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Factors Affecting Distribution Pattern of the White Mango Scale Insect, *Aulacaspis tubercularis* (Newstead) (Hemiptera: Diaspididae) on Mango Trees at Esna District, Luxor Governorate, Egypt

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Abstract

The present work was carried out throughout two successive years (2017/2018 and 2018/2019) to determine effect of different tree cardinal directions, strata of tree, leaf surfaces and orchard depth (distances from boarders of orchard) of mango trees on distribution of *A. tubercularis* at Esna district, Luxor governorate. The obtained results showed that there significant differences between the population means at the four cardinal directions and highly significant differences between the different stratums of tree and between surfaces of leaf and also between different distances from boarders of mango orchard during the two successive years. The results obtained that the grand means were relatively higher at the south direction (86.40 ± 4.85 and 82.74 ± 4.14 individuals per leaf), followed by east site (84.35 ± 5.00 and 82.34 ± 4.14 individuals per leaf). In contrast, north direction was the least infested by insect (83.18 ± 4.92 and 79.84 ± 4.24 individuals per leaf). While, the west direction was moderately infested with this insect as mean (84.01 ± 4.67 and 81.06 ± 3.96 individuals per leaf) for the two years of study, respectively. Also, the middle stratum leaves of tree was the most preference parts and highest infestation by insect as mean (105.36 ± 6.06 and 99.96 ± 5.03 individuals per leaf), followed by the bottom stratum leaves of mango tree (97.04 ± 5.57 and 91.49 ± 4.55 individuals) for the two years, respectively. The top stratum leaves was the least infestation by insect as mean (51.05 ± 2.98 and 53.03 ± 2.84 individuals) during the two successive years, respectively.

Generally, it can be concluded from the current investigation that that the insect population occurred on different tree directions in all stratums of mango tree and on surfaces of leaf on the all year round during the two years of investigation. *A. tubercularis* prefers the upper surface on the middle stratum of tree in east southern side where its population was always abundant allover the year and mango trees which far from the orchard boarders were more heavily infested by pest than the nearby trees from the boarders during the two years of study.

***Keywords**: Aulacaspis tubercularis, population density, distribution patterns, directional preference and mango trees.*

Introduction

Mango trees are subjected to infestation by different pests. Among these pests, the white mango scale insect, *Aulacaspis tubercularis* (Newstead) (Heimptera: Diaspididae) is considered one of the most destructive pests of mango trees representing 27% of the scale insect pests in Egypt (Bakr *et al*., 2009). It is now wide-

spread in many mango-growing countries. This pest injures the shoots, twigs, leaves, branches and fruits by sucking the plant sap with the mouth parts, causing thereafter deformations, defoliation, drying up of young twigs, dieback, poor blossoming, death of twig by the action of the toxic saliva and so affecting the commercial value of fruits and their export potential especially to late cultivars where it causes conspicuous pink blemishes around the feeding sites of the scales (Nabil *et al*., 2012 and Sayed, 2012). Usually, occurrence of the sever infestation lead to the death of the whole trees. The hard scale insect has long thread like mouthparts (stylets) six to eight times longer than its body tall. Most species of armored scale overwinter as eggs beneath the female cover in spring egg hatch into tiny mobile crawlers which migrate to new feeding sites (Draz *et al*., 2011). Cardinal directions of plant influence the insect flight, movement, and dispersal pattern. Most of insects move towards east west axis than south north axis (Bancroft, 2005). This dispersal habit of insects helps in formulating particular monitoring and recommendation methods for pest control. Insects on the basis of habitat requirement try to settle on branches that meet their optimum requirements for obtaining heat, sunshine and humidity. Monitoring from these sites helps in formulation of earlier pest management approaches (Karar *et al*., 2013). *A. tubercularis* abundance is affected by several factors, especially microclimate created by irrigation methods, cardinal directions and distance between trees. Pruning the trees can also reduced infestations (Sanad, 2017).

The objective of this study is to identify the behaviour and distribution of *A. tubercularis* based on tree cardinal directions, different strata of tree, leaf surfaces and orchard depth (distances from boarders of orchard) of mango trees over a period of two successive years (2017/2018 and 2018/2019) at Esna district, Luxor governorate to assess the proper and adequate timing of control procedures.

Materials and Methods

The present work was conducted on mango trees (mixed varieties) in private orchard of about five feddans, on 10 years-old trees at Esna district, Luxor governorate from March 2017 until February 2019, to determine effect of the horizontal and vertical distribution of *A. tubercularis,* on mango trees, and leaf surfaces.

Four mango trees, almost similar in size, height, vegetative growth and received the same horticultural practices, were selected and labeled. These chosen mango trees did not receive any pesticidal control treatments before and during the period of investigation. Each tree was divided into four main directions (east, west, north and south). The rate of infestation was determined at three strata per tree, i.e., vertical heights above the soil surface of growing mango tree (1.5, 2.5 m and greater than 2.5 meters). All sampling was conducted from 11520 leaves *i.e.* (4 trees x 4 directions x 3 levels x 5 leaves x 48 dates) over a two-year period from the terminal shoots of the tree. Each sample was placed in a polyethylene

bag and all samples of every date were transferred to the laboratory for inspection using a stereo-microscope. Numbers of total alive insects in different directions and different levels on upper and lower surfaces of mango trees were precisely counted and recorded in each inspected date.

Directional preference was determine by applying the following formula (Mahmoud, 1981):

$$F_1 = E - W$$

$$F_2 = N - S$$

$$\tan.Q = F_2 / F_1$$

F_1: Mean number of insects in the east direction (E) minus insect numbers in west direction (W), if the former is higher, and the reverse if the latter is higher.

F_2: Mean number of insects in the north direction (N) minus insect numbers in south direction (S), if the former is higher, and the reverse applies if the insect number in south direction is higher. The figure obtained represents the tangent: the corresponding values of which was obtained from the mathematical table.

tan.Q: Tan of the angle between the two forces.

The effect of orchard depth of mango on distribution of *A. tuberculoris* has been studied on Goleck mango variety in private orchard of about five feddans, of 10 years-old at Esna district, Luxor governorate during two successive years of (2017/2018 and 2018/2019). Distances from boarders of mango orchard of 5, 15, 25, 50 and 75 meters far from the orchard boarder.

Four mango trees were selected and labeled for each distance, these trees were almost similar and as uniform as possible in size, age (10 years), height, vegetative growth and received the same horticultural practices without any chemical treatments before and during the investigation. Samples of 40 leaves (from four trees) were randomly selected from each distance at bimonthly intervals to conduct the study. The samples were transferred to the laboratory in polyethylene bags for inspection using a stereo-microscope. Total numbers of alive insects on mango leaves were counted and recorded for each inspected date.

The seasonal mean numbers of total population of *A. tuberculoris* per leaf was considered in this study to express the population size of pest. Spring season viz. (March, April and May months), summer (June, July and August), autumn (September, October and November) and winter (December, January and February). Data were analyzed using analysis of variance (ANOVA) at significance levels of $P \leq 0.05$ using LSD values. Standard error (S.E.) was also calculated.

The amount of change **(±)** of *A. tuberculoris* individuals on leaves on far boarders of orchard, as compared to those nearby boarders of orchard at distance (5 m) was calculated according to the following equation:

$$\text{Change \%} = \frac{A - B}{A} \times 100$$

Where, A = mean number of *A. tuberculoris* individuals on leaves of mango trees in far boarders of orchard

B= mean number of *A. tuberculoris* individuals on leaves of mango trees in nearby boarders of orchard at distance (5 m).

All obtained data were sub-

jected to statistical analysis by computer (MSTATC Program software, 1980) and were depicted graphically by Microsoft Excel 2010.

Results and Discussion

Leaf samples of mango trees infested with *A. tubercularis* to estimate insect population density showed considerable variations in its distribution patterns not only on tree leaves, but also in the different orchard sites. These remarkable observations may elucidate that insect distribution is regulated by other factors rather than wind direction and velocity which is known as important factors in this concern. The following factors were evaluated as affecting the insect distribution and spread in mango orchards:

1- Cardinal directions of mango tree (horizontal distribution):

The monthly mean cardinal distribution of *A. tubercularis* (average no. of individuals per leaf) at Esna district, Luxor governorate, Egypt, for two years from March, 2017 to February, 2019 were determined in Table (1).

Analysis of variance demonstrated significant differences between the population means of the four cardinal directions during the two years. Also, the general average for population was higher for the southern direction (86.40 ± 4.85 and 82.74 ± 4.14 individuals per leaf), followed by eastern site (84.35 ± 5.00 and 82.34 ± 4.14 individuals per leaf). In contrast, north direction was the least infested by insect (83.18 ± 4.92 and 79.84 ± 4.24 individuals per leaf). While, the west site were moderately infested with this insect as mean (84.01 ± 4.67 and 81.06 ± 3.96 individuals per leaf). Overall mean populations *A. tubercularis* per leaf were highest for each of the two years during the autumn (129.93 ± 2.62 and 114.77 ± 3.42), followed by summer (79.58 ± 1.92 and 80.98 ± 2.92), spring (70.05 ± 2.46 and 65.59 ± 1.74) and winter (58.38 ± 3.83 and 64.64 ± 3.12) during the two successive years, respectively.

During the first year (2017/18) of the study, there were significant differences between cardinal directions for each of the seasons, except in the winter season which was highly significant differences.

While, the second year of (2018/19), the results showed that the population density of insect were smaller than the preceding year. Also, highly significant differences among cardinal directions were recorded in the spring and winter seasons. No significant differences were found in the summer or autumn seasons, when the comparisons were directed for each season separately. Significant differences were observed among cardinal directions for the comparisons of combined effect for the whole year were recorded in each of year from the two years (2017-2019).

Data show that leaves collected from the south side of the mango trees accounted for 25.57 – 25.38%, the east (24.96 – 25.26%), the west (24.86 – 24.87%), and the north (24.62 – 24.49%) of the total scale insect population (Table 1).

Based on current results for the two years of investigation, and mainly relying on the significant differences concluded that the southern and eastern sides of the mango tree appears to be more preferred for in-

festation with *A. tubercularis*. The differences of distribution might be attributed to the pooled effect of the wind direction and the duration of leaflets exposure to the sun rays (Eraki, 1998). In the study area the main wind direction was north-west and thus drifts more newly emerged crawlers of the pest southeastwards where it may aggregate for feeding and growth (El-Said, 2000). This may be due to the direction blowing winds from the northern to the southern carrying the newly hatched crawlers and enabling them to settle on the leaves of those directions (Draz *et al.*, 2011).

Results indicated that, in both years of investigation the preferred direction was the east southern (Fig., 1), it may be concluded, therefore, that *A. tubercularis* prefers to accumulate at the east southern side of the mango trees usually being more subjected to sun and relatively warmer than the other sides. The previous deduced results are of great value when planning for chemical control programme against this insect.

These results were in agreement with El-Metwally *et al*. (2011) in Damietta, Egypt, mentioned that, *A. tubercularis* preferred south direction than other cardinal directions. Also, Nabil *et al*. (2012) in Sharkia, Egypt, reported significant differences among the four cardinal directions of mango trees where observed that, *A. tubercularis* concentrated in eastern side. On the contrary, Bakr *et al.* (2009) mentioned that *A. tubercularis* perfected east and west directions during cooler and summer weather. The differences between those results and the present may be attributed to the variation between some weather factors and /or agro-ecosystem. Sanad (2017) in Qaliobiya, Egypt, reported that the infestations of *A. tubercularis* was heaviest recorded in south and east directions of tree as compared with the other directions.

2- Strata of mango tree (vertical distribution):

Results depicted in Table (2), indicated that the middle stratum leaves of tree was the most preferred by the white scale insect, *A. tubercularis* as general average of 105.36 ± 6.06 and 99.96 ± 5.03 of individuals per leaf, followed by the bottom stratum leaves (97.04 ± 5.57 and 91.49 ± 4.55 of scale), while the top stratum was the least infested by insect as mean of 51.05 ± 2.98 and 53.03 ± 2.84 of scale per leaf, during the two tested years, respectively. Analysis of variance indicated that there were highly significant differences in the population means among the three strata for each season. Also, significant differences were observed among different stratums for comparisons of combined effect for the whole year during the two years (2017-2019) (Table 2).

The highest average of insect population occurred in autumn at the middle stratum leaves of tree were 162.12 ± 6.86 and 140.72 ± 8.24 individuals per leaf, followed by the bottom and top stratum leaves of mango tree. The respective scale densities reported that the average of insect per leaf were (148.98 ± 6.35 and 127.65 ± 7.44) and (78.69 ± 3.38 and 75.95 ± 5.80 individuals per leaf) through the two years of investigation, respectively, Table (2). Overall, the mean population densities of *A. tubercularis* for each of the two years

were similar, which may due to the environmental conditions was nearly similar. Furthermore, the mean numbers of this insect per leaf, were significantly higher (both the middle and bottom stratum leaves) as compared with the top stratum leaves and representing 41.57, 38.29 and 20.14% for 2017- 18, respectively and 40.89, 37.42 and 21.69% for 2018-19, respectively (Table, 2).

The differences in distribution pattern of insect on the different stratums of tree, which may be due to the differences in the environmental conditions (wind direction, sunlight and other factors). Also, the middle stratum leaves of tree were good shelter for the insects. Previous results emphasize that; *A. tubercularis* prefer the middle and bottom stratum leaves of mango tree. These results agree with that obtained by Draz *et al.* (2011) at El-Behaira governorate, Egypt. They also reported that the population of the purple scale insect, *Lepidosaphes beckii* prefer the middle stratum of navel orange trees as preferable site for feeding, developing and multiplications of nymphs and/or adults. Nabil *et al*. (2012) in Sharkia, Egypt, reported that infestation at the bottom level of the tree was higher than the top one.

3- Leaf surface:

Results in Table (3), showed that upper surface of the leaf was more heavily infested than the lower one. The overall mean number for this pest per leaf on the upper surface was 47.89 ± 3.04 and 46.41 ± 2.55 for two years of study, respectively. While, the general mean number of *A. tubercularis* on the lower surface of the leaf was 36.59 ± 2.28 and 35.08 ± 1.92 for two years, respectively.

Also, the statistical analysis of data, indicated highly significant differences between the population of the both surfaces of the leaf during the two years of study, for each season separately or for the combined effect for the whole year. No significant differences were observed in the summer season through the two years of study (2017-2019), Table (3).

Insect population on upper surface of leaf were 56.69 and 56.95% as the total number of insects, while these values ranged between 43.31 and 43.05% on the lower surface of the leaf for two years, respectively. Generally, the percentages of the pest population on surfaces of the leaf for each of the two years were similar. This may due to the similarity of environmental conditions (Table, 3). Concerning, this pest preferred the upper surface of leaves during spring, autumn and winter, while preferred the lower surface of leaves during the hot months (summer months) through the two consecutive years.

This means that the insect is behaves as photopositive and the upper surface of leaf were exposed to more sunlight than the lower ones. The aforementioned results emphasize that, *A. tubercularis* prefers the upper surface of mango leaf than the lower ones. These results were in agreement with Bakr *et al.* (2009). They mentioned that *A. tubercularis* preferred the upper surface of leaves. El-Metwally *et al*. (2011) in Damietta, Egypt, mentioned that, *A. tubercularis* pest preferred the upper surface of leaves during cold month (winter months) while preferred the lower

surface of leaves during the hot months (summer months). Also, Nabil *et al*. (2012) in Sharkia, Egypt, reported that the total number of alive stages of *A. tubercularis* were higher on the upper surface than the lower one at the top and bottom levels of mango tree. Sanad (2017) in Qaliobiya, Egypt, recorded that the upper leaf surface of mango leaf was preferable by *A. tubercularis* as compared with the lower one.

Results represented in Table (4), showed the distribution patterns of *A. tubercularis* in mango trees, given as accumulated counts that were done during the two years of (2017/2018 and 2018/2019). The results showed that the insect population distributed on different tree directions and all stratums of mango trees and its surfaces on the all year round during the two years of investigation. Also, the distribution of the pest considerably differs from one direction to another and from stratum of tree to another and also on its surfaces through the two years. These differences may be due to the differences in the environmental conditions and other factors. The highest population density of *A. tubercularis* was recorded at the upper surface on the middle stratum of tree in east southern side than the other directions and strata. The most likely reason for this distribution pattern is the temperature difference among the various aspects of the trees. Although the east and west directions of the tree get the same amount of direct sunlight, the air temperature during the morning is lower than that during afternoon. The combined effect of the high air temperature and the direct sunlight could cause the lower infestation on the west direction. These results were driven from the original data for seasonal abundance once studied, where each sampling leaf was sampled in the four cardinal directions. Each direction sub-sample and each stratum sub-sub-sample was examined separately and the data pooled for seasonal abundance of *A. tubercularis*.

These results were in agreement with Labuschagne *et al.* (1995) in South Africa, reported that the highest infestation of the white mango scale insect occurred on the shady south-facing lower aspect of the mango tree. Draz *et al.* (2011) at El-Behaira governorate, Egypt, however with different insect species and different host, also stated that the population distribution pattern of *L. beckii* considerably differ from one direction to another on navel orange tree.

4- Orchard depth:

Data are represented in Table (5), indicated that the distribution of *A. tubercularis* under field conditions is governed by orchard depth *i.e.*, distance of mango trees from orchard borders. The results showed that the mango trees far from the orchard boarder were more heavily infested by *A. tubercularis* than the nearby ones.

Also, the general average for population per leaf was higher on distance 75 m far from the mango orchard boarder as mean (111.93 ± 6.79 and 104.68 ± 5.56 individuals), followed by trees located at 50 m (102.00 ± 5.82 and 96.04 ± 4.92 individuals), followed by trees located at 25 m (71.26 ± 4.51 and 65.86 ± 3.70 individuals). In contrast, the trees on distance 5 m nearby from the orchard

boarder were the least infested by insect (11.93 ± 0.67 and 11.56 ± 0.58 per leaf). While, the distance of trees at 15 m was moderately infested with this insect as mean (46.78 ± 2.81 and 43.04 ± 2.30 per leaf) are represented in Table (5).

Analysis of variance indicated that there were highly significant differences between the population means at the different distances from boarders of orchard, when the comparison were directed for each season separately or for the combined effect for the whole year during the two years (2017-2019), Table (5).

Concerning, the seasons of year, the highest average of insect population occurred in autumn season at the trees on distance 75 m far from the orchard boarder were (173.15 ± 8.08 and 148.45 ± 8.85 individuals per leaf). While, the least average of population recorded in spring season at the trees on distance 5 m were (8.92 ± 0.57 and 8.31 ± 0.30 individuals per leaf) through the two years.

Data show that leaves collected from the mango trees on distance 75 m far from the orchard boarder accounted for 32.55 – 32.59% of the total scale insect population, followed by the trees located at 50 m (29.66-29.90%), at 25 m (20.72 – 20.50%), at 15 m (13.60- 13.40%) and at 5 m (3.47 – 3.60%) are represented in Table (5). Overall, the percentages of the population densities of *A. tubercularis* for each of the two years were similar, which may due to the environmental conditions was nearly similar.

It could be concluded that the mango trees which nearest to orchard boarders may be suffer the least infestation and was exhibited the smallest density of insect population (diminished) as compared with the trees located at far distances. These differences which may be due to the differences in the environmental conditions from inside to outside of orchard mango boarders and other factors viz., (wind direction, sunlight, irrigation and density of plants).

These results were disagreed with those obtained by Mohammad *et al.* (2005), however with different insect species and different host, also reported that the sugarcane plant infestation by the soft scale insect, *Pulvinaria tenuivalvata* (Newstead) decreased as the distance between plant location and field boarder increased, so sugarcane plants nearby the field boarder were heavily infested than plants far from field boarder.

Generally, it can be concluded from the current investigation that the insect population occurred on different tree directions and all stratums of mango trees and its surfaces on the all year round during the two years of investigation. *A. tubercularis* prefers the upper surface on the middle stratum of tree in east southern side where its population was always abundant allover the year and mango trees which far from the orchard boarders were more heavily infested by pest than the nearby trees from the boarders during the two years of study. Also, the obtained results revealed that the months of autumn and summer were the most favorable seasons for *A. tubercularis* activity, multiplication and distribution, while spring and winter months had the

lowest population. Also, this pest preferred the upper surface of leaves during months of the spring, autumn and winter and it choosed the lower surface of leaves during the hot months (summer months) through the two consecutive years.

The above mentioned results can be explained this tendency. These results could have important implications. Firstly, population censuses should be sampled on the highly infested aspect of the tree, thus saving time and effort. Secondly, the chemical spray programme could be adapted to concentrate on the highly infested aspect of the tree. Trials should, however, be performed to verify these assumptions.

Table 1. Mean numbers of *A. tubercularis* total population occurred in different directions of mango tree at Esna district, Luxor governorate during the successive two years (2017/2018 and 2018/2019)

Years	Seasons	Mango tree directions				Total	Mean ± S.E.	L.S.D. %5	% From overall seasonal total			
		North	South	East	West				North	South	East	West
		Average no. of *A. tubercularis* individuals per leaf ± S.E.										
2017 / 2018	Spring	68.00 ± 4.62	72.25 ± 4.90	70.08 ± 5.49	69.87 ± 5.20	280.20	70.05 ± 2.46	2.64 *	24.27	25.79	25.01	24.93
	Summer	80.59 ± 4.71	78.89 ± 4.14	77.69 ± 3.35	81.16 ± 3.45	318.33	79.58 ± 1.92	2.47 *	25.32	24.78	24.40	25.50
	Autumn	128.94 ± 5.79	132.77 ± 4.46	130.75 ± 6.61	127.25 ± 4.33	519.71	129.93 ± 2.62	3.68 *	24.81	25.55	25.16	24.48
	Winter	55.20 ± 7.30	61.70 ± 8.17	58.86 ± 8.07	57.75 ± 7.99	233.51	58.38 ± 3.83	3.59 **	23.64	26.42	25.21	24.73
	General average	83.18 ± 4.92	86.40 ± 4.85	84.35 ± 5.00	84.01 ± 4.67	337.94	84.48 ± 2.41	2.22 *	24.62	25.57	24.96	24.86
2018 / 2019	Spring	62.76 ± 3.76	67.52 ± 3.46	66.68 ± 3.39	65.40 ± 3.72	262.35	65.59 ± 1.74	1.76 **	23.92	25.74	25.42	24.93
	Summer	80.97 ± 6.58	80.83 ± 6.06	79.54 ± 5.73	82.56 ± 5.71	323.92	80.98 ± 2.92	N.S.	25.00	24.96	24.56	25.49
	Autumn	113.73 ± 7.37	116.88 ± 7.21	116.05 ± 7.27	112.41 ± 6.34	459.08	114.77 ± 3.42	N.S.	24.77	25.46	25.28	24.49
	Winter	61.91 ± 6.02	65.71 ± 6.24	67.07 ± 6.91	63.89 ± 6.52	258.57	64.64 ± 3.12	2.95 **	23.94	25.41	25.94	24.71
	General average	79.84 ± 4.24	82.74 ± 4.14	82.34 ± 4.14	81.06 ± 3.96	325.98	81.49 ± 2.05	1.88 *	24.49	25.38	25.26	24.87

L.S.D.: Least significant difference; * significant for $P \leq 0.05$; ** significant for $P \leq 0.01$;
N.S. = Non Significant.

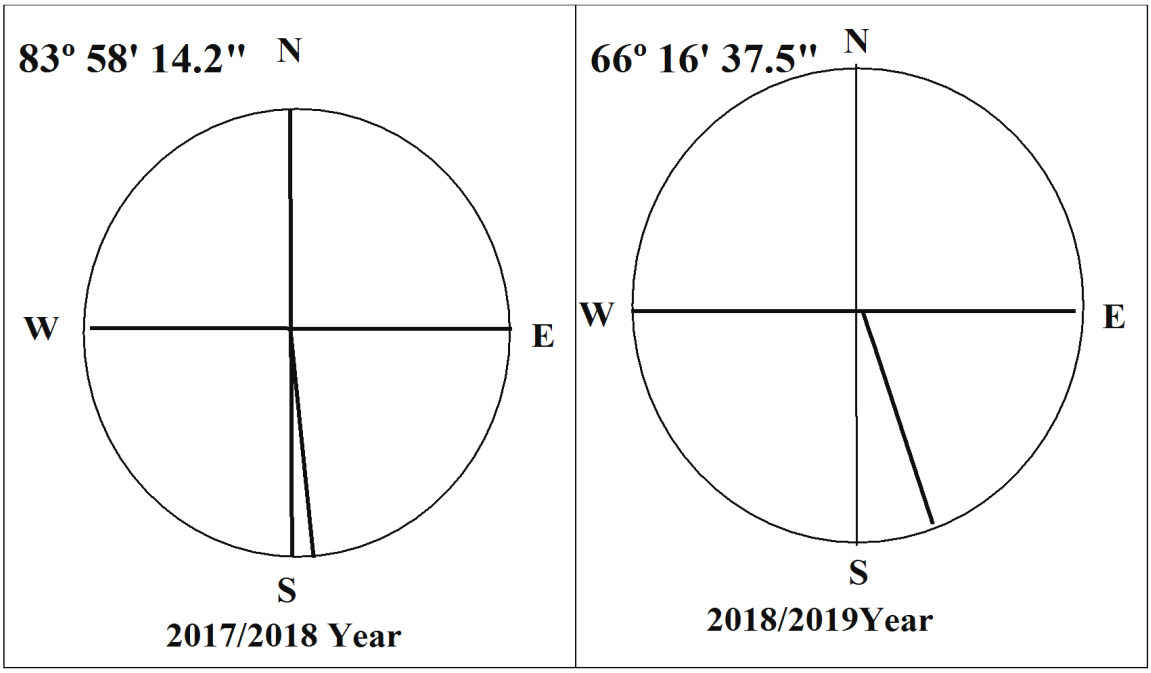

Fig. (1): Directional preference of *A. tubercularis* total population on mango tree through the two years from spring, 2017 to winter, 2019 at Esna district, Luxor governorate.

Table 2. Mean numbers of A. tubercularis total population in the different strata of mango tree through the two consecutive years of (2017/2018 and 2018/2019) at Esna district, Luxor governorate:

Years	Seasons	Mango tree strata			Total	Mean ± S.E.	L.S.D. %5	% From overall seasonal total		
		Bottom	Middle	Top						
		Average no. of *A. tubercularis* individuals per leaf ± S.E.						Bottom	Middle	Top
2017 / 2018	Spring	79.69 ± 5.50	86.46 ± 5.96	44.01 ± 3.64	210.15	70.05 ± 4.26	3.07 **	37.92	41.14	20.94
	Summer	93.01 ± 4.47	100.87 ± 4.86	44.87 ± 2.59	238.75	79.58 ± 4.77	4.36 **	38.96	42.25	18.79
	Autumn	148.98 ± 6.35	162.12 ± 6.86	78.69 ± 3.38	389.78	129.93 ± 6.98	4.77 **	38.22	41.59	20.19
	Winter	66.49 ± 9.02	71.99 ± 9.66	36.65 ± 4.94	175.13	58.38 ± 5.27	4.06 **	37.96	41.11	20.93
	General average	97.04 ± 5.57	105.36 ± 6.06	51.05 ± 2.98	253.45	84.48 ± 3.52	2.51 **	38.29	41.57	20.14
2018 / 2019	Spring	73.37 ± 4.13	79.74 ± 4.30	43.65 ± 2.34	196.76	65.59 ± 3.37	2.63 **	37.29	40.53	22.19
	Summer	92.83 ± 6.66	100.92 ± 7.32	49.18 ± 4.20	242.94	80.98 ± 5.18	4.78 **	38.21	41.54	20.24
	Autumn	127.65 ± 7.44	140.72 ± 8.24	75.95 ± 5.80	344.31	114.77 ± 6.23	4.55 **	37.07	40.87	22.06
	Winter	72.10 ± 7.39	78.47 ± 7.87	43.36 ± 4.00	193.93	64.64 ± 4.53	4.02 **	37.18	40.46	22.36
	General average	91.49 ± 4.55	99.96 ± 5.03	53.03 ± 2.84	244.48	81.49 ± 2.97	2.24 **	37.42	40.89	21.69

Table 3. Mean numbers of *A. tubercularis* total population occurred on the surfaces of mango leaf during the two successive years of (2017/2018 and 2018/2019) at Esna district, Luxor governorate:

Years	Seasons	Mango leaf surfaces		Total	Mean ± SE	L.S.D. %5	% From overall seasonal total	
		Upper	Lower					
		Average no. of *A. tubercularis* individuals per leaf ± S.E.					Upper surface	Lower surface
2017 / 2018	Spring	40.53 ± 3.12	29.52 ± 1.97	70.05	35.03 ± 2.14	1.78 **	57.86	42.14
	Summer	39.74 ± 2.30	39.84 ± 2.88	79.58	39.79 ± 1.80	N.S.	49.94	50.06
	Autumn	75.25 ± 4.52	54.68 ± 4.14	129.93	64.96 ± 3.68	3.26 **	57.92	42.08
	Winter	36.05 ± 5.51	22.32 ± 2.40	58.38	29.19 ± 3.27	2.30 **	61.76	38.24
	General average	47.89 ± 3.04	36.59 ± 2.28	84.48	42.24 ± 1.98	1.30 **	56.69	43.31
2018 / 2019	Spring	37.62 ± 2.17	27.96 ± 1.44	65.59	32.79 ± 1.62	1.46 **	57.36	42.64
	Summer	40.09 ± 2.91	40.89 ± 3.93	80.98	40.49 ± 2.39	N.S.	49.50	50.50
	Autumn	69.04 ± 4.42	45.73 ± 3.57	114.77	57.39 ± 3.69	2.79 **	60.16	39.84
	Winter	38.90 ± 4.05	25.74 ± 2.59	64.64	32.32 ± 2.72	1.90 **	60.18	39.82
	General average	46.41 ± 2.55	35.08 ± 1.92	81.49	40.75 ± 1.69	1.08 **	56.95	43.05

Table 4. The spatial distribution of the white mango scale insect, *A. tubercularis* per leaf, given as a general average counts that was done during the two successive years of (2017-2019) at Esna district, Luxor governorate.

Directions	Strata	Surfaces	Average no. of *A. tubercularis* individuals per leaf					
			First year (2017/2018)			Second year (2018/2019)		
North	Bottom	Upper	50.34	93.16	83.18	50.25	88.41	79.84
		Lower	42.82			38.16		
	Middle	Upper	58.51	103.99		58.45	98.88	
		Lower	45.47			40.43		
	Top	Upper	27.75	52.40		28.55	52.24	
		Lower	24.65			23.69		
South	Bottom	Upper	58.28	103.63	86.40	52.28	93.68	82.74
		Lower	45.35			41.40		
	Middle	Upper	67.26	109.30		58.86	101.03	
		Lower	42.04					
	Top	Upper	26.56	46.27		29.93	53.49	
		Lower	19.71			23.57		
East	Bottom	Upper	55.99	96.34	84.35	53.45	93.10	82.34
		Lower	40.35			39.64		
	Middle	Upper	62.23	103.90		58.82	100.29	
		Lower	41.67			41.48		
	Top	Upper	29.47	52.79		29.58	53.62	
		Lower	23.32			24.04		
West	Bottom	Upper	51.09	95.03	84.01	49.57	90.76	81.06
		Lower	43.94			41.19		
	Middle	Upper	59.03	104.24		57.45	99.64	
		Lower	45.21			42.19		
	Top	Upper	28.20	52.75		29.76	52.79	
		Lower	24.55			23.03		
General average			84.48			81.49		

Table 5. Means numbers of *A. tubercularis* total population in the different distances from boarders of mango orchard during consecutive years of (2017/2018 and 2018/2019) at Esna district, Luxor governorate:

Years	Seasons	Different distances from mango orchard boarders					Total	Mean ± S.E.	L.S.D. %5	% From overall seasonal total				
		5 m	15 m	25 m	50 m	75 m				5 m	15 m	25 m	50 m	75 m
		Average no. of *A. tubercularis* individuals per leaf ± S.E.												
2017 / 2018	Spring	8.92 ± 0.57	34.76 ± 3.22	58.92 ± 4.62	85.00 ± 6.08	93.52 ± 8.13	281.12	56.22 ± 4.66	4.54 **	3.17	12.36	20.96	30.24	33.27
	Summer	11.24 ± 0.50	45.51 ± 2.58	67.45 ± 3.58	96.85 ± 4.67	108.40 ± 6.55	329.45	65.89 ± 4.91	4.79 **	3.41	13.81	20.47	29.40	32.90
	Autumn	18.48 ± 0.41	72.66 ± 3.57	112.91 ± 5.83	157.67 ± 5.90	173.15 ± 8.08	534.87	106.97 ± 7.73	7.76 **	3.46	13.58	21.11	29.48	32.37
	Winter	9.10 ± 1.18	34.20 ± 4.09	45.76 ± 6.93	68.50 ± 8.58	72.62 ± 10.00	230.18	46.04 ± 4.26	4.30 **	3.95	14.86	19.88	29.76	31.55
	Mean	11.93 ± 0.67	46.78 ± 2.81	71.26 ± 4.51	102.00 ± 5.82	111.93 ± 6.79	343.91	68.78 ± 3.14	3.00 **	3.47	13.60	20.72	29.66	32.55
	* The amount of change (±) %	------	(+) 74.49	(+) 83.25	(+) 88.30	(+) 89.34								
2018 / 2019	Spring	8.31 ± 0.30	30.34± 1.89	53.02 ± 3.19	77.26 ± 4.01	85.14 ± 5.82	254.07	50.81 ± 4.04	3.92 **	3.27	11.94	20.87	30.41	33.51
	Summer	11.44 ± 0.82	44.07± 3.62	65.99 ± 4.99	95.86 ± 7.13	108.05 ± 9.29	325.40	65.08 ± 5.22	5.12 **	3.51	13.54	20.28	29.46	33.20
	Autumn	16.39 ± 0.93	60.49± 3.39	96.13 ± 6.76	135.66 ± 8.39	148.45 ± 8.85	457.13	91.43 ± 6.91	6.89 **	3.59	13.23	21.03	29.68	32.48
	Winter	10.10 ± 0.95	37.27± 4.07	48.29 ± 5.23	75.37 ± 7.89	77.08 ± 7.14	248.11	49.62 ± 4.06	4.09 **	4.07	15.02	19.46	30.38	31.07
	Mean	11.56 ± 0.58	43.04 ± 2.30	65.86 ± 3.70	96.04 ± 4.92	104.68 ± 5.56	321.18	64.24 ± 2.80	2.66 **	3.60	13.40	20.50	29.90	32.59
	* The amount of change (±) %	------	(+) 73.14	(+) 82.45	(+) 87.96	(+) 88.96								

* refers to the percentage of increase (+) or reduction (-) in number of *A. tubercularis* individuals on leaves of mango trees on far boarders of orchard as compared to mango trees nearby boarders of orchard at distance (5 m).

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العوامل المؤثرة فى توزيع حشرة المانجو القشرية البيضاء على أشجار المانجو فى مركز إسنا- محافظة الأقصر - مصر

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الملخص

تعتبر حشرة المانجو القشرية البيضاء من الآفات الخطيرة التى تصيب أشجار المانجو فى محافظة الأقصر. تمتص هذه الآفة العصارة النباتية مما يؤدى إلى أصفرار الأوراق وجفافها وتساقطها وتسبب موت الفروع وفى حالة الإصابة الشديدة تنتقل إلى الثمار وتسبب تشوهات فى الثمار مما يودى إلى تقليل القيمة التسويقية للثمار. ولذلك فقد تم تقدير نظم توزيع الحشرة على الاتجاهات الأربعة الرئيسية للشجرة وعلى طبقات الشجرة وعلى سطحى الورقة وعلى المسافات المختلفة للاشجار من خارج المزرعة الى الداخل لأشجار المانجو فى مركز إسنا محافظة الأقصر خلال عامين متتالين (٢٠١٧/٢٠١٨ و ٢٠١٨/٢٠١٩).

أوضحت النتائج، وجود أختلافات معنوية بين متوسطات تعداد الحشرة في الأتجاهات الأربعة الرئيسية للشجرة وأختلافات عالية المعنوية بين الطبقات المختلفة للشجرة وبين سطحى الورقة وبين المسافات المختلفة للأشجار المنزرعة فى الحدود الخارجية للمزرعة الى الداخل خلال عامين متتالين. وأظهرت النتائج، أن المتوسط العام للتعداد كان أعلى إصابة في الاتجاه الجنوبي بمتوسط (٨٦,٤٠ ± ٤,٨٥ و٨٢,٧٤ ± ٤,١٤ فرداً لكلّ ورقة)، يليها أتجاة الشرق بمتوسط (٨٤,٣٥ ± ٥,٠٠ و٨٢,٣٤ ± ٤,١٤ فرداً لكلّ ورقة). وعلى العكس، كان الأتجاه الشمالى للشجرة أقل إصابة بالحشرة بمتوسط (٨٣,١٨ ± ٤,٩٢ و٧٩,٨٤ ± ٤,٢٤ فرداً لكلّ ورقة). بينما كان الأتجاه الغربى للشجرة متوسط الإصابة (٨٤,٠١ ± ٤,٦٧ و٨١,٠٦ ± ٣,٩٦ فرداً لكلّ ورقة)، خلال عامين مِنْ الدراسةِ، على التوالي.

كما أشارت النتائج أن أوراق الطبقة الوسطية للشجرة أكثر الأجزاءِ تفضيلاً وإصابة بالحشرةِ بمتوسط (١٠٥,٦ ± ٦,٠٦ و٩٩,٩٦ ± ٥,٠٣ فرداً لكل ورقة)، يليها أوراق الطبقة القاعدية للشجرة بمتوسط (٩٧,٠٤ ± ٥,٥٧ و ٩١,٤٩ ± ٤,٥٥ فرداً لكل ورقة)، بينما أوراق الطبقة الطرفية للشجرة كَانتْ أقلّ إصابة بالحشرةِ بمتوسط (٥١,٠٥ ± ٢,٩٨ و٥٣,٠٣ ± ٢,٨٤ فرداً لكل ورقة خلال عامين، على التوالي.

وخلاصة هذه الدراسة، أن جميع أطوار الحشرة تتواجد فى الأتجاهات الأربعة الرئيسية للشجرةِ وعلى كل الطبقات المختلفة لشجرة المانجو وعلى سطحى الورقة على مدار العام خلال عامى الدراسة. وتفضل الحشرة السطح العلوى على أوراق الطبقة الوسطية للشجرة فى الأتجاه الجنوبى الشرقى طوال العام. وتزداد الإصابة الحشرية كلما أتجهنا من الخارج إلى الداخل المزرعة.