

The Within-Tree Distribution of the Oriental Scale Insect, *Aonidiella orientalis* (Newstead) on *Ficus nitida* Thumb Trees

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Abstract. Observations were carried out to study the distribution of the oriental scale insect, *Aonidiella orientalis* (Newstead) on leaves of four *Ficus nitida* trees, at the Agricultural Experimental Station of the College of Agriculture, King Saud University, Deirab during 1987 - 1988.

In all Seasons of the year, no significant differences occurred between the mean number of scales on leaves on the south and west sides of the trees. The highest mean number of scales on a single leaf (5.9 individuals) was recorded on leaves on the west, and the lowest (4.15) on leaves on the north side. The highest population always occurred on the west side except during winter when leaves on the south had a higher number of scales. Crawlers seemed to prefer settling in a warmer place during cold weather.

In spring, leaves had the highest population (7.15 individuals/leaf), followed by leaves in winter (6.38). The lowest number (2.59) was recorded on leaves during summer. This was most probably due to extremely high temperature which increased mortality among crawlers and adult males.

Leaves in the bottom portion of the tree had more scales than did those of the middle or the upper portions. Leaves inside canopy of the tree had more scales than those of the periphery of the canopy. This may be a photic response.

The upper surface of leaves was more densely covered with scales than the lower surface. The population of live scales on the upper surface was approximately 10 times that of the lower surface. This distribution may be due to thigmotaxis.

Introduction

The oriental scale insect, *Aonidiella orientalis* (Newstead) is the most dominant species of scale in Riyadh region [1]. It seems to be better adapted to the arid climate of the area. It is a polyphagous insect which usually occurs on foliage of host plants both in desert and in the coastal regions [2]. These scale insects reproduce very rapidly and quietly attain very high population densities. In severe infestations, plants may be seriously affected.

In a previous paper by the authors [3], studies on the population dynamics of this insect were carried out. The present work is an attempt to quantify the distribution of *A. orientalis* on *Ficus nitida* Thumb trees. We will discuss vertical and horizontal distribution of scales in different regions of trees, the distribution of scales in the four cardinal quadrants of trees, in different seasons of the year and on both surfaces of leaves.

Methods and Technique

This work was carried out in the Agricultural and Experimental Station of the College of Agriculture, King Saud University at Deirab. Four adjacent *F. nitida* trees of almost the same height (3m), size, vigour and shape were selected for inspection. The distribution of scales was studied by random sampling and inspection of leaves, following the same procedure adopted by Badawi and Al-Ahmed [3].

To determine the vertical distribution of scales on trees, random samples of leaves (20 each, 5 leaves from each direction) were taken from each of three heights (top, middle and bottom) of the canopy of each tree. Four samples were taken and inspected at fortnightly intervals starting May 25, 1988. The density and sex of scales on leaves was compared at the different height levels.

for studying the horizontal distribution of scales on trees, samples of 20 leaves each (5 from each of the cardinal quadrants) were taken at random from the periphery and inner core of each tree at shoulder height. Six samples from each zone were taken at fortnightly intervals starting September 28, 1988.

In all counts, data were subjected to statistical analysis [4] and means were separated when needed according to Duncan's multiple range test at the 5% level.

Results and Discussion

1- Distribution in the four cardinal quadrants of the tree

Table 1 shows the mean number of scales per 1 sq. inch of leaf surface in the four cardinal quadrants of trees at different seasons of the year. Irrespective of season, the highest mean number (5.90 scales) was recorded on leaves on the west, and the lowest (4.15 scales) on those on the north side of the tree. Each of these means alone formed a significantly separable group. Means recorded on leaves of the south and east directions together formed another group.

The data also show that there was a persistent tendency for the highest population to occur on the west except during winter where leaves on the south direction had a higher mean number of scales (7.26 scales). This may be due to longer exposure

Table 1. Mean number of scales per sq. inch of upper and lower surfaces of *F. nitida* trees in the 4 cardinal directions and during different seasons of the year 1987-1988.

Seasons	Directions				Mean \pm S.É.
	North	South	East	West	
Winter	5.23 \pm 2.22	7.26 \pm 2.64	6.41 \pm 2.78	6.61 \pm 2.14	6.38 \pm 1.20 A
Spring	5.68 \pm 2.15	8.00 \pm 2.31	6.31 \pm 2.08	8.61 \pm 2.32	7.15 \pm 1.08 A
Summer	2.28 \pm 0.76	2.70 \pm 0.87	2.13 \pm 0.62	3.25 \pm 1.22	2.59 \pm 0.44 B
Autumn	3.41 \pm 0.87	4.50 \pm 1.15	3.09 \pm 0.74	5.14 \pm 1.09	4.04 \pm 0.48 B
Mean \pm S.E.	4.15 \pm 0.82 B	5.61 \pm 0.96 BA	4.48 \pm 0.91 BA	5.90 \pm 0.90 A	

L.S.D. (5%) for directions or seasons = 1.57

Means with the same letter are not significantly different at 5% level according to Duncan's new multiple range test.

of the west side to direct sun [5]. Similar results were however, given by Dickson and Lindgren [6] with *A. aurantii* and Schwiga and Grunberg [7] with *Chrysomphalus ficus*.

During summer, the population of scales reached its lowest level. This was true for all directions.

In spring, the south and west directions had the highest mean numbers of scales. The differences between them and those on either the north or east were statistically significant.

In autumn, significantly more scales occurred on the west side than on the north and east sides of the tree.

2- Distribution in different seasons

When leaves on all directions were pooled, those in spring had the highest population (7.15 scales) followed by winter (6.38 scales). There was no significant difference between these two means. The least number of scales (2.59 scales) was observed on leaves during summer. High temperature and dry weather were found to increase the mortality rates among crawlers of *A. aurantii* [8] and adult males of same [9].

By the end of summer and beginning of autumn, temperature decreased and relative humidity gradually increased. The mean number of scales recorded (4.04 scales) was slightly higher than that of summer but was still lower than that of either spring or winter.

3- Vertical distribution

Fig. 1 shows clearly that highest population always occurred on leaves in the bottom third of the tree. A total of 80.56 scales (69.0 on the upper surface and 11.55 on the lower surface) were found on 10 sq. inches of the leaves of this zone compared to 44.75 and 25.87 for leaves of the middle and top thirds respectively. The population of scales on leaves of the bottom third formed a significantly separable group. Populations on leaves of both the middle and top zones were not significantly different from one another.

Our results confirm those of Habib and Khalifa [10] and Hafez *et al.* [11] who stated that the lower and middle zones of the tree are exposed to more favourable conditions than the upper zone where leaves are exposed to direct sun. However, Orphanides [12] states that passive dispersal of crawlers accounts for the lower density of scales on the upper half of the tree.

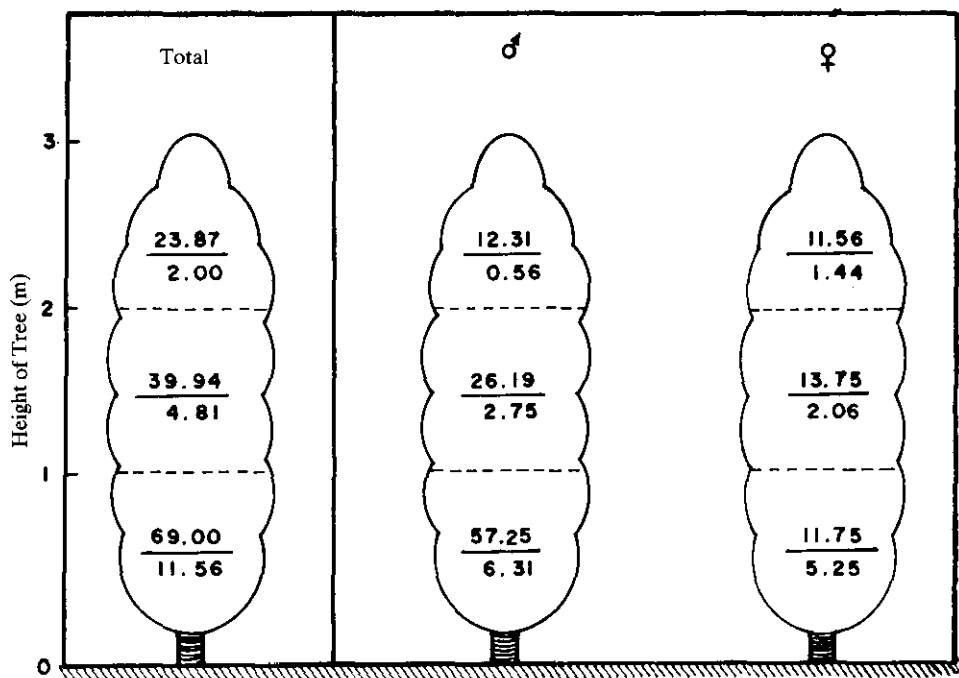


Fig. 1. The vertical distribution of *A. orientalis*: Mean number of scales per sq. inch on the upper surface of 20 leaves at three height levels of *F. nitida* trees. lower surface

4- Horizontal distribution

Fig. 2 indicates that the central zone of the tree had more scales than the periphery of the canopy. Means of 90.3 and 67.0 individuals per 20 leaves were recorded for both zones respectively. Leaves of the inside core had almost 57% of the live scales. The difference between the means was not statistically significant.

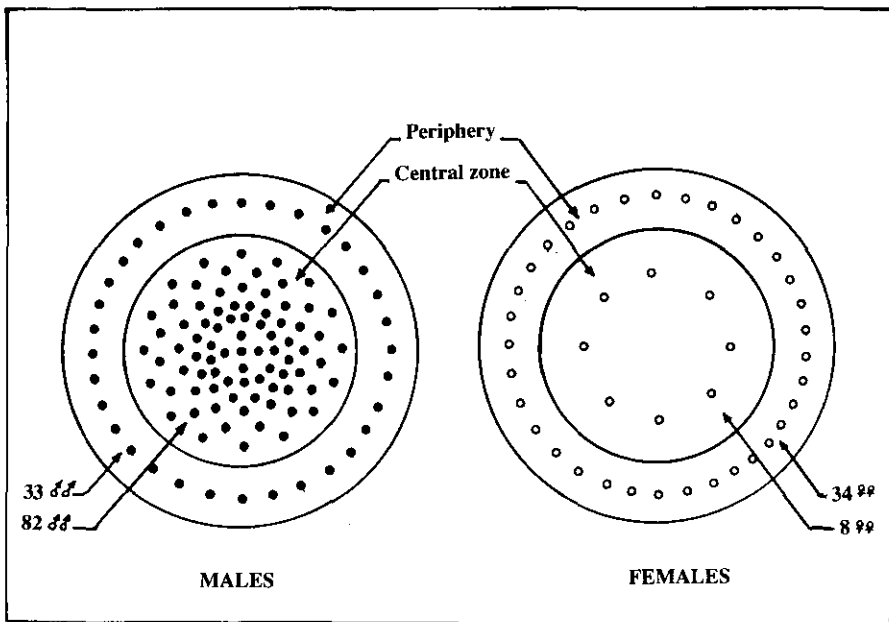


Fig. 2. The horizontal distribution of *A. orientalis*: Mean number of male and female scales per sq. inch on both surfaces of 20 leaves at the periphery and central zone of *F. nitida* trees.

Habib *et al.* [13] reported that the accumulation of the red scale, *A. aurantii* on the central shady core of the tree is probably a photic response. Their laboratory experiments supported this assumption; newly hatched crawlers avoided any source of illumination when exposed to it. Flanders [14] stated that the red scale crawlers exhibited a rather weak positive phototropism and a strong negative geotropism.

It is interesting to note that almost equal numbers of male and female scales were present on leaves on the periphery of the tree, while females in the central zone represented no more than 10 % of the total number of scales in this zone. This could be the result of parasitization. During autumn the central zone had the highest number of parasitized scales (99.67 scales / 20 leaves compared to 23.17 scales / 20 leaves in the periphery) and more than 98 % of Parasitized scales were females.

5- Distribution on leaf surfaces

Scales observed on the upper surfaces of leaves always outnumbered those of the lower surfaces. This was common at all heights (Fig. 1), in all cardinal quadrants and in all seasons of the year (Table 2). The mean number of scales per square inch of the upper and lower surfaces of leaves were 4.6 and 0.44 respectively. The difference between both means was statistically significant.

Table 2. Mean number of scales per sq. inch on both surface of leaves in the 4 cardinal directions of *F. nitida* trees during different seasons.

Directions and seasons	Mean number of scales \pm S.E. /leaf	
	Upper surface	Lower surface
North	3.84 \pm 0.70	0.31 \pm 0.05
South	5.15 \pm 0.76	0.47 \pm 0.07
East	4.02 \pm 0.79	0.46 \pm 0.11
West	5.39 \pm 0.66	0.52 \pm 0.06
Winter	5.93 \pm 0.99	0.45 \pm 0.07
Spring	6.48 \pm 0.81	0.67 \pm 0.12
Summer	2.35 \pm 0.35	0.22 \pm 0.03
Autumn	3.63 \pm 0.27	0.41 \pm 0.05
Mean	4.60 \pm 0.37 A	0.44 \pm 0.04 B

L.S.D. (5%) for surfaces = 0.55

Means followed by the same letter are not significantly different at the 5% level according to Duncan's new multiple range test.

Our results confirm those of Moussa [15] who found that the upper surface of leaves harboured 78-92 % of the total population of the oriental scale insect, *A. orientalis*. Orphanides [12] and Liotta *et al.* [16] reported that there was always more individuals of *A. aurantii* on the upper surfaces than on the lower surfaces of leaves. According to Bodenheimer [17], crawlers of the latter species settle almost invariably on the side of the leaf of fruit exposed to the light due to thermotaxis rather than phototaxis.

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التوزيع الداخلي للحشرة القشرية الشرقية على أشجار الفيكس نتدا

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ملخص البحث. في دراسة لطريقة توزيع الحشرة القشرية الشرقية على أوراق الفيكس نتدا بمحطة التجارب الزراعية بديراب خلال عام ١٩٨٧/١٩٨٨م لم يكن هناك فرق إحصائي معنوي بين متوسط أعداد الحشرة على الأوراق في الجهتين الجنوبية والغربية من الشجرة وذلك خلال جميع فصول السنة. وقد سجل أعلى معدل للقشور على الورقة الواحدة (بوصة مربعة لكل سطح) ٩, ٥ أفراد في الجهة الغربية وأقلها (١٥, ٤) في الجهة الشمالية. وكان هناك اتجاهًا دائمًا لوجود أكبر تعداد من الحشرات في الجهة الغربية ماعدا خلال فصل الشتاء حيث كانت أوراق الجانب الجنوبي أكثرها ازدحامًا بالقشور. ويبدو أن الأفراد حديثة الفقس تفضل الإقامة في الأماكن الدافئة خلال فصل الشتاء البارد.

وقد احتوت الأوراق خلال فصل الربيع على أعلى معدل للحشرات (١٥, ٧ فرد لكل ورقة) يليها الأوراق خلال فصل الشتاء (٣٨, ٦ فرد). وظهر أقل معدل (٥٩, ٢ فرد) خلال الصيف. ومن المحتمل أن يكون ذلك نتيجة للحرارة المرتفعة والجفاف الذي يرفع من نسبة الموت بين الأفراد حديثة الفقس والحشرات الكاملة الذكور.

كذلك احتوت أوراق المنطقة السفلى من الأشجار على أعلى معدل للحشرات يفوق ما وجد على أوراق كل من المنطقتين الوسطى والعلوية. وكان الفرق بينها معنويًا. كما احتوت الأوراق الداخلية على نسبة من الحشرات تفوق ما وجد على أوراق الحافة الخارجية وإن لم يكن هناك فرق معنوي بينها. وكانت كثافة الحشرات على السطح العلوي للأوراق أكبر منها على السطح السفلي حيث بلغ ١٠ أمثاله. وقد يكون هذا التوزيع نتيجة لاستجابة حرارية.