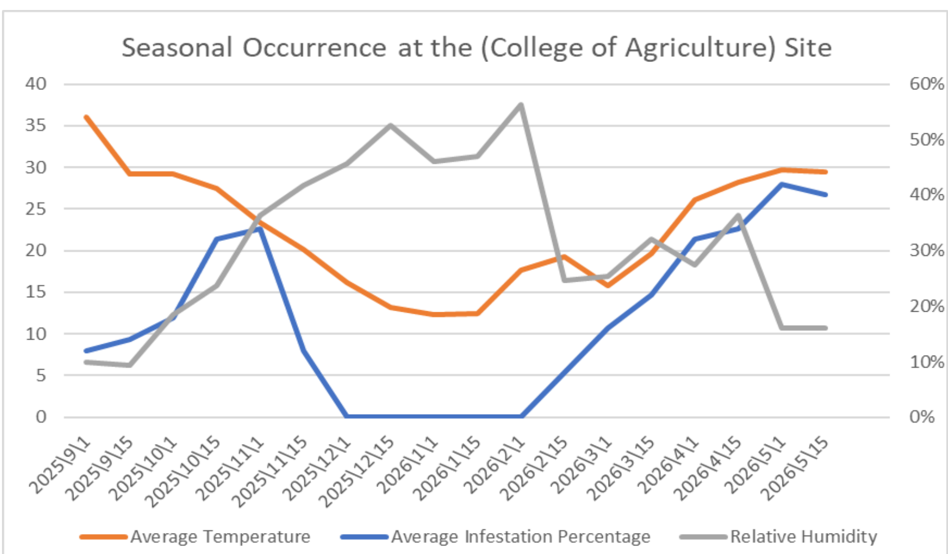

Figure (4) Seasonal occurrence of *Tarucus theophrastus* at the College of Agriculture site L.S.D. (0.05) = 8.52.

Note: The left axis represents Temperature (°C), while the right axis represents Relative Humidity (%) and Infestation Percentage (%).

Infestation Percentage on Trees

As shown in Figure (5), the seasonal occurrence of *T. theophrastus* reveals that the insect is present throughout the year on jujube trees, with the notable exception of December and January, where infestation levels reached (0%). The data indicates that population density is intrinsically linked to climatic fluctuations; the infestation began with high intensity (100%) at both sites in early September (1/9/2025) under high temperatures (36 °C) and low relative humidity (9.9%). As the season progressed towards mid-November (15/11/2025), the infestation rate began to decline to (80%) at the University site and (40%) at the Al-Tabar site, coinciding with a drop in temperature to (20.1 °C) and an increase in relative humidity to (41.7%). The total disappearance of the insect during December and January (0% infestation) aligns with a further decrease in temperatures to (13.2 °C) and an increase in relative humidity (52.5%), which induced winter quiescence. Subsequently, in the spring season, the insect population resumed activity in mid-February (15/2/2026) with an infestation rate of (80%) at the University site and (40%) at the Al-Tabar site, as temperatures rose to (19.3 °C) and humidity dropped to (24.7%). The infestation escalated to (100%) by early March (1/3/2026) and persisted at this level until the final reading (15/5/2026), confirming that temperature and relative humidity are primary drivers of the insect's seasonal population dynamics. The data indicates that population density is intrinsically linked to climatic fluctuations the infestation began with high intensity (100%) at the study sites during the autumn months and persisted until mid-November (15/11/2025), coinciding with favorable temperatures. This aligns with Al-Tamimi (1999), who observed similar patterns in seasonal insect activity. The total disappearance of the insect during winter (December and January) is directly attributed to the sharp drop in temperatures and rising humidity, which induced winter quiescence. This thermal variability significantly alters the insect's physiological capabilities (Wigglesworth, 1972) and impacts essential vital functions, supporting the findings of (Chapman, 1978). Subsequently, the resumption of infestation in mid-February (15/2/2026) coincides with the moderation of temperatures, explaining the insect's recovery of biological activity after enduring harsh climatic conditions (Buttiker and Krupp, 1985). These observations support the hypothesis that climatic conditions act as a primary determinant for the distribution, persistence, and population dynamics of insect communities.

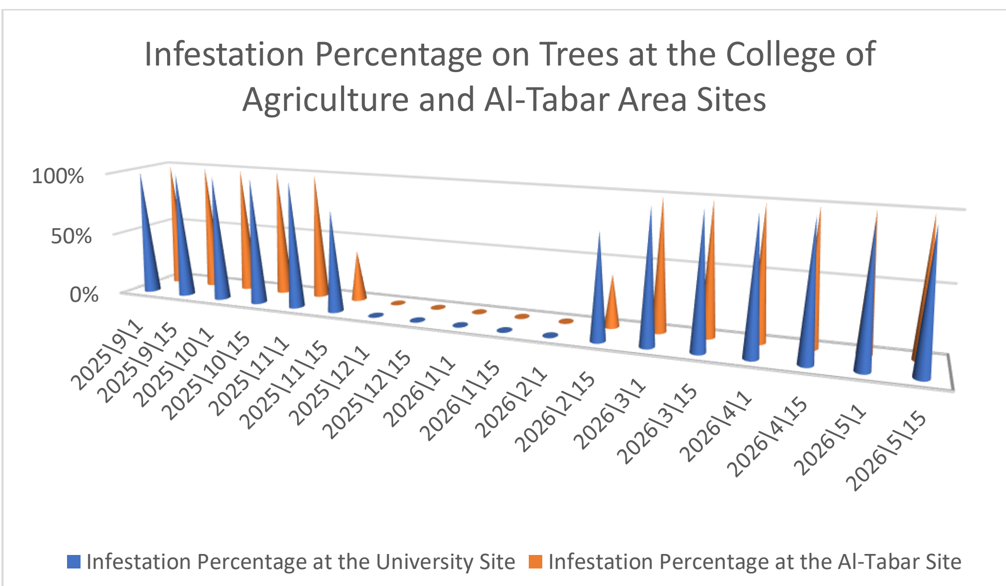

Figure (5) Infestation percentage of trees at the College of Agriculture and Al-Tabar area sites

Infestation Percentage on Jujube tree Leaves

1-For the First Site (University/College of Agriculture)

The results shown in Figure 6 indicate that *T. theophrastus* infestation on the leaves is present throughout most of the year, with the exception of December and January, when activity ceases completely.

The seasonal occurrence and population density of the insect are intrinsically linked to fluctuations in climatic conditions, particularly temperature and relative humidity, which act as primary drivers for the insect's life cycle and infestation dynamics at the study site. Regarding the specific infestation rates, the first incidence was recorded on (1/9/2025) at (8.00%), under a temperature of (36°C) and a relative humidity of (9.9%). This percentage then began to rise in the middle of the month (15/9/2025), reaching 17.33% at a temperature of 29.2°C and relative humidity of 9.4%. Insect infestation rates continued to rise, reaching a record high at the beginning of October (1/10/2025) of 28.67% at a temperature of 29.2 °C and relative humidity of 18.4%. The infection rate then reached 29.33% in mid-October (15/10/2025) at a temperature of 27.45 °C and a relative humidity of 23.7%, and remained at 29.33% until the beginning of November (1/11/2025) at a temperature of 23.4 °C and a relative humidity of 36.4%. Following this period, the infection rate decreased significantly in mid-November (15/11/2025) to 10% at a temperature of 20.1 °C and a relative humidity of 41.7%, and continued to decrease to 0% at the beginning of December (1/12/2025) at a temperature of 16.2 °C and a relative humidity of 45.7% , The absence of infection persisted throughout the winter season (Al-Yaqobi, 2002), the infection then reappeared, with an infection rate of 5.6% recorded in mid-February (15/2/2026) at a temperature of 19.3 °C and relative humidity of 24.7%. This rate rose to 13% at the beginning of March (1/3/2026) at a temperature of 15.8 °C and relative humidity of 25.4%, and increased further to 22.6% in mid-March (15/3/2026) at a temperature of 19.7 °C and relative humidity of 32%.

At the beginning of April (1/4/2026), the infection rate climbed to 33% at a temperature of 26.1 °C and relative humidity of 27.4%. Then, in mid-April (15/4/2026), the infection rate reached 24.2% at a temperature of 28.15 °C and relative humidity of 36.4%. Finally, at the beginning of May (1/5/2026), the infection rate was 19.6% at a temperature of 29.7 °C and a relative humidity of 16.13%. In mid-May (15/5/2026), the infection rate was 14.8% at a temperature of 29.5 °C and a relative humidity of 16.06%. Statistical analysis showed statistically significant differences between the average infection rates on the leaves during the different time periods.

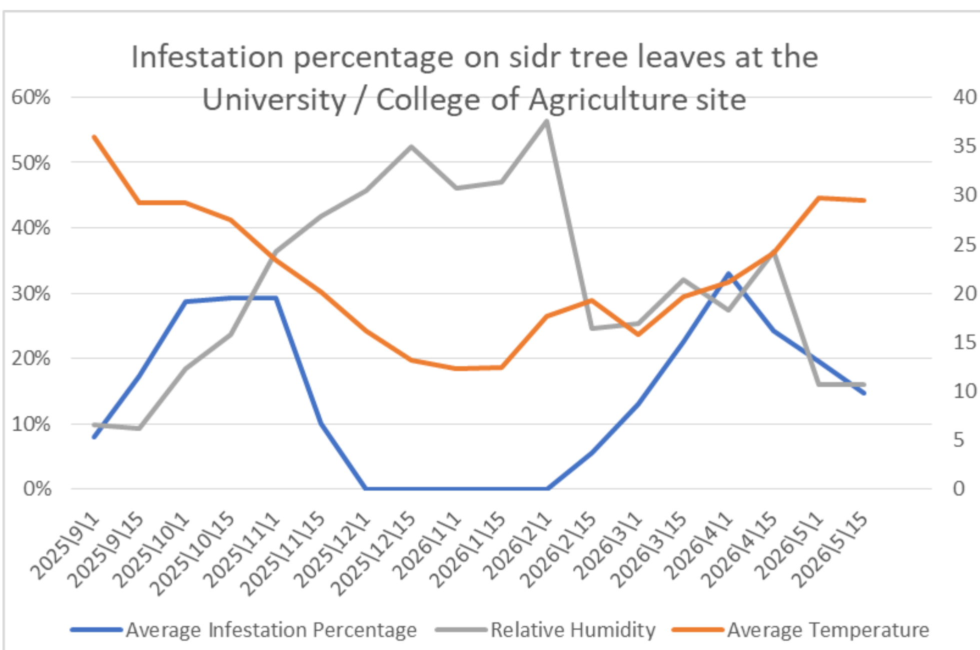

Figure (6) Infestation percentage of insect *T. theophrastus* the University / College of Agriculture Site
L.S.D. (0.05) = 7.137.

Note: The left axis represents Temperature (°C), while the right axis represents Relative Humidity (%) and Infestation Percentage (%).

2-For the Second Site (Al-Tabar Area)

The results presented in Figure (7) for the Al-Tabar area demonstrate that *T. theophrastus* infestation persists throughout most of the year, with a complete absence of activity during the winter months of December and January. The infestation patterns in this location also highlight the critical influence of climatic variations, as temperature and relative humidity remain the primary factors dictating the insect's seasonal population dynamics. Regarding the specific infestation rates at this site, the first recorded incidence occurred on (1/9/2025) at (2.7%), under a temperature of (36 °C) and a relative humidity of (9.9%). By mid-month (15/9/2025), the infestation rate had reached 8.0% at a temperature of 29.2 °C and a relative humidity of 9.4% , Infestation rates continued to rise, reaching a record high at the beginning of October (1/10/2025) of 20.7% at a temperature of 29.2 °C and a relative humidity of 18.4%. The rate then reached 24.0% by mid-October (15/10/2025) at a temperature of 27.45 °C and a relative humidity of 23.7%. This percentage continued until the beginning of November (1/11/2025), reaching 11.3% at a temperature of 23.4 °C and a relative humidity of 36.4%.

After this period, a reading of 4.0% was recorded in mid-November (15/11/2025) at a temperature of 20.1°C and a relative humidity of 41.7%. It continued to decrease, reaching 0% at the beginning of December (1/12/2025) at a temperature of 16.2 °C and a relative humidity of 45.7%. The infection then disappeared completely throughout the winter (Al-Yaqobi, 2002).

Subsequently, an infection rate of 2.4% was recorded in mid-February (15/2/2026) at a temperature of 19.3 °C and a relative humidity of 24.7%. The percentage then rose at the beginning of March (1/3/2026) to 9.6% at a temperature of 15.8 °C and a relative humidity of 25.4%, and increased further in mid-March (15/3/2026) to 20.4% at a temperature of 19.7 °C and a relative humidity of 32%, at the beginning of April (1/4/2026), the infection rate was recorded at 19.6% at a temperature of 26.1 °C and a relative humidity of 27.4%. Then, in mid-April (15/4/2026), the infection rate was recorded at 17.6% at a temperature of 28.15 °C and a relative humidity of 36.4%. At the beginning of May (1/5/2026), the infestation rate reached 14.8% at a temperature of 29.7 °C and a relative humidity of 16.13%. By mid-May (15/5/2026), the infestation rate had dropped to 11.2% at a temperature of 29.5 °C and a relative humidity of 16.06%.

The results indicate a clear significant variation in infestation rates between the study sites, with the University site recording a mean infestation rate of (14.58%), while the Al-Tabar site recorded the lowest rate of (9.35%). This variation may be attributed to differences in agricultural practices and the plant diversity surrounding the jujube trees (Marshall *et al.*, 2003).

At the University site, the rise in infestation percentage may possibly be a result of neglected field operations and the absence of periodic tree pruning, along with the spread of wild plants and weeds such as, Common reeds, Common mallow, and *Euphorbia milii*. Additionally, the proximity to *Eucalyptus*, *Conocarpus*, *Acacia*, and *Nerium* trees, when left unpruned, may possibly provide an ideal environment and a safe haven for the insect (Anyszka and Kohut, 2011).

In contrast, the low infestation rate at the Al-Tabar site may possibly be due to the absence of weeds, which may be a result of continuous soil tillage and the seasonal cultivation of crops such as wheat, barley, fava beans, and cowpeas. Although some weeds may be present, consistent tillage and pruning may possibly renew the foliage and reduce the insect's population accumulation (Jedruszczak and Antoszek, 2004). Such practices may possibly deprive the insect of a safe haven and alternative hosts, which may limit its spread and impact on the leaves compared to environments dense with weeds (Derksen *et al.*, 1993). Statistical analysis revealed significant differences in infestation rates on the leaves across the different recording dates.

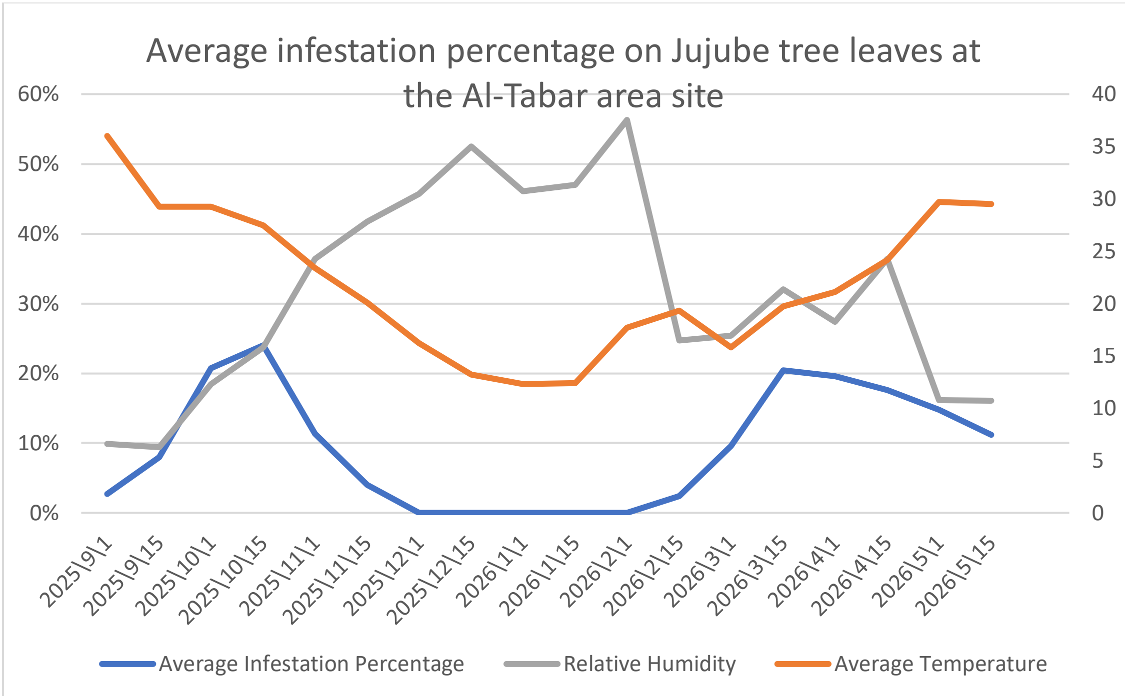

Figure (7) Average infestation percentage on jujube tree leaves at the Al-Tabar Area site. L.S.D. (0.05) = 7.77

Calculation of Infestation Severity at the University and Al-Tabar Area Sites

As shown in Figure (8) for the two sites (University and Al-Tabar) that the calculation of the average infestation severity of the insect (*T. theophrastus)* was clearly affected by the continuous changes in average temperatures and average relative humidity throughout the study period. The infestation began to appear at the beginning of September (1/9/2025) with an infestation severity rate of 15% at the University site and 7% at the Al-Tabar site at a temperature of 36 °C and a relative humidity of 9.9%. It recorded an increase in the middle of September (15/9/2025), reaching 20% at the University and 12% at Al-Tabar at a temperature of 29.2°C and a relative humidity of 9.4%.

Subsequently, the infestation severity continued to rise continuously, recording a rate of 32% at the University and 30% at Al-Tabar in October (1/10/2025) at a temperature of 29.2 °C and a relative humidity of 18.4%. This was followed by a steady climb in the middle of October (15/10/2025), where the infestation severity reached 49% at the University and 32% at Al-Tabar at a temperature of 27.45 °C and a relative humidity of 23.7%. After that, the clear activity of the insect continued at the beginning of November (1/11/2025) to record the autumnal peak of infestation severity at 53% at the University site and 34% at the Al-Tabar site at a temperature of 23.4 °C and a relative humidity of 36.4%.

Meanwhile, the percentages declined in the middle of November (15/11/2025), registering 30% at the University and 20% at Al-Tabar at a temperature of 20.1 °C and a relative humidity of 45.7%, leading up to the beginning of December (1/12/2025), where the infestation severity dropped to 0% at both sites as the temperature reached 16.2 °C. This decline in infestation severity during the colder months is consistent with the findings of (Al-Tamimi, 1999), who noted that the biological activity of Tarucus species is highly sensitive to seasonal temperature fluctuations. The observed cessation of insect activity at lower temperatures suggests that the population enters a quiescence phase to survive the winter cold, a behavior supported by the physiological principles of insect development established by (Wigglesworth, 1972) and (Hodson and Al-Rawy, 1956). Furthermore, the consistently higher infestation rates at the University site compared to Al-Tabar may be attributed to local environmental micro-climatic conditions or host plant vigor, as discussed in the context of insect-habitat diversity by (Deghiche-Diab *et al*., 2020).

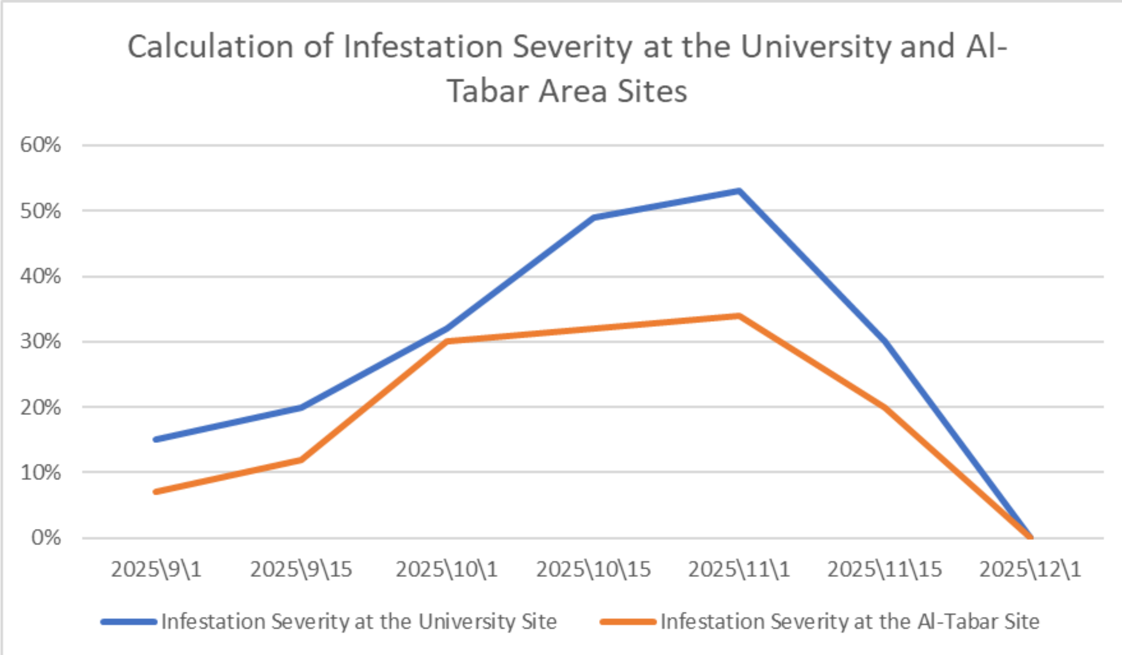

Figure (8) Calculation of infestation severity at the University and Al-Tabar sites

CONCLUSIONS

The findings of this study offer practical guidance for farmers and agricultural stakeholders in Maysan Governorate. By understanding the seasonal activity and peak infestation periods of *T. theophrastus*, farmers can implement timely and targeted Integrated Pest Management (IPM) strategies, such as mechanical pruning and field sanitation, specifically before the autumn and spring peaks. Furthermore, the correlation between weed density and infestation severity suggests that maintaining clean fields and regular tillage acts as a natural preventive measure. Such eco-friendly practices not only reduce the need for synthetic chemical pesticides—thereby lowering production costs and environmental impact—but also preserve the economic and nutritional value of jujube trees, ultimately supporting sustainable agricultural productivity and local food security**.**

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