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# The Population Dynamics of the Oriental Scale Insect, *Aonidiella orientalis* (Newstead) and Factors Affecting its Seasonal Abundance

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ABSTRACT. Based on random samples of leaves taken at about fortnightly intervals from four *Ficus nitida* trees, studies on the population dynamics of the oriental scale, *Aonidiella orientalis* (Newstead) and factors affecting its seasonal abundance were carried out throughout the year 1987-1988. Counts of alive scales were made on 1 sq. inch per each leaf surface.

Four distinct peaks representing four annual generations were observed; two winter and two spring generations. During summer, the population attained its lowest level probably due to the extremely high temperature and arid climate prevailing during this period of the year. A steady increase in the population of insects was observed in autumn, and the first peak of abundance appeared at the beginning of winter.

Temperature was negatively and significantly correlated with the population, values of (r) for the maximum and mean temperatures obtained (−0.6667 and −0.5995 respectively) were highly significant. On the other hand, rainfall had no apparent effect on the population (r=0.2813), while correlation with the relative humidity was slightly positive (r=0.4897). As a general rule, the sides of trees exposed to the winds harboured less individuals than the opposite sides. Crawlers seem to be forced to drift by wind to more protected zones.

Numerous species of scales have been previously recorded on a wide range of host plants in Saudi Arabia (Martin 1972, Abu-Thuraya 1982, Matile-Ferrero 1984, Al-Ahmed and Badawi 1989). Of these, the oriental scale insect, *Aonidiella orientalis* (Newstead) which seems to be more adapted to the arid climate was the most dominant (Al-Ahmed and Badawi 1989). This species is a widespread and polyphagous diaspidid usually occurring upon foliage of host plants both in the desert as well as in the coastal regions (Matile-Ferrero 1984).

Work on *A. orientalis,* unlike most other species of scales is very limited. A study of the available literature shows that save for a single paper on its bionomics

(Moussa 1986) and a few papers dealing with its recognition characters (McKenzie 1938), synonymy (Balachowsky 1956), geographical distribution (Gentry 1965) and host plants (Martin 1972, Abu-Thuraya 1982, Matile-Ferrero 1984) nothing of importance on the ecology of this insect has been published.

The present study follows out the population dynamics of this species throughout the different seasons of the year and shows the effect of certain climatic factors on its seasonal abundance.

## Methods and Technique

For studying the population dynamics of this insect, four adjacent *Ficus nitida* trees, in the orchard of the Agricultural Experimental Station of the College of Agriculture, King Saud University at Deirab were selected for this purpose. The trees were nearly of the same height (3 meters), size, vigour and shape. No toxic chemicals were applied to the trees one year before starting this work.

The seasonal changes were followed by sampling leaves from each tree at fortnightly intervals for a complete year starting December 22, 1987. A total of 26 samples from each tree were taken throughout the study period. Each sample consisted of 40 leaves, 10 leaves picked up at random from each of the four cardinal quadrants of the tree. In the laboratory, and by means of a stereoscopic microscope, counts were made of alive, dead and parasitized scales on one square inch of both surfaces of each leaf. Empty male scales were considered living males (Habib and Khalifa 1957).

Records of the maximum, minimum and mean temperatures, relative humidity, rate of rainfall and wind direction were obtained from the Meteorological Section of the Experimental Station. The correlation coefficients (r) were calculated to determine to what extent would the scale population and its distribution be affected by the prevailing climatic conditions.

## Results and Discussion

1. *Seasonal fluctuations of population:*

A study of the data in Table 1 and the graphical representation of Fig. 1 shows clearly that the population of the oriental scale, *A. orientalis* fluctuated up and down indicating continuous reproduction of th insect all the year round. Four distinct peaks, probably representing four annual generations were observed; two winter generations at about the end of December 1987 and the end of January

**Table 1.** Number of alive scale insects on 320 sq. inches of leaves (10 leaves × 4 directions × 4 trees × 1 sq. inch/leaf surface) and the quotient of increase

| Season | Date | No. of scales | Quotient of increase | Season | Date | No. of scales | Quotient of increase |
|---|---|---|---|---|---|---|---|
| Winter | 22 Dec. 87 | 1203 | 1.50 | Summer | 22 Jun. 88 | 432 | 1.13 |
| | 5 Jan. 88 | 852 | 0.71 | | 6 Jul. 88 | 489 | 1.13 |
| | 20 Jan. 88 | 1258 | 1.48 | | 20 Jul. 88 | 300 | 0.61 |
| | 4 Feb. 88 | 1009 | 0.80 | | 3 Aug. 88 | 495 | 1.65 |
| | 18 Feb. 88 | 851 | 0.84 | | 17 Aug. 88 | 487 | 0.98 |
| | 2 Mar. 88 | 952 | 1.12 | | 31 Aug. 88 | 280 | 0.57 |
| | Total | 6125 | | | Total | 2483 | |
| Spring | 16 Mar. 88 | 1347 | 1.41 | Autumn | 28 Sep. 88 | 435 | 0.90 |
| | 30 Mar. 88 | 1041 | 0.77 | | 12 Oct. 88 | 512 | 1.18 |
| | 13 Apr. 88 | 1950 | 1.87 | | 26 Oct. 88 | 668 | 1.30 |
| | 27 Apr. 88 | 1386 | 0.71 | | 9 Nov. 88 | 752 | 1.13 |
| | 11 May 88 | 531 | 0.38 | | 23 Nov. 88 | 702 | 0.93 |
| | 25 May 88 | 609 | 1.15 | | 7 Dec. 88 | 804 | 1.14 |
| | Total | 6864 | | | Total | 3873 | |

*N.B.* Two more specimens on June 8, 1988 (382 scales, Q value = 0.63) and on September 14, 1988 (485 scales, Q value = 1.73) were inspected but were not included in this table.

1988 respectively, and two spring generations; on mid March and mid April 1988 respectively. The populations of the four peaks increased progressively, so that the latter was the highest.

During the summer period, a sudden drop in the population of the insect occurred and the population attained its lowest level. This may be attributed to the extremely high temperature prevailing during this season. High summer temperature is believed to significantly increase mortality of the young stages of the red scale, *A. aurantii* (Morse *et al.* 1985) and adult males of same (Yan and Isman 1986).

During autumn, and as the temperature started to decline, a steady increase in the population of scales was observed, and the first peak of abundance appeared at the beginning of winter.

Comparison between the population of insects in the four seasons of the year indicates that the highest count (6864 individuals or 35.5% of the total) was obtained in spring, followed in order by that of winter (31.7%), autumn (20.0%) and summer (12.8%).

The average annual fluctuations as calculated by dividing the maximum population by the minimum, and the highest quotient of increase (Q) as calculated by dividing the population of each count by that of the preceding one (Bodenheimer 1951) were 6.96 and 1.87 respectively. The latter figure was obtained in spring at a temperature ranging between 15.2 and 30.0°C and 30% R.H. which seem to be the optimum conditions for the development of this insect in the area.

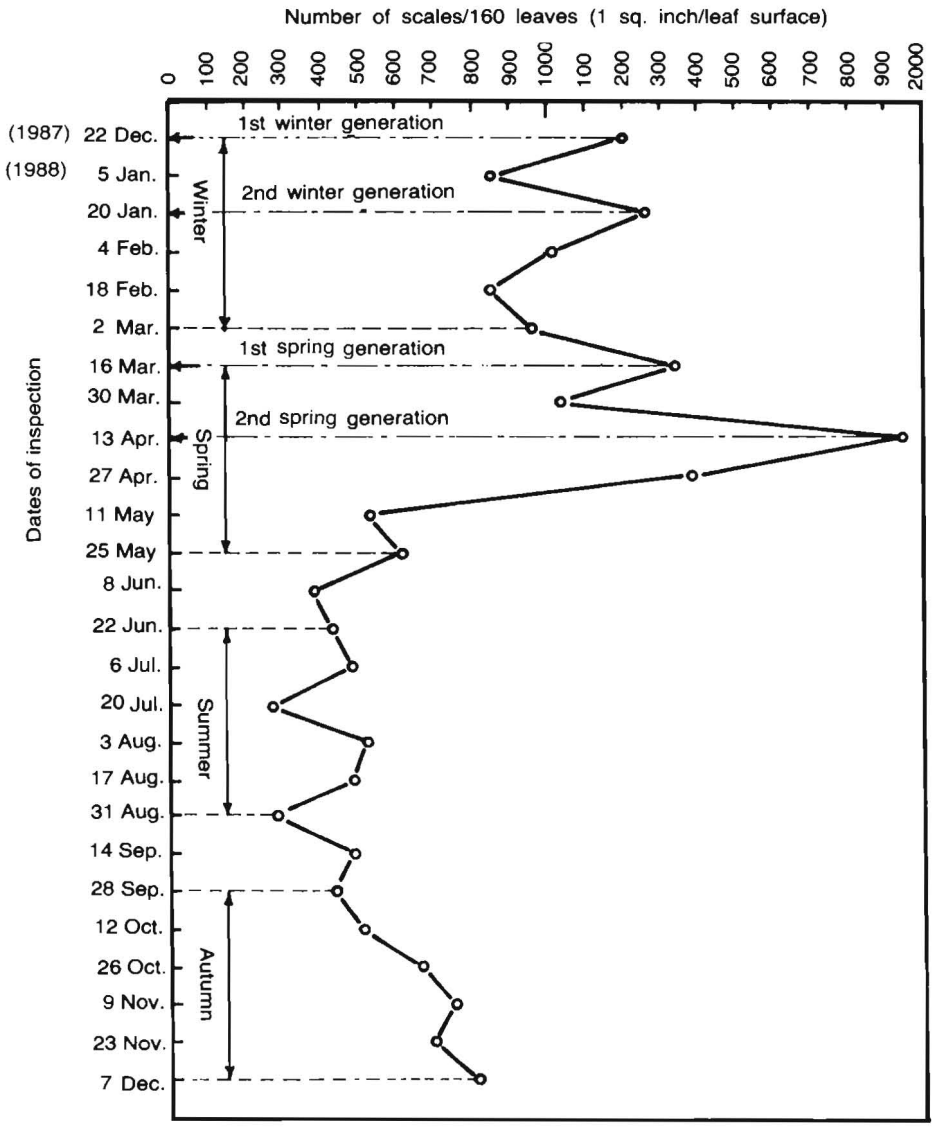


**Fig. 1.** Seasonal fluctuations of *A. orientalis* population on leaves of *F. nitida* trees throughout the year 1987-1988.

2. *Factors affecting the seasonal abundance:*

The effects of temperature (maximum, minimum and mean), relative humidity, rainfall and wind direction on the population of this insect were discussed.

*(a) Effect of temperature:*

Temperature was negatively and significantly correlated with the population of alive insects. Values of (r) for the maximum (−0.6667) and mean temperatures (−0.5995) were highly significant, that of the mean temperature (−0.4912) was significant at 5% level only.

Under local conditions of the Central region of Saudi Arabia (arid zone), high summer temperature which may rise up to 50°C seems to be more critical to scale insects and can be regarded as one of the main factors determining its distribution and abundance.

*(b) Effect of relative humidity:*

Records of the relative humidity indicated that the locality is characterized by an extremely dry climate. It reached its absolute maximum (65.4%) at the beginning of December 1988 and for a very short period not exceeding one week, and attained its absolute minimum (20.9%) at the end of August. The relative humidity proved to have a slight positive effect on the population of this insect; value of (r) obtained (0.4897) was significant at 5% level of probability.

*(c) Effect of rainfall:*

The total amount of rain that fell down throughout the year was 128.2 mm over a period of 112 days from January 5 to April 27, 1988. Rainfall seems to have no significant effect on the population (r=0.2813).

*(d) Effect of wind direction:*

The distribution of scales on leaves of the four cardinal quadrants of trees during the four seasons was affected by wind direction. As a general rule, the sides of trees facing the wind always harboured a relatively lower scale population (Fig. 2). This comes in agreement with the findings of Bodenheimer (1930) and Bodenheimer and Steinitiz (1937) who stated that crawlers of the purple scale, *Lepidosaphes beckii* were forced to drift by wind and shelter in more protected zones.

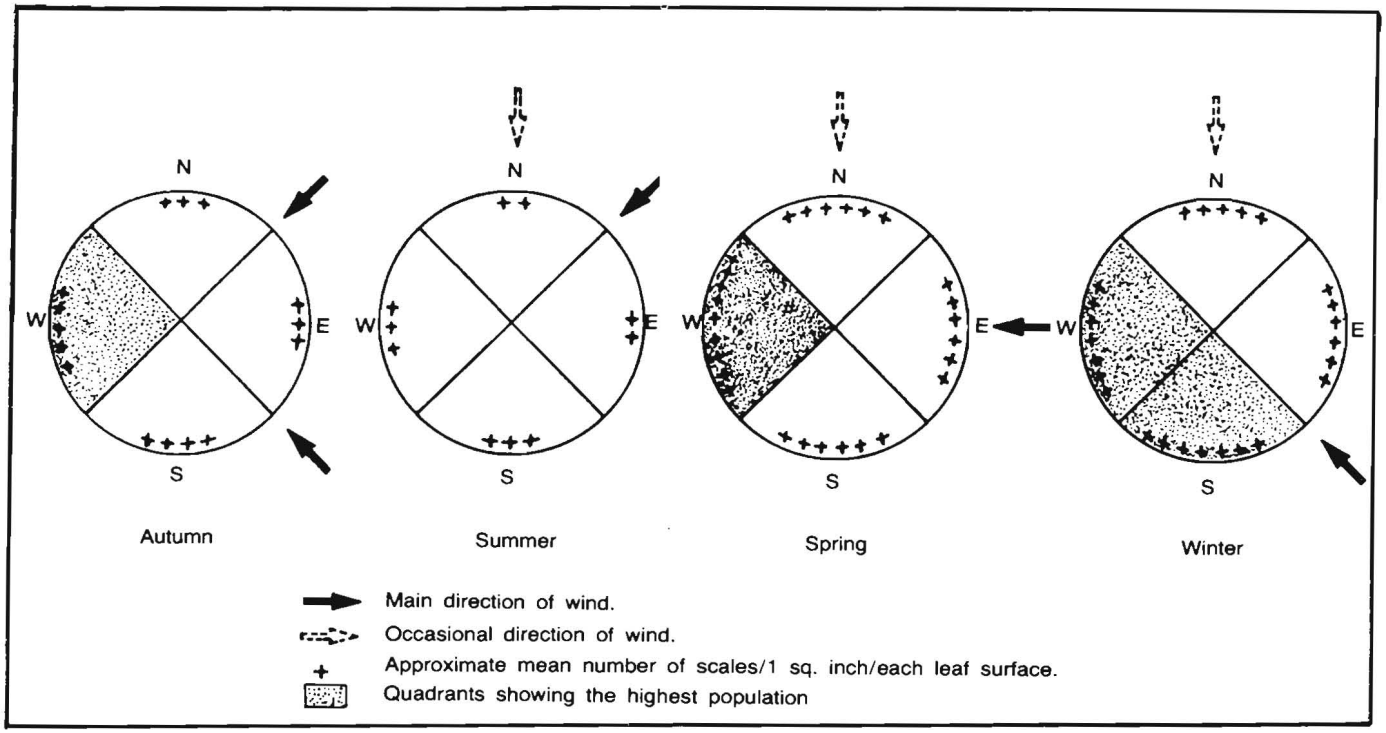


**Fig. 2.** Effect of wind direction on the distribution of *A. orientalis* scales in the four cardinal quadrants of *F. nitida* trees.

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# ديناميكية التعداد للحشرة القشرية الشرقية والعوامل المؤثرة على وفرتها الموسمية

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أجريت دراسات عن ديناميكية التعداد للحشرة القشرية الشرقية والعوامل التي تؤثر على وفرتها الموسمية خلال العام ١٩٨٧ ـ ١٩٨٨ عن طريق أخذ عينات عشوائية من الأوراق المصابة كل أسبوعين تقريباً من ٤ أشجار من الفيكس نتدا بمحطة التجارب الزراعية بمنطقة ديراب وحصر الحشرات الحية على بوصة مربعة لكل سطح من سطحي كل ورقة.

وقد لوحظ وجود أربع ذروات واضحة (تمثل ٤ أجيال سنوياً). اثنان منها خلال فصل الشتاء ومثلهما في الربيع. وقد انخفض تعداد الحشرة إلى أقل مستوى له خلال شهور الصيف، ربما بسبب الحرارة الشديدة والجفاف اللذين يسودان خلال هذه الفترة من السنة. وكانت هناك زيادة مضطردة في تعداد الحشرة خلال فصل الخريف لتظهر أول ذروة في بداية الشتاء.

كانت هناك علاقة سالبة معنوياً بين تعداد الحشرة ودرجات الحرارة فقد بلغت قيمة معامل الإرتباط لدرجتي الحرارة القصوى والمتوسطة (ـ ٠,٦٦٦٧ ـ ـ ٠,٥٩٩٥ على التوالي) وهي معنوية على مستوى ١ ٪. ولم يكن لمعدل سقوط

الأمطار تأثير واضح على تعداد الحشرة بينما كانت العلاقة مع الرطوبة النسبية موجبة على مستوى ٥ ٪ فقط. وكقاعدة عامة احتوت جوانب الأشجار المعرضة للرياح عدداً أقل من الأفراد عن الجوانب المقابلة لها. ويبدو أن الأفراد حديثة الفقس تُجبر على التحرك إلى أماكن أكثر حماية بفعل الرياح.