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# Influence of Mango Cultivars on the Population Density of the White Mango Scale Insect, *Aulacaspis tubercularis* (Homoptera: Diaspididae) in Damietta Governorate

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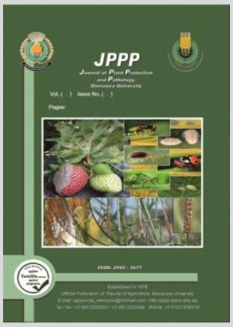


## ABSTRACT

The white mango scale insect, *Aulacaspis tubercularis* (Diaspididae: Homoptera), is one of the most destructive pests affecting mango trees in Egypt. This study investigates the impact of different mango cultivars on the population dynamics of this insect in New Damietta mango orchards during the 2022 and 2023 seasons. The effects of natural enemies and weather factors, including mean temperature (°C), relative humidity (%), tree orientation, and seasonality, were analyzed. The findings revealed three annual population peaks of *A. tubercularis*, occurring in February, May, and August across different mango cultivars. The highest infestation levels were recorded during summer, with mean densities of 3623.5 ± 564.3 and 2733.3 ± 434.1 individuals per 125 leaves in the first and second study years, respectively, while the lowest populations were observed in winter. Statistical analysis showed that *A. tubercularis* populations were significantly influenced by natural enemies and daily means temperature, whereas relative humidity had no significant effect. Additionally, the insect exhibited a preference for the southern orientation of mango trees. These findings provide valuable insights into the seasonal trends and ecological interactions of *A. tubercularis*, contributing to the development of effective integrated pest management strategies for mango orchards in Egypt.

***Keywords***: *Aulacaspis tubercularis*, mango cultivars, seasonality, directions.

## INTRODUCTION

Mango trees (*Mangifera indica* L., family Anacardiaceae) are among Egypt's most important fruit crops, valued for their high nutritional content, including lipids, salts, sugars, proteins, and vitamins (FAO, n.d.). They also play a vital economic role, especially in juice production, with Egyptian cultivars being highly regarded for export due to their exceptional quality (Economic Agricultural Report, 2007). This has led to a significant increase in the area cultivated with mangoes in recent years (Abdelsalam *et al*., 2018). According to the Economic Agricultural Report from the Central Administration for Economic Agriculture, Ministry of Agriculture (2007), mango cultivation in Egypt covered approximately 129,073 acres in 2007, yielding about 497,771 tons. Historical accounts by Abdelsalam *et al.* (2018) suggest that mangoes were introduced to Egypt around 200 years ago. By 2015, the cultivated area had expanded to approximately 102,071.76 hectares, with most of the production concentrated in Ismailia Governorate.

Understanding these interactions is crucial for developing integrated pest management (IPM) strategies tailored to local climatic conditions, optimizing biological control, and reducing pesticide dependency in mango orchards. Mango cultivars such as Gahrawy, Sokary, and Baladi exhibit varying susceptibility to insect pests, which can significantly influence their cultivation and productivity. Key pests like mango hoppers (*Idioscopus spp.*), fruit flies (*Bactrocera spp.*), and mealybugs (*Drosicha mangiferae*) are prevalent across these cultivars, but their infestation levels can differ based on the variety's physical and chemical characteristics (El-Sayed *et al*., 2021). For instance, Sokary may show higher resilience due to its dense foliage, while Gahrawy and Baladi might be more prone to specific pest attacks due to their softer fruit texture (Hassan *et al*., 2020). Understanding varietal responses to pests is essential for effective pest management and sustainable mango production. The direct losses caused by the mango stone weevil *Sternochetus mangiferae* (Fab.) range from 5% to 80%, depending on the mango variety (Verghese, 2000). Additionally, an MSW infestation can trigger the premature drop of maturing fruits, leading to indirect losses. Although mango trees produce a large number of fruits per panicle, most of them naturally fall off before reaching the size of a pea (Singh, 1978).

In many countries of the world, the most important pests that affect mango trees are scale insects especially *Aulacaspis tubercularis* (Diaspididae: Hemiptera), Gallardo (1983), Williams and Watson (1988). According to Colyn and Schaffer (1993), Peña *et al.* (1998) and Joubert *et al.* (2000) the white mango scale insect, *A. tubercularis*, attacks all parts of the mango tree, branches, leaves and fruits, which affects the commercial value of the fruits and the possibility of exporting them. Younger trees are considered the most vulnerable to damage resulting from this pest, as it causes loss of leaves, death of branches, and the ability to produce fruit, especially in dry areas such as South Africa. It also represents the most important problem for mangoes in the continents of Africa, North and South America, the Caribbean islands and Australia.

Ascher *et al.* (1995) reported that *Aulacaspis tubercularis* is among the most significant insect pests attacking mango trees, with population peaks occurring at different times throughout the year. In the Kapmuiden region, characterized by high temperatures, the population peak was observed in August, much earlier than in the Nelspruit region, where it occurred in November. In Egypt's Beni-Suef Governorate,

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Radwan (2003) documented three generations of *A. tubercularis* on mango trees. Similarly, Kwaiz (2009) recorded three infestation peaks in Egypt, occurring in March, June, and November, with the lowest population observed in mid-July.

Therefore, this study was carried out to monitor fluctuations in the population of this pest in mango orchards in Damietta Governorate. Additionally, it aimed to examine the influence of environmental factors (temperature, relative humidity, and preferred direction) as well as biotic factors (predators and parasitoids) on the population dynamics of this insect.

## MATERIALS AND METHODS

The experiments for the current study were conducted from January 2022 to December 2024 on mango trees (*Mangifera indica* L.) of the family Anacardiaceae. Three cultivars, Ghrawy, Sokary, and Baladi approximately seven years old, were selected from a private orchard exclusively planted with mango trees mixed cultivars. The orchard, covering an area of approximately three feddans, is located in the New Damietta region of Damietta Governorate, Egypt. Throughout the study period, no chemical control measures were applied to the selected orchard. All trees received uniform standard horticultural practices.

**1. Sample size:**

For this study, five trees of each of the three mango cultivars within the same orchard were selected and labeled. The chosen trees were uniform in their infestation levels by *Aulacaspis tubercularis* and comparable in size, shape, height, and vegetation. Samples were collected biweekly throughout the study period from the middle of each selected tree and from the four cardinal directions: north, south, east, and west.

A total of 125 mango leaves were sampled for each of the three mango cultivars during the two-season study period [i.e., 5 trees × 5 sampling points (4 cardinal directions + center) × 5 leaves]. Samples were collected from each direction of the mango trees using garden scissors and immediately placed into plastic bags for same-day analysis. In the laboratory, a stereomicroscope was used to observe and record the nymphal and adult stages of *A. tubercularis* as well as its predators, including both immature and adult stages.

To assess the parasitism ratios of *A. tubercularis*, the insects in each sample were categorized into two groups: healthy, living insects and parasitized insects. The parasitized group included those containing parasitoid larvae or pupae, as well as those with emergence holes from adult parasitoids. Each parasitized and healthy insect was carefully counted and recorded.

**2. Distribution of *A. tubercularis:***

Directional preference of *A. tubercularis* was determined by applying the following equation Al Shidi *et al.* (2018) and Gillison (2006):

**F1 = (East – West)  F2 = (North – South)**

**Tan. Q = F2/F1**

**Where**:

**F1 = Total numbers of *A. tubercularis* on the (East direction) minus that on the (West direction) if former is higher, and vice versa.**

**F2 = Total numbers of *A. tubercularis* on the (North direction) minus that on the (South direction) if former is higher, and vice versa.**

The tangent is represented by the resulting figure, whose matching value the equation received.

**Tan. Q = Tan of the angle between F1 and F2.**

During the two study years, the distribution of *A. tubercularis* populations in various seasons was also determined.

**3. Meteorological data:**

The Central Laboratory for Agricultural Climate provided data on the average air temperature (°C) and average relative air humidity (R.H. %) for the experimental area throughout the study period.

**4. Statistical analysis:**

The impact of the tested factors, including temperature (°C) and relative humidity (%), on the population abundance of *Aulacaspis tubercularis* was analyzed using a one-way analysis of variance (ANOVA) in the SPSS system. To assess the significance of differences between means, Duncan's Multiple Range Test (Duncan, 1955) was applied at a 0.05 probability level.

## RESULTS AND DISCUSSION

**Effect of different mango cultivars on the population density of the white mango scale insect, *Aulacospis tubercularis*:**

Data presented in Figs. (1 and 2), showed that, *A. tubercularis* recorded three peaks on mango trees during the first year 2022, the first peak recorded in 15th of Feb. 2022 and represented by (1105, 905 and 789 indiv./125 leaves) for Gahrawy, Sokary and Baladi respectively. The second one in 15th of May 2022 and represented by (1492, 1292 and 1151 indiv./ 125 leaves) for Gahrawy, Sokary and Baladi respectively, the third one in 15th of Aug. 2022 and represented by (5550, 5350 and 4855 indiv./ 125 leaves) for Gahrawy, Sokary and Baladi respectively Fig. (1).

On the other hand, the same insect, *A. tubercularis* recorded three peaks on mango trees during the second year of study 2023, the first peak recorded in 15th of Feb. 2023 and represented by (845, 681 and 632 indiv./125 leaves) for Gahrawy, Sokary and Baladi respectively. The second one in 15th of May 2023 and represented by (1142, 972 and 898 indiv./ 125 leaves) for Gahrawy, Sokary and Baladi respectively, the third one in 1st of Aug. 2023 and represented by (4264, 4094 and 3599 indiv./ 125 leaves) for Gahrawy, Sokary and Baladi respectively Fig. (2).

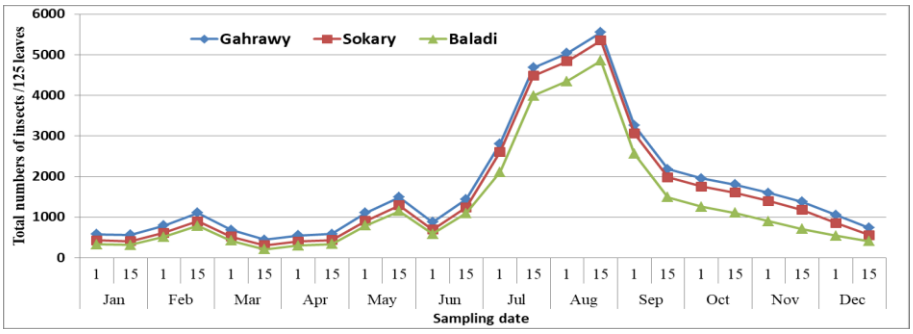



**Fig. 1. Population density of *A. tubercularis* on three mango cultivars during first year 2022 in New-Damietta region.**

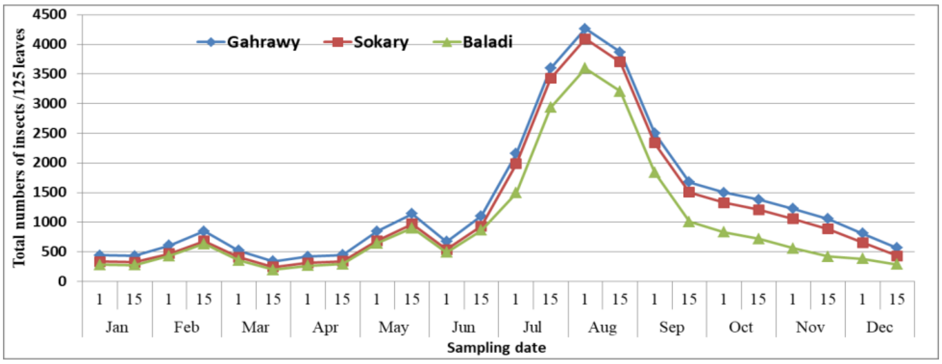



**Fig. 2. Population density of *A. tubercularis* on three mango cultivars during second year 2023 in New-Damietta region.**

The highest population abundance of *A. tubercularis* during the two years was in August Figs. (1 and 2).

These findings underline the complexity of *A. tubercularis* population dynamics and the role of both environmental factors and natural enemies in shaping pest activity.

The results obtained in this study are consistent with those of Ascher *et al*. (1995), who observed that the population peaks of *A. tubercularis* occurred at different times throughout the year. Specifically, the highest population density was recorded in August in the Kapmuiden region, which is characterized by high temperatures, significantly earlier than the peak in the Nelspruit region, which occurred three months later in November. In Beni-Swief Governorate, Egypt, Radwan (2003) documented three generations of *A. tubercularis* on mango trees, further supporting the multi-generational nature of the pest. Similarly, Kwaiz (2009) reported three distinct peaks of infestation in Egypt, occurring in March, June, and November, with the lowest population recorded in mid-July. Nabil *et al*. (2012) also recorded a single peak of *A. tubercularis* in its live stage in November each year. Attia *et al.* (2020) observed two peaks in the seasonal activity of *A. tubercularis* and its parasitoids on Hendi variety mango trees over two studied years. According to Ata (2024) the white mango scale insect, *A. tubercularis* (Diaspididae: Hemiptera) recorded three peaks of abundance annually that occurred in the months of May, August and February on mango trees (Gahrawy cultivar) in New Damietta region, Damietta Governorate. The influence of mango cultivar on piercing-sucking insect pests was explored in a study by Abd Elrahman *et al.* (2007), which provided valuable insights into how different mango cultivars affect the population density of *Icerya seychellarum*, commonly known as the Seychelles fluted scale. Their findings indicated that the cultivar Sultanis had the highest population density of the scale, followed by Baladi and Hendi. In contrast, Ewaisi recorded the lowest annual population density across the 2003 and 2004 seasons. The differences in population density among the four cultivars were found to be statistically significant at the 0.05% level, highlighting the impact of cultivar selection on pest populations.

**Seasonal distribution of the white mango scale insect, *Aulacospis tubercularis*:**

The data presented in Table (1) and Fig. (3) illustrate the impact of different seasons on the population density of the white mango scale insect, *Aulacaspis tubercularis*, during the two study years (2022–2023).

**Table 1. seasonality average numbers of *A. tubercularis* on different mango cultivars during two successive years 2022 and 2023 in New-Damietta region.**

| .Season | 1st year | | | | 2nd year | | | |
|---|---|---|---|---|---|---|---|---|
| | Gahrawy | Sokary | Baladi | Average | Gahrawy | Sokary | Baladi | Average |
| Winter | 697.8±96.8 | 532.8±87.4 | 432.0±84.9 | 554.2±89.7 b | 531.5±74.4 | 409.2±64.1 | 361.3±64.5 | 434.0±67.7 b |
| Spring | 1011.5±169.6 | 830.2±160.4 | 712.0±152.7 | 851.2±160.9 b | 772.7±130.5 | 631.2±118.1 | 575.5±114.0 | 659.8±120.9 b |
| Sumer | 3921.8±564.3 | 3721.8±553.2 | 3226.8±545.7 | 3623.5±564.3 a | 3011.7±434.1 | 2841.7±441.2 | 2346.7±382.3 | 2733.3±434.1 a |
| Autumn | 1421.5±192.4 | 1225.7±189.3 | 822.7±136.8 | 1156.6±172.3 b | 1087.8±147.9 | 927.5±141.9 | 533.0±87.5 | 849.4±124.8 b |
| Total | 7052.7 | 6310.5 | 5193.5 | 6185.6 | 5403.7 | 4809.5 | 3816.5 | 4676.6 |
| Annulay Ave. | 1763.2±301.5 | 1577.6±299.1 | 1298.4±271.9 | 1546.4±290.5 | 1350.9±231.9 | 1202.4±228.5 | 954.1±198.7 | 1169.1±219.1 |

**The average numbers followed by the same litter within the same column are insignificant differences.**

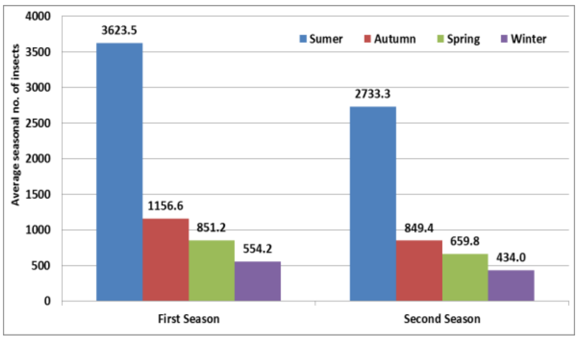



**Fig. 3. Seasonal distribution of *A. tubercularis* on mango tree during the two successive years of the study 2022 and 2023 in New-Damietta region.**

The results showed that the average numbers of *A. tubercularis* during the four seasons of the two studied years were divided into two categories according to statistical analysis during the 1st and 2nd years.

During the 1st year the 1st category was showed by the summer season that recorded the highest average numbers of this insect (nymphal and adult stages) and represented with 3623.5±564.3 individuals/125 leaves in the 1st year. The other three seasons represented the other category and represented with 1156.6±172.3, 851.2±160.9 and 554.2±89.7 individuals/125 leaves, on autumn, spring and winter seasons, respectively.

The same trend was observed in the 2nd year of study, the statistical analysis showed that the summer season that recorded the highest average numbers of this insect (nymphal and adult stages) and represented with 2733.3±434.1 individuals/125 leaves. The other three seasons represented the other category and represented with 849.4±124.8, 659.8±120.9 and 434.0±67.7 individuals/125 leaves, on autumn, spring and winter seasons, respectively.

According to the different mango cultivars, Gahrawy, Sokary and Baladi the same trend as well as the general average was observed.

From the obtained results can summarized that the summer months was the most preferable for *A. tubercularis on mango tree* followed by autumn months.

These results were relatively in agreement with Bakry and Tolba (2019) who mentioned that, the overall mean populations of *A. tubercularis* on mango leaves were highest during autumn months followed by summer months, spring months and winter months in Luxor Governorate, Egypt. *A. tubercularis* is a photopositive insect and because more sunlight reaches the upper surface of the leaf than its lower surface. The above results confirm that: *A. tubercularis* prefers the upper surface of mango leaves than the lower surface also it prefer the more shining direction than the other one. According to Bakry and El-Zoghby (2019), the summer and fall seasons of the year had more favorable weather conditions for the growth and multiplication of *A. tubercularis* insects. Additionally, the optimal times for insect activity differed depending on the research years and the examined stages. Also, Sanad (2017) who found that, in autumn season the *A. tubercularis* insects recorded its largest number in Qalubiya, Egypt. According to Ata (2024) the summer months had the maximum population of the white mango scale insect, *Aulacaspis tubercularis*, conversely, the winter months of both seasons saw the lowest of insect population on mango trees (Gahrawy cultivar) in New Damietta region, Damietta Governorate.

**Influence of the mango tree directions on distribution of *Aulacospis tubercularis* population on mango trees:**

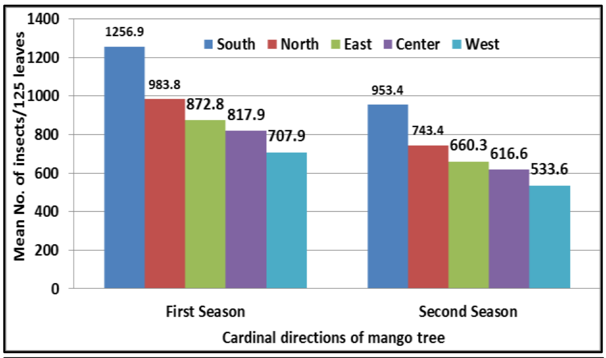
The data presented in Fig.s (4&5) demonstrate the effect of different directions of mango tree on the distribution of *Aulacaspis tubercularis* populations during the first and second years. These findings were derived from the original seasonal abundance data, where each mango tree was sampled in the four cardinal directions, along with the center. Each directional subsample was analyzed separately, and the data were subsequently pooled to assess seasonal abundance.

In the first year 2022, the population in the south of the mango tree was higher than other directions, the annual average number of the insect was 1256.9±229.7 insects/ sample. It was followed by the north, east and center of the tree and represented by 983.8±183.4, 872.8±165.1 and 817.9±156.0insects/ sample. The lowest population of the insect was accumulated in the west direction of the mango tree and represented by 707.9±137.5 insects/ sample.

The same trend was showed during the 2nd year 2023, the population in the south of the mango tree was higher than other directions the annual average number of the insect were 953.4±174.1 insects/ sample followed by the north, east and center of the tree and represented by 743.4±138.6, 660.3±124.3 and 616.6±117.4 insects/ sample. The lowest population of the insect was accumulated in the west direction of the mango tree and represented by 533.6±103.1 insects/ sample.

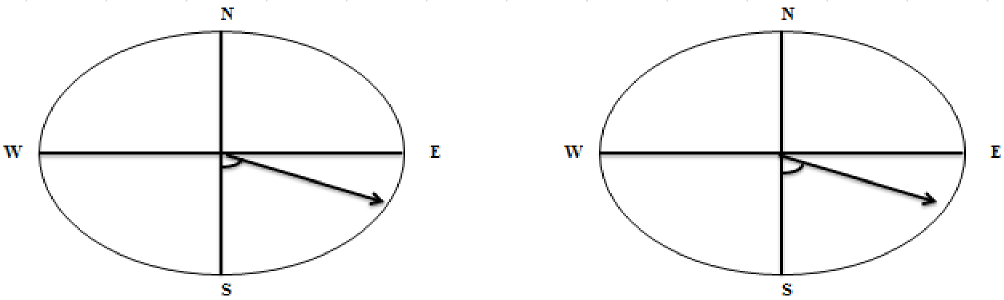
The statistical analysis showed that there were non-significant differences in mean numbers of *A. tubercularis* between different directions of mango tree LSD 0.05 were 38.8 and 47.2 insects in the 1st and 2nd years, respectively. The southern direction of mango tree harbored the highest numbers of this insect during the two tested years.

From Figure (5), it is clear that the white mango scale insect, *A. tubercularis* was mostly accumulated in the area between the southern and eastern directions of the mango tree during the 1st and 2nd years of the study performing an angle of 58.9 and 58.9 degrees to the east.




| Season | South | North | East | Center | West | LSD 0.05 |
|---|---|---|---|---|---|---|
| First | 1256.9±229.7 a | 983.8±183.4 a | 872.8±165.1 a | 817.9±156.0 a | 707.9±137.5 a | 496.3 insects |
| Second | 953.4±174.1 a | 743.4±138.6 a | 660.3±124.3 a | 616.6±117.4 a | 533.6±103.1 a | 374.6 insects |

**Fig. 4. Mean numbers of *Aulacaspis tubercularis* across different directions of mango trees in the first (2022) and second (2023) years in New-Damietta region. Means followed by the same letter indicate no significant difference.**




**Angle = 58.9º**
**First year 2022**

**Angle = 58.9º**
**Second year 2023**

**Fig. 5. Preferred cardinal directions for *Aulacaspis tubercularis* on mango trees in New Damietta region during 2022 and 2023 years.**

These results can be attributed to the fact that the insect is photopositive and prefers a warm environment.

The results of this study align with the findings of El-Metwally *et al.* (2011), who observed that in Damietta Governorate, *A. tubercularis* preferred the southern direction of mango trees over other cardinal directions. Similarly, in Qaliobiya, Egypt, Sanad (2017) found that the south and east directions of the tree experienced the highest infestations of *A. tubercularis*, compared to other directions. In a study conducted by Bakry and Tolba (2019) in Luxor Governorate, Upper Egypt, significant differences in the population of *A. tubercularis* were recorded across the various directions of the mango tree. The grand mean population density was highest on the south side, followed by the east side. In contrast, the north side had the lowest infestation levels, while the west side had a moderate amount. These findings suggest that *A. tubercularis* tends to accumulate on the east and southern sides of mango trees, where the conditions are warmer and more exposed to sunlight, which may favor the pest's development. Conversely, *A. tubercularis* exhibited a preference for the east and west directions during the summer and under cooler conditions, as reported by Bakr *et al*. (2009). Attia *et al*. (2020) further observed that the northeastern direction of mango trees was the most favorable for *A. tubercularis* and its associated parasitoids in Sharkia Governorate. Similarly, Nabil *et al*. (2012) in Sharkia Governorate observed significant variations in *Aulacaspis tubercularis* distribution among the four cardinal directions of mango trees, with the pest predominantly concentrated on the northeastern side. These findings highlight the influence of tree orientation and environmental conditions on the spatial distribution of *A. tubercularis*. In contrast, Ata (2024) suggested that differences in weather conditions and/or agro-ecosystem factors might explain the discrepancies between previous studies and the current findings. Over the two years of investigation, *A. tubercularis* exhibited a preference for the southern direction of mango trees in the New Damietta region, Damietta Governorate.

**Influence of certain weather factors (temperature °c and relative humidity %) on the population density of the white mango scale, *Aulacaspis tubercularis*:**

The simple correlation coefficient (r) and regression coefficient (b) between the daily mean temperature, daily mean relative humidity, and the population density of the white mango scale, *A. tubercularis*, during the first and second years are presented in Table (2). These statistical analyses help quantify the relationship between environmental factors and pest abundance, providing insights into how temperature and humidity influence *A. tubercularis* population dynamics.

The correlation between the population of *A. tubercularis* and the daily mean of temperature was significantly positive in the 1$^{st}$ and 2$^{nd}$ years, the correlation (r) were 0.694 and 0.680 respectively, whereas the correlation between relative humidity and the population of *A. tubercularis* was non-significant positive in the first and second years, the correlation (r) were 0.115 and 0.146 respectively.

The partial regression data in Table (2) show the exact impact of every meteorological element that was investigated. These numbers demonstrated the same pattern as the simple correlation coefficient. The total impacts of daily mean of temperature℃, and relative humidity R.H. % on the total population of *A. tubercularis* during the two successive years were 48.8 and 47.8%, respectively.

The obtained results suggest that *A. tubercularis* is significantly influenced by temperature. This can be attributed to the insect's photopositive nature and its preference for warm environments, which likely support its development and reproduction. The tendency of *A. tubercularis* to favor sunlit and warmer areas, such as the south and east sides of mango trees, further highlights the impact of temperature on its distribution and population dynamics.

These findings are supported by several studies. Nabil *et al*. (2012) reported that the combined effects of weather factors, including temperature (°C), relative humidity (R.H. %), and light intensity (Lux), had a significant impact on *Aulacaspis tubercularis* populations. Over two years, these factors influenced population dynamics by 63.19% and 40.20% in the upper canopy level and by 77.66% and 39.44% in the lower canopy level. Furthermore, Attia *et al*. (2020) found that the total number of *A. tubercularis* live stages was affected by 70.60% and 87.13% in the first and second years, respectively. These results were based on the coefficient of determination (C.D. %), which considered maximum and minimum temperatures (°C), relative humidity (R.H. %), and solar radiation (MJ/m²). Similarly, Ascher *et al*. (1995) observed that the population peaks of *A. tubercularis* varied throughout the year depending on regional climatic conditions. In the Kapmuiden district, characterized by high temperatures, the population peak occurred in August, whereas in the cooler Nelspruit region, it was recorded later in November. These findings emphasize the critical role of climatic factors, particularly temperature and light intensity, in shaping the seasonal dynamics and spatial distribution of *A. tubercularis*. Additionally, Abd Elrahman *et al*. (2007) revealed that the population density of the Seychelles fluted scale, *Icerya seychellarum* Westwood (Margarodidae: Homoptera), exhibited a significant positive correlation with temperature and an insignificant negative correlation with relative humidity in mango orchards in Giza Governorate, Egypt.

Ata (2024) showed that the overall population of *A. tubercularis* was affected significantly by natural enemies and the daily mean temperature, whereas the overall population of the tested pest was not significantly affected by R.H. % on mango trees (Gahrawy cultivar) in New Damietta region, Damietta Governorate.

**Table 2. Simple correlation and regression coefficients, along with explained variance (E.V.), between the tested weather factors and biweekly mean populations of *Aulacaspis tubercularis* during 2022 and 2023 in New-Damietta region.**

| Year | Factor | Simple correlation analysis | | Multiple regression analysis | | | | |
|---|---|---|---|---|---|---|---|---|
| | | r. | P. | b. | p. | "F" | Prob>F | E.V. |
| 2022 | Temp. ◦C | 0.694 | 0.000 | 141.92 | 0.000 | 9.99 | 0.001 | 48.80% |
| | R.H. % | 0.115 | 0.594 | 34.84 | 0.615 | | | |
| 2023 | Temp. ◦C | 0.680 | 0.000 | 112.85 | 0.000 | 9.61 | 0.001 | 47.80% |
| | R.H. % | 0.146 | 0.497 | 25.02 | 0.431 | | | |

**Influence of the natural enemies; predators and parasitoids on the population density of the white mango scale insect, *Aulacospis tubercularis*:**

During the investigation period extended during two years from beginning of January 2022 until the end of December 2023, there are three predatory insects associated with *A. tubercularis* were recorded, the three predators were belonging to Order Coleoptera, *Rodolia cardinalis* and *Scymnus coccivora* (Family: Coccinillidae) and *Cybocephalus micans* (Family: Nitidulidae). In addition to the predatory insects that recorded, there are three parasitoids that associated with *A. tubercularis* were recorded, the three parasitoids were belonging to Order Hymenoptera, *Aspidiotiphagus* sp., *Aphytis* sp. and *Encarsia* sp. (Family: Aphelinidae).

The simple correlation (r) and regression (b) coefficients between the population density of *A. tubercularis* and the associated natural enemies, (predatory insects and parasitoids) during the first (2022) and second (2023) years are given in Table (3).

The statistical analysis showed that only one predator, *Cybocephalus micans* correlated significantly with *A. tubercularis* during the two years of study, the correlation value (r) were 0.999 and 0.938 respectively, while the other two predators as well as the parasitoid showed non-significant relation with the this insect during the two years of study.

The partial regression data in Table (3) show the precise effect of every predatory insect that was investigated. These numbers demonstrated the same pattern as the simple correlation coefficient in addition to significant relation with the tested parasitoid. The total impacts of the predatory insects and the parasitoid on the total population of *A. tubercularis* during the two successive years were 88.3 and 85.9%, respectively.

**Table 3. Simple correlation and regression coefficients, along with explained variance (E.V.), between predators and the biweekly mean populations of *Aulacaspis tubercularis* during 2022 and 2023 in Damietta Governorate.**

| Year | Factor | Simple correlation analysis | | Multiple regression analysis | | | | |
|---|---|---|---|---|---|---|---|---|
| | | r. | P. | b. | p. | "F" | Prob>F | E.V. |
| 2022 | *R. cardinalis* | 0.31 | 0.140 | 1.018 | 0.657 | 19.41 | 0.000 | 88.30% |
| | *Scymnus coccivora* | 0.341 | 0.103 | -1.645 | 0.745 | | | |
| | *Cybocephalus micans* | 0.999 | 0.000 | 145.612 | 0.000 | | | |
| | Parasitoids | 0.228 | 0.284 | -0.268 | 0.000 | | | |
| 2023 | *R. cardinalis* | 0.222 | 0.296 | 0.633 | 0.875 | 18.7 | 0.000 | 85.90% |
| | *Scymnus coccivora* | 0.340 | 0.104 | -2.314 | 0.746 | | | |
| | *Cybocephalus micans* | 0.938 | 0.000 | 143.708 | 0.000 | | | |
| | Parasitoids | 0.249 | 0.241 | -0.375 | 0.000 | | | |

The obtained results revealed the presence of three predators and three parasitoids that feed on *A. tubercularis*, contributing to a reduction in its population on mango trees. These natural enemies play a crucial role in regulating the pest population and highlight the importance of biological control in integrated pest management strategies for mango cultivation.

These findings are consistent with the observations of several researchers. Kamel *et al*. (2003), Nabil *et al*. (2012), and Hamdy (2016) studied the seasonal fluctuations of eighteen parasitoid species belonging to the genus *Aphytis* in Egyptian fields, examining ten host plants infested by eleven armored scale insect species from the family Diaspididae. Nabil *et al*. (2012) reported that parasitism rates on *Aonidiella tubercularis* ranged from 0.8% to 14.6%. Additionally, they were the first to record the coleopteran predator *Cybocephalus micans* Reitter (Family: Nitidulidae) as a natural enemy of *A. tubercularis* in Egypt, with mean parasitism rates of 2.78% in the first year and 7.37% in the second year. Attia *et al.* (2020) identified two Hymenoptera species, *Aspidiotiphagus* sp. and *Aphytis* sp. (Family: Aphelinidae), as parasitoids of *A. tubercularis*, highlighting the crucial role of natural enemies in regulating pest populations. Similarly, Ata (2024) observed that the populations of *A. tubercularis* and its natural enemies were synchronized on mango trees (*Gahrawy* cultivar) in the New Damietta region, Damietta Governorate.

These findings underscore the importance of parasitoids and predators in the biological control of *A. tubercularis* in mango orchards.

## CONCLUSION

The white mango scale insect, *Aulacaspis tubercularis*, exhibited three annual population peaks with the highest population abundance occurring in August in both seasons. Additionally, mango cultivars had a significant impact on the population density of *A. tubercularis*, with the highest infestation recorded on the *Gahrawy* cultivar.

The summer months was the most preferable for *A. tubercularis on mango tree* followed by autumn months.

Insignificant differences in the mean numbers of *Aulacaspis tubercularis* among the different cardinal directions of the mango tree were found. However, the southern direction harbored the highest population of this insect during both study years. Notably, *A. tubercularis* was predominantly concentrated in the area between the southern and eastern directions of the mango tree throughout the study period.

The total impacts of the predatory insects and the parasitoid on the total population of *A. tubercularis* during the two successive years were 88.3 and 85.9%, respectively.

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## تأثير أصناف المانجو المختلفة على الكثافة العددية لحشرة المانجو القشرية البيضاء في محافظة دمياط


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### الملخص


تُعد حشرة المانجو القشرية البيضاء ، التابع لعائلة الحشرات القشرية المسلحة ورتبة متشابهة الأجنحة، من أكثر الآفات تدميرًا لأشجار المانجو في مصر. تهدف هذه الدراسة إلى تقييم تأثير الأصناف المختلفة من أشجار المانجو على ديناميكيات تعداد تلك الآفة في بساتين المانجو بمنطقة دمياط الجديدة خلال موسمي٢٠٢٢-٢٠٢٣ . كما تم تحليل تأثير الأعداء الطبيعية والعوامل المناخية، بما في ذلك متوسط درجة الحرارة °م، الرطوبة النسبية (%) ، الإتجاهات الأصلية لشجرة المانجو، وأيضًا تأثير التغيرات الموسمية على تعداد تلك الآفة. كشفت النتائج عن ثلاث ذُروات سنوية لتعداد تلك الآفة، حيث سُجلت في فبراير، مايو، وأغسطس على مختلف أصناف المانجو. وبلغت أعلى معدلات الإصابة خلال فصل الصيف، بمتوسط كثافة 564.3 ± 3623.5 و 434.1 ± 2733.3 فردًا لكل 125 ورقة خلال العامين الأول والثاني من الدراسة، على التوالي، في حين سُجلت أدنى الكثافات خلال فصل الشتاء. أظهرت التحليلات الإحصائية أن تعداد تلك الآفة تأثر بشكل كبير بكل من الأعداء الطبيعية ومتوسط درجة الحرارة اليومية، بينما لم يكن للرطوبة النسبية تأثير معنوي .كما تبين أن هذه الآفة تفضل الاتجاه الجنوبي لأشجار المانجو. توفر هذه النتائج رؤى هامة حول الدورات الموسمية والتفاعلات البيئية لحشرة المانجو القشرية البيضاء، مما يساهم في تطوير استراتيجيات فعالة للإدارة المتكاملة للآفة في بساتين المانجو بمصر.


***الكلمات الدالة:*** *Aulacaspis tubercularis* :، أصناف المانجو، التغيرات الموسمية، الاتجاهات.