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Research Article

# Evaluation of Different Factors Affecting the Distribution of the Mango Shield Scale, *Milviscutulus mangiferae* (Green) Infesting Mango Trees

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## Abstract

In two consecutive years (2018/2019 and 2019/2020), field trials were conducted to evaluate the factors impacting *M. mangiferae* on mango trees in different cardinal directions, plant strata, and leaf surfaces in a private mango orchard (Balady cultivar) at Esna district, Luxor Governorate, Egypt. The findings showed that *M. mangiferae* affected mango trees year-round over the course of the two-year experiment, and that it appeared on leaf surfaces, in all tree layers, and in all mango tree directions during all half-monthly investigation periods. Additionally, compared to other directions and strata, the southern location of the tree's basal layer had the largest population density of *M. mangiferae*. The present data can be applied to help design monitoring and control programmes of *M. mangiferae* on mango trees. Additionally, compared to other directions and strata, the southern location of the tree's basal layer had the largest population density of *M. mangiferae*. Additionally, the results showed extremely significant differences between the various leaf surfaces as well as between the count averages at the four cardinal directions and between the various tree strata. The available information can be used to create programs for the monitoring and management of *M. mangiferae* on mango trees.

**Keywords:** *Milviscutulus mangiferae*, seasonal incidence, mango trees, distribution patterns

## Introduction

The mango shield scale, *Milviscutulus mangiferae* (Green) (Hemiptera: Coccidae) is one of the most significant pests of mango trees [1,2]. *M. mangiferae* has been detected and recorded in Egypt for the first time as a novel pest affecting a mango orchard in the Ismailia Governorate. Nymphs and female adults of *M. mangiferae* damage the mango tree's fruits, leaves, leaflets, and veins [3-5].

Typically, this insect causes deformations in the plant by sucking the sap with its mouth parts, weakening the plant infected itself [6].

Additionally, this pest excretes a significant amount of honeydew, which coats plant leaves, attracts ants to leaves, and promotes the growth of sooty mould fungus, which gives infested plants a dirty black appearance, impairs respiration and photosynthesis and otherwise lowers the quality of the plant, resulting in significant economic loss [7,8].

A significant *M. mangiferae* infestation will impair tree vigor and leaf size, resulting in discoloration, leaf drop, and branch death [5]. The four basic directions of the plant affect the flying, moving, and dispersal tendencies of insects. According to Bancroft [9], who mentioned that most insects choose to travel along the east-west axis over the south-north axis. The development of specialized pest control surveillance and recommendation systems is aided by this insect's dispersal behavior.

The establishment of specialized pest control management and systems for recommendations is aided by this insect's dispersal behavior. Based on the needs of their habitat, insects attempt to settle on branches that meet the ideal conditions for heat, sunlight, and humidity. Early pest management techniques can be developed with the help of monitoring from these areas [10].

The literature does not contain any details about the dispersal pattern of *M. mangiferae*. As a result, the present research was carried out for two consecutive years (2018/2019 and 2019/2020) in mango trees at Esna district, Luxor Governorate, to identify the parameters impacting *M. mangiferae* distribution on mango plants. This research can be utilized to create strategies for pest surveillance and management.

## Materials and Methods

The mango shield scale, *M. mangiferae* infesting mango trees (*Mangifera indica* L.) were was checked out at every two weeks intervals at Esna district, Luxor governorate, over the two successive years of study at every two weeks intervals (i.e. from March 1, 2018 until February 15, 2020).

### Sampling

Four mango trees were chosen and given unique labels. They were all around the same size, age (10 years), height, vegetative development, and horticultural procedures. These mango trees were randomly selected for sampling at intervals of every two weeks, and no chemical control measures were applied to them before or throughout the investigation period. The rate of infection at two strata per tree, or vertical heights above the soil surface of growing mango trees (1.5 m and greater than 1.5 meters), was determined by dividing each tree into four sections facing east, west, north, and south. A total of 7680 leaves (4 trees x 4 directions x 2 planes x 5 leaves x 48 dates) were sampled over two years from the terminal buds of the tree.

### Examination

Regularly every two weeks, samples were gathered and transported right away to the lab in plastic bags for further examination with the use of a stereoscopic microscope. The total number of alive insects was carefully counted and recorded on the upper and bottom surfaces of mango trees in various directions and levels, and then they were separately sorted next to each date that was inspected. The Department of Scale Insects and Mealybugs, Plant Protection Research Institute, Agricultural Research Center at Giza, Egypt, has specialists who have identified this pest.

The monthly mean numbers of all alive individuals on 10 leaves and standard error (SE) were counted and recorded to show the magnitude of the pest population. LSD values were used in the analysis of variance (ANOVA) of the data at significance levels of $P \leq 0.05$.

The following formula was used to predict directional preference [11]

$F_1 = E - W$ $F_2 = N - S$

$\tan.Q = F_2 / F_1$

- **$F_1$:** The difference between the average number of insects moving eastward and those moving westward, if the former is higher and the opposite if the latter.
- **$F_2$:** If the mean number of insects moving north is greater than the mean number moving south, and vice versa if the mean number of insects moving south is higher. The obtained graphic illustrates the tangent, the values for which were taken from the mathematical table.
- **tan.Q:** The angle formed by the two forces.
- Many researchers have utilized this technique to study Coccoidea pests, including [12-14].

### Statistical analysis

All data was statistically evaluated on a computer using the MSTATC Program software [15] and graphically represented using Microsoft Excel 2010.

## Result and Discussion

In order to assess the insect population, *M. mangiferae* -infected mango trees' leaf samples revealed notable alterations in distribution characteristics not only on plant leaves but also across the tree's cardinal orientations. These unexpected results might suggest involving variables other than the well-known wind direction and velocity affect insect dispersion. The following factors were evaluated as influencing the spread and dispersion of insects in mango trees.

### Horizontal distribution of mango tree (Cardinal directions)

The half-monthly cardinal distribution of the total population of *M. mangiferae* (expressed as average no. of individuals per leaf) at Esna district, Luxor Governorate during the two successive years of (2018/2019 and 2019/2020) are represented in table 1 and illustrated by pie -charts in figure 1.

The analysis of variance revealed significant variances between the population means at the different cardinal ways, where the L.S.D values were (1.87 and 1.47) throughout the two successive years of (2018/2019 and 2019/2020), respectively, were recorded when the comparison, the combined effect of the whole year. The southern location of the field had higher population densities, as a general average (42.89 ± 2.53 and 36.76 ± 2.34 individuals per leaf), followed by eastern site (41.55 ± 2.49 and 35.57 ± 2.30 individuals per leaf) over the two years, respectively. Whereas, the north site was the least population with a averages (40.20 ± 2.37 and 34.53 ± 2.21 individuals per leaf). However, the western direction was moderately infested as an average (40.60 ± 2.35 and 34.84 ± 2.19 individuals per leaf), as shown in Tables (49 and 50).

The data represented in Table (1) and illustrated by pie -charts in Fig. (1), mentioned that the highest percentage was 25.96–25.94% of the total insect population occurred in leaves collected from south site, over the two years, respectively. Followed by east direction was 25.14- 25.10% of the total insect population throughout the two years, respectively. While, the lowest percentage were 24.33-24.37% was evaluated in the north site for the two years, respectively. But, the western direction was exhibited as (24.57-24.59%) of the total alive population, for the two years, respectively.

Based on present results throughout the two years of study, and mainly relying on the significant variances concluded that the southern and eastern directions of the mango tree shows to be more preferred for population size of *M. mangiferae* as compared to the other sites. These conclusions were drawn from the initial analysis of seasonal abundance, which involved sampling every leaf in every one of the four cardinal directions. The results regarding seasonal abundance were pooled after every way sub-sample had been independently investigated. In addition, there were highly significant variances between cardinal tendencies among seasons of year in spring and winter seasons, except in the summer and autumn seasons was insignificant differences during the first year, when the comparisons, were directed, for each season separately (Table 1, Figure 1,2).

| Data of inspection | | Mango tree directions | | | | | | F value | L.S.D at %5 | %From overall seasonal total | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Average no. of total alive stages per leaf ± S.E. | | | | | | | | | | | |
| | | North | South | East | West | Total | Mean ± SE | | | North | South | East | West |
| 2018/2019 | Spring | 17.83 ± 1.26 | 19.47 ± 1.28 | 18.89 ± 1.25 | 18.42 ± 1.27 | 74.61 | 18.65 ± 0.62 | 5.68 | 0.83 ** | 23.90 | 26.10 | 25.32 | 24.68 |
| | Summer | 41.69 ± 3.35 | 41.42 ± 3.33 | 40.29 ± 3.29 | 41.74 ± 3.28 | 165.14 | 41.29 ± 1.63 | 0.73 | N.S. | 25.25 | 25.08 | 24.40 | 25.27 |
| | Autumn | 61.60 ± 4.76 | 64.82 ± 4.99 | 63.45 ± 5.08 | 60.71 ± 4.71 | 250.58 | 62.64 ± 2.41 | 2.70 | N.S. | 24.58 | 25.87 | 25.32 | 24.23 |
| | Winter | 39.67 ± 3.94 | 45.87 ± 4.76 | 43.55 ± 4.58 | 41.52 ± 4.23 | 170.62 | 42.65 ± 2.17 | 5.05 | 3.35 ** | 23.25 | 26.88 | 25.53 | 24.34 |
| | Mean | 40.20 ± 2.37 | 42.89 ± 2.53 | 41.55 ± 2.49 | 40.60 ± 2.35 | 165.24 | 41.31 ± 1.21 | 3.21 | 1.87 * | 24.33 | 25.96 | 25.14 | 24.57 |
| 2019/2020 | Spring | 11.65 ± 1.46 | 12.65 ± 1.51 | 12.21 ± 1.43 | 11.99 ± 1.47 | 48.49 | 12.12 ± 0.72 | 1.14 | N.S. | 24.01 | 26.08 | 25.18 | 24.73 |
| | Summer | 38.09 ± 2.50 | 37.80 ± 2.46 | 36.72 ± 2.39 | 38.13 ± 2.42 | 150.75 | 37.69 ± 1.20 | 1.72 | N.S. | 25.27 | 25.08 | 24.36 | 25.30 |
| | Autumn | 52.58 ± 4.99 | 55.34 ± 5.22 | 54.16 ± 5.25 | 51.84 ± 4.93 | 213.92 | 53.48 ± 2.51 | 1.49 | N.S. | 24.58 | 25.87 | 25.32 | 24.23 |
| | Winter | 35.79 ± 3.10 | 41.26 ± 3.74 | 39.20 ± 3.61 | 37.41 ± 3.33 | 153.66 | 38.42 ± 1.71 | 6.63 | 2.58 ** | 23.29 | 26.85 | 25.51 | 24.35 |
| | Mean | 34.53 ± 2.21 | 36.76 ± 2.34 | 35.57 ± 2.30 | 34.84 ± 2.19 | 141.71 | 35.43 ± 1.13 | 2.50 | 1.47 * | 24.37 | 25.94 | 25.10 | 24.59 |

**Table 1:** Average numbers of *M. mangiferae* total population in the different directions of mango tree during season of year at Esna district, Luxor Governorate through the two successive years of (2018/2019 and 2019/2020).

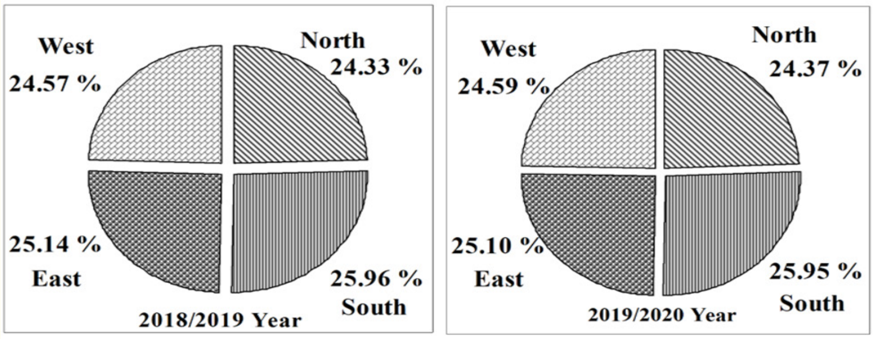


**Figure 1:** Relative distribution of *M. mangiferae* total population on the different directions of mango tree during season of year at Esna district, Luxor Governorate through the two successive years of (2018/2019 and 2019/2020).

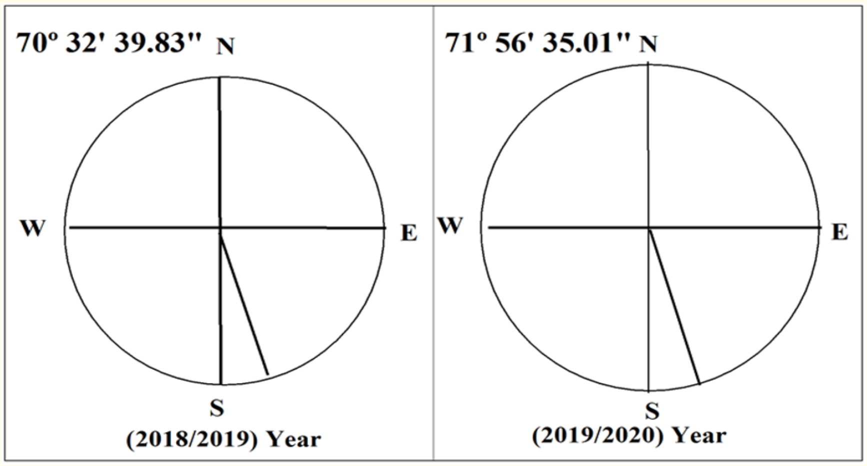


**Figure 2:** Directional preference of *M. mangifera*e total population of mango tree during season of year at Esna district, Luxor Governorate through the two successive years of (2018/2019 and 2019/2020).

While, it observed insignificant variances were recorded in the all studied seasons, except significant differences were appeared in winter season during the second year (2019/2020).

As regarding, the data in table (1), the maximum mean population in distribution was estimated in Autumn season (62.64 ± 2.41 and 53.48 ± 2.51 individuals per leaf) than the different seasons of year, over the two successive years, respectively.

As well, the highest average of insect population occurred at the tree south direction (64.82 ± 4.99 and 55.34 ± 5.22 individuals per leaf), followed by the eastern (63.45 ± 5.08 and 54.16 ± 5.25 individuals per leaf), followed by northern way (60.71 ± 4.71 and 51.84 ± 4.93 individuals per leaf) and finally western direction (61.60 ± 4.76 and 52.58 ± 4.99 individuals per leaf), during the two successive years, respectively.

As well as, the data during the two years as recorded in the table (1), the results exhibited that the population densities of *M. mangiferae* were higher (41.31 ± 1.21 individuals per leaf) in the first year than that the second year as (35.43 ± 1.13 individuals per leaf).

Results mentioned that, in both years of inspection the preferred direction was the south-eastern direction (Figure 2), *M. mangiferae* prefers to accumulate on the south-eastern side of the mango trees, which is usually more exposed to the sun and relatively warmer than the other sides, with angles of 70º 32’ 39.83” and 71º 56’ 35.01” for total alive population over the two seasons, respectively, according to the results in figure 2.

### Vertical distribution of mango tree (Strata)

The distribution pattern of the total population of *M. mangiferae* of leaves in the both stratums (basal and apical) on mango tree at Esna district, Luxor governorate during the two years of (2018/2019 and 2019/2020) are summarized in table 2 and illustrated by pie -charts in figure 3.

Results represented in table 2, revealed that the basal strata leaves of tree was the maximum population densities of *M. mangiferae* as general average (48.50 ± 2.84 and 41.58 ± 2.63 of individuals per leaf), while, the apical leaves was the least counts by insect as averages (34.12 ± 2.02 and 29.27 ± 1.89 of individuals per leaf) over the two years, respectively.

In addition, the highest average of insect population was exhibited in autumn months at basal stratum leaves of tree were (73.34 ± 5.60 and 62.49 ± 5.85 individuals per leaf), but the apical leaves of mango tree were (51.95 ± 4.16 and 44.47 ± 4.38 individuals per leaf) over the two years of investigation, respectively, table 2.

Analysis of variance suggested that there were highly significant variances between the population means at the two strata, were registered when the comparison the pooled effect of the whole year, where the L.S.D values were (1.98 and 1.84) across the two successive years of (2018/2019 and 2019/2020), respectively, (Table 2).

Likewise, there were highly significant variances between two stratums in all the studied seasons of year, when the comparisons,

| Data of inspection | | Mango tree stratums | | | | L.S.D at %5 | %From overall seasonal total | |
|---|---|---|---|---|---|---|---|---|
| | | Average no. of total alive stages per leaf ± SE | | | | | | |
| | | Basal | Apical | Total | Mean ± SE | | Basal | Apical |
| 2018/2019 | Spring | 21.75 ± 1.45 | 15.56 ± 1.07 | 37.31 | 18.65 ± 1.00 | 0.97 | 58.29 | 41.71 |
| | Summer | 49.21 ± 4.02 | 33.36 ± 2.60 | 82.57 | 41.29 ± 2.63 | 1.19 | 59.60 | 40.40 |
| | Autumn | 73.34 ± 5.60 | 51.95 ± 4.16 | 125.29 | 62.64 ± 3.79 | 3.71 | 58.54 | 41.46 |
| | Winter | 49.71 ± 5.08 | 35.60 ± 3.67 | 85.31 | 42.65 ± 3.27 | 3.70 | 58.27 | 41.73 |
| | Mean | 48.50 ± 2.84 | 34.12 ± 2.02 | 82.62 | 41.31 ± 1.82 | 1.98 | 58.71 | 41.29 |
| 2019/2020 | Spring | 14.14 ± 1.70 | 10.11 ± 1.23 | 24.25 | 12.12 ± 1.08 | 1.19 | 58.30 | 41.70 |
| | Summer | 44.89 ± 2.96 | 30.48 ± 1.91 | 75.38 | 37.69 ± 2.04 | 1.98 | 59.56 | 40.44 |
| | Autumn | 62.49 ± 5.80 | 44.47 ± 4.38 | 106.96 | 53.48 ± 3.83 | 4.06 | 58.43 | 41.57 |
| | Winter | 44.79 ± 3.99 | 32.04 ± 2.89 | 76.83 | 38.42 ± 2.61 | 2.90 | 58.30 | 41.70 |
| | Mean | 41.58 ± 2.63 | 29.27 ± 1.89 | 70.85 | 35.43 ± 1.67 | 1.84 | 58.68 | 41.32 |

**Table 2:** Average numbers of *M. mangiferae* total population in the different strata of mango tree during season of year at Esna district, Luxor Governorate through the two successive years of (2018/2019 and 2019/2020).

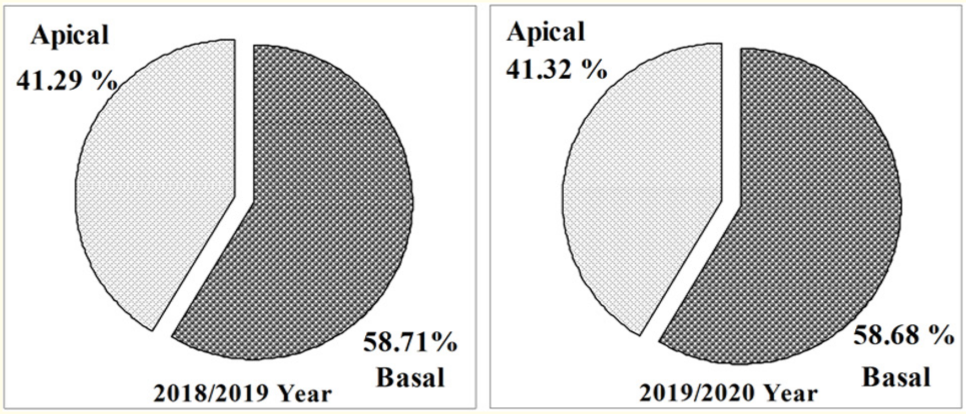


**Figure 3:** Relative distribution of *M. mangiferae* total population on the different stratums of mango tree at Esna district, Luxor Governorate through the two successive years of (2018/2019 and 2019/2020).

were directed, for each season separately, during the two year of (2018/2019 and 2019/2020) (Table 2).

Generally, the mean population densities of *M. mangiferae*, were significantly higher both the basal stratum leaves as compared with the apical stratum leaves and accounted for 58.71 and 41.29% in 2018/2019, respectively and 58.68 and 41.32% in 2019/2020, respectively (Table 2) and illustrated by pie -charts in figure 3.

It obvious that the percentages of population densities of *M. mangiferae* for each of the two years were similar, which may due to the environmental factors, was nearly similar.

As well, the basal leaves on mango tree in the all seasons of year over the two years of study, received the maximum population densities of pest as compared to the other strata.

Furthermore, the differences in distribution pattern of insect on the two stratums of tree (apical and basal), which may be due to the variances in the environmental variables, wind direction, sunlight and other factors.

Generally, the basal leaves of tree that good shelter for insect especially in the sensitive developmental stages and feeding, activity and growth of insect.

## Distribution of infestation on leaf surface

As for the relative distribution pattern of the total alive population of *M. mangiferae* on surfaces of the mango leaf are represented in tables 3 and illustrated by pie -charts in Figure 4, mentioned that the upper surface of mango leaf were exhibited minimum population as compared to the lower surfaces. Likewise, the overall mean number of individuals on upper surface of leaf averaged (17.19 ± 0.93 and 14.63 ± 0.82 individuals per leaf) during the two years, respectively. But, the lower surface of leaf was maximum population as a general average (24.12 ± 1.62 and 20.80 ± 1.53 individuals per leaf) throughout two years of study, respectively.

As for the results of statistical analysis of data, appeared highly significant variances between the population size means at the two surfaces of leaf (lower and upper); L.S.D values were 1.09 and 1.01 throughout the two years of study, respectively, when the comparison the pooled effect for the whole year (Table 3).

Furthermore, there were highly significant variances between the both surfaces in all seasons of year over the two years of study, when the comparison were directed for each season separately, except no significant variances were exhibited in the summer season over the two years of study (2018/2019 and 2019/2020), table 3.

Insect population on lower surface of leaf comprised (58.39 and 58.71%) of the total number of insects, while these values about (41.61 and 41.29%) on the upper surface of leaf across two years, respectively.

Overall, the population percentages of *M. mangiferae* on two surfaces of leaf for each of the two years were similar, which may be due to the environmental conditions, was nearly similar, are represented in table 3.

As regarding, the highest average of insect population take place in autumn months at lower surface of leaves were (38.06 ± 3.71 and 32.76 ± 3.77 individuals per leaf), whereas the upper surfaces of mango leaves were (24.59 ± 1.43 and 20.72 ± 1.47 individuals per leaf) for the two years of investigation, respectively table 3.

It is evident that the insect behaves as a photo-negative and prefers the lower surface of the leaf because it has been not exposed to sunlight compared to the upper surface.

| Data of inspection | | Mango leaf surfaces | | | | L.S.D at %5 | %From overall seasonal total | |
|---|---|---|---|---|---|---|---|---|
| | | Average no. of total alive stages per leaf ± SE | | | | | | |
| | | Lower surface | Upper surface | Total | Mean ± SE | | Lower | Upper |
| 2018/ 2019 | Spring | 10.94 ± 0.76 | 7.71 ± 0.51 | 18.65 | 9.33 ± 0.51 | 0.56 ** | 58.65 | 41.35 |
| | Summer | 20.84 ± 1.80 | 20.44 ± 1.82 | 41.29 | 20.64 ± 1.27 | N.S. | 50.48 | 49.52 |
| | Autumn | 38.06 ± 3.71 | 24.59 ± 1.43 | 62.64 | 31.32 ± 2.20 | 2.47 ** | 60.75 | 39.25 |
| | Winter | 26.65 ± 3.01 | 16.00 ± 1.41 | 42.65 | 21.33 ± 1.82 | 2.10 ** | 62.49 | 37.51 |
| | Mean | 24.12 ± 1.62 | 17.19 ± 0.93 | 41.31 | 20.65 ± 0.97 | 1.09 ** | 58.39 | 41.61 |
| 2019/ 2020 | Spring | 7.09 ± 0.86 | 5.03 ± 0.62 | 12.12 | 6.06 ± 0.54 | 0.63 ** | 58.49 | 41.51 |
| | Summer | 19.43 ± 1.71 | 18.26 ± 1.05 | 37.69 | 18.84 ± 1.00 | 1.13 * | 51.56 | 48.44 |
| | Autumn | 32.76 ± 3.77 | 20.72 ± 1.47 | 53.48 | 26.74 ± 2.19 | 2.49 ** | 61.26 | 38.74 |
| | Winter | 23.90 ± 2.39 | 14.51 ± 1.10 | 38.42 | 19.21 ± 1.47 | 1.68 ** | 62.22 | 37.78 |
| | Mean | 20.80 ± 1.53 | 14.63 ± 0.82 | 35.43 | 17.71 ± 0.89 | 1.01 ** | 58.71 | 41.29 |

**Table 3:** Average numbers of *M. mangiferae* total population on the different surfaces of mango leaf at Esna district, Luxor Governorate during the two successive years of (2018/2019 and 2019/2020).

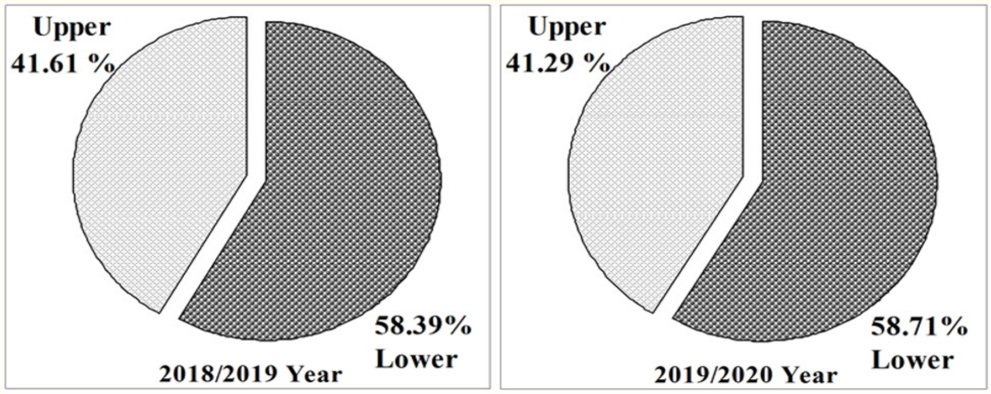


**Figure 4:** Relative distribution of *M. mangiferae* total population on the different surfaces of mango leaf at Esna district, Luxor Governorate during the two successive years of (2018/2019 and 2019/2020).

Data represented in table 4 and illustrated in figure 5 and 6, mentioned that the relative distribution of *M. mangiferae* in mango trees, given as accumulated counts that were done over the two years of (2018/2019 and 2019/2020).

The findings showed that throughout the two years of the experiment, the insect population was visible on various tree orientations, all mango tree strata, and its surfaces all year long. Similarly, during the course of two years, the patterns of pest distribution significantly vary from one direction to another, from one tree stratum to another, as well as on the surfaces of the tree.

The variations could result from varying environmental conditions and other variables.

Compared to other directions and strata, the bottom surface of the tree's base layer in the southern position had the largest population density of *M. mangiferae*.

The temperature difference between the different parts of the trees is the most likely cause of this distribution pattern.

| Directions | Strata | Surfaces | Average no. of individuals per leaf | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | First year (2018/2019) | | | Second year (2019/2020) | | |
| North | Basal | Lower | 27.43 | 47.83 | 80.40 | 23.73 | 41.06 | 69.06 |
| | | Upper | 20.40 | | | 17.33 | | |
| | Apical | Lower | 18.27 | 32.57 | | 15.78 | 28.00 | |
| | | Upper | 14.30 | | | 12.22 | | |
| South | Basal | Lower | 31.65 | 50.30 | 85.79 | 27.20 | 43.09 | 73.52 |
| | | Upper | 18.65 | | | 15.88 | | |
| | Apical | Lower | 19.99 | 35.49 | | 17.23 | 30.44 | |
| | | Upper | 15.49 | | | 13.21 | | |
| East | Basal | Lower | 29.25 | 47.83 | 83.10 | 25.14 | 40.95 | 71.14 |
| | | Upper | 18.58 | | | 15.81 | | |
| | Apical | Lower | 20.08 | 35.27 | | 17.29 | 30.20 | |
| | | Upper | 15.18 | | | 12.91 | | |
| West | Basal | Lower | 27.72 | 48.06 | 81.19 | 23.98 | 41.22 | 69.69 |
| | | Upper | 20.33 | | | 17.24 | | |
| | Apical | Lower | 18.58 | 33.14 | | 16.04 | 28.46 | |
| | | Upper | 14.56 | | | 12.43 | | |
| General average | | | 41.31 | | | 35.43 | | |

**Table 4:** The spatial distribution of *M. mangiferae* total population per leaf, given as a general average count that was done during the two successive years of (2018-2020) at Esna district, Luxor Governorate.

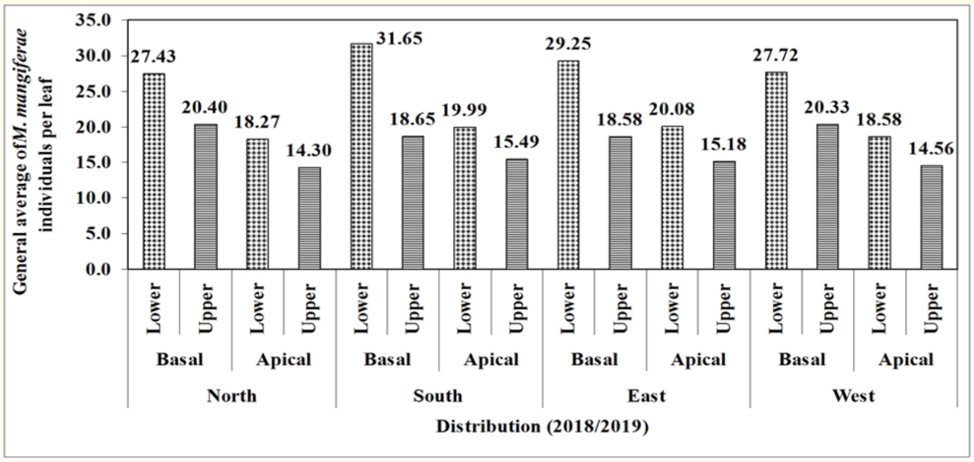


**Figure 5:** The spatial distribution of *M. mangiferae* total population per leaf, given as a general average counts that was done during the first year of (2018/2019) at Esna district, Luxor Governorate.

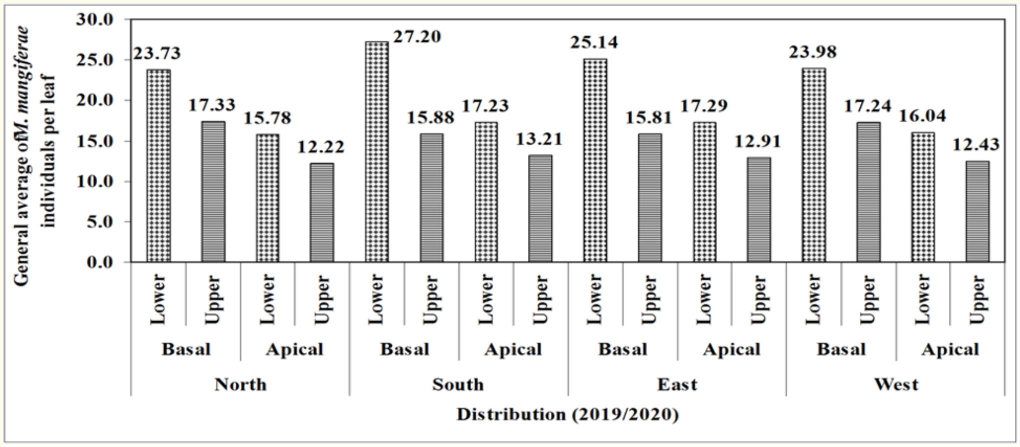


**Figure 6:** The spatial distribution of *M. mangiferae* total population per leaf, given as a general average counts that was done during the second year of (2019/2020) at Esna district, Luxor Governorate.

The tree receives the same amount of direct sunshine facing east and west, yet the early morning air temperature is lower than the late- afternoon air temperature. The reduced infestation in the west direction may result from the combined effects of the hot air and direct sunlight. The initial data for seasonal occurrence once investigated, where every sample leaf was collected in all four major directions, served as the basis for these findings. The data were combined to determine the seasonal occurrence of *M. mangiferae* after being evaluated independently for every cardinal trend subsample and every layer sub-sub-sample.

## Discussions

According to the mango shield scale, *M. mangiferae* (Hemiptera: Coccidae), is a significant pest of the mango (*Mangifera indica*) [5,16]. Data showed that M. mangiferae affected mango trees year-round during the two years of the experiment, and that it appeared on leaf surfaces, in all tree layers, and in all mango tree directions during all intervals of weekly investigations. Additionally, compared to other orientations and strata, the southern site of the tree's basal layer had the largest population density of *M. mangiferae*. In addition, the results showed that there were highly significant differences between the various strata of counts in the four main directions and very significant differences between the different strata of tree and between both surfaces of leaf.

The cumulative influence of the wind direction and the length of the leaves' exposure to the sun's rays may be responsible for these variations in their dispersion [17]. Such a conclusion appears to be logical given that the predominant wind direction in the region under study was north-west, which causes more newly emerged crawlers to drift towards the southeast, where they may assemble for feeding and developing [18,19]. This may be because winds blowing from the north to the south transport the newly emerged crawlers and allow them to settle on the leaves in those directions [20].

When preparing a chemical control strategy against scale insects, the previously obtained results are quite valuable. *Aulacaspis tubercularis* favoured the south direction over the other cardinal directions, according to El-Metwally., *et al*. [21]. in Damietta, Egypt, who also used different bug species and the same plant host. Nabil., *et al*. [22] in Sharkia, Egypt, documented notable variations in the four cardinal directions of mango trees and found that *A. tubercularis* was more abundant on the eastern side of the plants. *A. tubercularis* populations were noted in several mango tree directions year-round over the two years of the experiment. According to Bakry and Tolba [12], the number of individuals with *A. tubercularis* in all four major directions of the mango orchard varied significantly during the course of two consecutive years. *tubercularis* also favours the east southern site, where it had a constant high population year-round for the past two years (2017-2018 and 2018/2019).

On the other hand, *A. tubercularis* mastered east and west orientation in colder and summer conditions, according to Bakr., *et al*. [23]. The variations in some weather conditions and/or agro-ecosystems may be responsible for the variations between the outcomes and the current. Amer [24] in Qaliobiya, Egypt, stated that compared to the other orientations of the tree, the south and east suffered the greatest infestations of *A. tubercularis*. According to Bakry and Tolba [12], the top stratum leaves had the lowest average number of alive *A. tubercularis* individuals over the course of two consecutive years (51.05 2.98 and 53.03 2.84 individuals per leaf, respectively), despite the fact that its population was always abundant all the year compared to the other stratums (middle and basal).

## Conclusion

These findings might have significant ramifications. First, to save time and effort, population censuses should only sample the heavily afflicted portion of the tree. Second, the chemical spray programme could be modified to focus on the part of the tree that is heavily affected. However, tests should be run to confirm these presumptions.

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