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# EFFECT OF *AONIDIELLA AURANTII* INFESTATION ON LEAF COMPONENTS AND FRUIT QUALITY OF TWO ORANGE VARIETIES.

BY

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## ABSTRACT

This study was carried out in Beni-Suef Governorate in 2001- 2003 at two locations (the first cultivated with Navel and the second with Valencia oranges) to determine the effect of the red scale, *Aonidiella aurantii* (Maskell) infestation. The damage was estimated as reduction in leaf area, leaf dry components (i.e. nitrogen, phosphorus and potassium), mean fruit weight, juice volume, total soluble solids, ascorbic acid, acidity and yield per tree.

Mean infestation levels by *A. aurantii* on Navel and Valencia oranges over one year prior to harvest, were 19.48 and 18.95 scale/leaf, respectively.

Reported percent reductions in case of Navel oranges were 12.4% for leaf area, 10.45, 14.44 and 11.03% for nitrogen, phosphorus, potassium, respectively. Yield per tree was reduced by 27.15%. Mean fruit weight, juice volume, total soluble solids, ascorbic acid were reduced by 25.3, 25.23, 23.66 and 12.66%, respectively. Acidity on the contrary was increased by 16.34 %, compared with the uninfested ones.

For Valencia oranges reduction vales were 18.25% for leaf area, 13.81. 19.32, and 21.8% for nitrogen, phosphorus, potassium, respectively. Yield per tree was reduced by 31.14%. Mean fruit weight, juice volume, total soluble solids, ascorbic acid were reduced by 27.24. 26.6, 20.84 and 33.86%, respectively. Acidity on the contrary was increased by 26.96 %, compared with the uninfested ones.

The results indicated that, the reductions in Valencia orange, was higher than that of Navel ones.

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**Key Words:** *Aonidiella aurantii*, infestation, orange trees, fruit quality.

## INTRODUCTION

*Citrus sinensis* (oranges) (Family Rutaceae) is the first in Egyptian citrus industry The area cultivation is about 199,000 feddans producing about

1,808,600 tons. The area cultivation with Navel and Valencia oranges are about 108,700 and 48,400 feddans producing about 1,008,500 and 433,600 tons, respectively (Anonymous, 2002).

Citrus trees are subject to armored scale insects (family Diaspididae) attack (i.e. *Lepidosaphes beckii* (Newm.), *Aonidiella aurantii* (Mask.), *Parlatoria oleae* (Colvee), *Chrysomphalus aonidum* (L.), *Mycetaspis personata* (Comstock), *Parlatoria ziziphi* (Lucas), *Aonidiella orientalis* (Newstead), *Parlatoria pergandii* (Comstock) (Willcocks 1922, Hall 1922-23-24, Priesner and Hosny 1932 and Ghabbour and Mohammad 1996).

California red scale, *A. aurantii* attacks all aerial parts of the tree including twigs, leaves, branches, and fruits. It feeds on the plant sap with its filamentous mouthparts. Heavily infested fruits may be downgraded in the packinghouse and if population levels are high, serious damage can occur to trees. Severe infestation causes leaf yellowing and drop, dieback of twigs and limbs, and occasionally death of the tree (Hassan 1993).

Tawfik (1985) reported that heavy citrus infestation with *P. ziziphi* affected juice volume, fruit fresh weight, causing loss percentage of 38.93 and 22.72%, respectively. Tawfik (1996) reported that infestation with *L. beckii* reduced orange fruits fresh weight, juice volume, and ascorbic acid contents, while acidity increased as a result of infestation. Tawfik and Swietlik (1996) carried out an experiment in Texas USA, to clarify the injury of sweet potato white fly, *Bemisia tabaci* (Gennadius) (Homoptera: Aleyrodidae) on the chemical composition of grapefruit and Naval orange leaves taking into consideration N, P, K, Mn, Fe, Zn, Cu and leaf area. The concentrations of these elements were determined and the rate of loss due to different levels of infestation was estimated. Significant differences between the levels of infestation were found with N, Mn and P, while there was no significant deference in the amounts of K and Cu.

Apple fruit characters (i.e. fruit weight, height and length were significantly affected by *P. oleae* infestation level. Fruits juice acidity was not significantly affected (Mohamed 2004).

This work aims to clarify the effect of *A. aurantii* infestation on leaf area, leaf dry components (i.e. nitrogen, phosphorus and potassium), as well as fruit quality and to obtain better information on the impact of feeding by this pest in order to minimize the extent of the invisible injuries of scale insects Navel and Valencia oranges yield.

## MATERIAL AND METHODS

This study was carried out in Beni-Suef Governorate in 2001- 2003 year at two locations (the first cultivated with Navel and the second cultivated with Valencia orange) to demonstrate the effect of the red scale *A. aurantii* infestation

on leaf area, leaf dry components (i.e. nitrogen, phosphorus and potassium), as well as fruit quality and yield per tree.

Blocks of six trees each were selected to present the following status:
(1) uninfested navel orange.
(2) infested navel orange.
(3) uninfested valencia orange.
(4) infested valencia orange.

The first and third blocks were almost free of infestation and were sprayed by insecticide to keep it with no infestation.

Each block was divided into three sub-blocks for replication of samples.

Samples of orange leaves were picked up at monthly intervals through out the year of study. Sample size was 20 leaves from terminal branches. All alive insects (as pre-adult and adult females) found in each sample were counted and recorded.

Individual samples consisted of 20 leaves (five months age) per replicate, (Chapman and Brown, 1950; Reuther and Smith, 1954) from non-fruiting terminal branches (Harding *et al.*, 1962). Leaves were taken from all sides of the tree between 0.6 and 2 m above the ground. The red scale insects were removed using smooth brush before washing. Samples were analyzed at Horticultural Research Institute. Drying and grinding of leaf samples was handled as described by Leyden (1963).

Leaf tissue was digested in a nitric and perchloric acids mixture and analyzed for potassium on an atomic absorption spectrophotometer.

Phosphorus was determined in the same digested solution using the chlorostannous-reduced molybdo-phosphoric blue color method (Jasckson, 1958).

Nitrogen was determined by the Kjeldahl's method following sulfuric acid digestion.

Samples consisted of 20 leaves from infested and uninfested trees (first leaf at terminal branch bases from all sides) were picked up to be measured leaf area in $cm^2$ using a plane-meter.

For yield estimation, the selected sub-block trees were harvested, weighted and recorded. Random fruit samples were taken from every sub-block for evaluation. Mean fruit weight was determined by weighting the 20 fruits and calculating the average.

For juice volume, fruit samples per sub-block were squeezed and the produced juice was measured using graduated cylinder.

Total soluble solids of juice: was determined using an Abbe refractometer.

Total acidity was calculated in terms of acid with 0.1 N Sodium hydroxide using phenolphthalein as indicator.

Ascorbic acid was determined using the method of Locaus (1944), by titrating 10 ml of juice with a standardized dichlorophenol dye solution after adding 5 ml of 2 % oxalic acid solution.

Statistical analysis using t-test was used to clarify the significance of loss between uninfested and infested with Navel and Valencia oranges.

## RESULTS& DISCUSSION

Results in Table (1) show monthly counts of *A. aurantii* on each leaf sample of Navel and Valencia oranges (one year before harvest) during 2001-2002 season at Beni-Suef Governorate. The counts of *A. aurantii* (as pre-adult and adult females) on Navel oranges began from Jan. to Dec. 2001, while the counts on Valencia oranges began from May, 2001 to Apr., 2002. Monthly total counts of *A. aurantii* ranged between 30.67 – 8.48 (mean 19.48) and 29.61– 8.44 (mean 18.95) scale/leaf for Navel and Valencia oranges, respectively.

**Table (1): Mean counts of *A. aurantii* on each leaf sample of Navel and Valencia oranges (one year before harvest) during 2001-2002.**

| Date | Navel | | | Date. | Valencia | | |
|---|---|---|---|---|---|---|---|
| | Pre-adult | Adult females | Total | | Pre-adult | Adult females | Total |
| Jan.2001 | 0.69 | 8.86 | 9.55 | May.2001 | 10.85 | 5.18 | 16.03 |
| Feb. | 0.54 | 11.82 | 12.36 | Jun. | 13.91 | 13.63 | 27.54 |
| Mar. | 18.35 | 11.49 | 29.84 | Jul. | 20.35 | 9.26 | 29.61 |
| Apr. | 19.25 | 3.58 | 22.83 | Aug. | 4.56 | 6.45 | 11.02 |
| May. | 9.58 | 3.90 | 13.48 | Sept. | 14.33 | 5.38 | 19.71 |
| Jun. | 12.64 | 12.35 | 24.99 | Oct. | 18.49 | 8.31 | 26.80 |
| Jul. | 19.07 | 11.60 | 30.67 | Nov. | 6.11 | 9.26 | 15.37 |
| Aug. | 3.30 | 5.18 | 8.48 | Dec.2001 | 3.93 | 19.66 | 23.58 |
| Sept. | 13.06 | 4.11 | 17.17 | Jan.2002 | 0.99 | 8.42 | 9.41 |
| Oct. | 17.20 | 7.01 | 24.22 | Feb. | 0.74 | 7.71 | 8.44 |
| Nov. | 4.83 | 7.99 | 12.82 | Mar. | 15.26 | 11.40 | 26.65 |
| Dec.2001 | 2.68 | 18.37 | 21.04 | Apr.2002 | 15.93 | 3.67 | 19.59 |
| Mean | 10.45 | 9.03 | 19.48 | Mean | 10.10 | 8.86 | 18.95 |

Obtained results (Table 2) indicated that this level of infestation with *A. aurantii*, (presented in Table, 1), affected significantly on leaves area ($cm^2$) in both Navel &Valencia orange trees. The recorded losses were 12.4 and 18.25%, respectively.

Tawfik and Switlik (1996) reported reduction of leaf area of Navel orange was in relation to infestation level with *B. tabaci*. Reduction reached 50% with highest level of infestation with *B. tabaci*.

Mohamed (1999) reported that infestation with *H. latania* on two varieties of olive trees caused reduction in leaves area of about 5%.

Radwan (2003) reported that infestation with *Pulvinaria psidii* Maskell (Homoptera: Coccoidae) on Mango and Guava young leaf area, caused reduction of 28 and 32.97 %, respectively.

Results in Table (2) also, show that the contents of the leaves from N. P. K. elements were affected by that level of infestation. The recorded reduction were 10.45, 14.44 and 11.03 % for N, P and K respectively (in case of Navel orange leaves) and 13.81, 19.32 and 16.86 % (in case of Valencia orange leaves), respectively. This indicated that Valencia orange leaves were more affected by infestation with *A. aurantii* than Navel orange leaves.

Tawfik (1985) stated that there were significant decreases in N.P.K. elements in leaves of orange as result of being infested with *P. ziziphi*, reached 22.17, 32 and 29.62%, respectively.

Tawfik (1996) results indicated significant decreases in case of N and P in Navel orange reached 28.62 and 25 % as result of infestation with *L. beckii*. The reduction of K element was insignificant. In case of Valencia orange the reduction reached 22.87, 38.57 and 27.26 % for N. P. K., respectively.

Tawfik and Switlik (1996) reported gradual decreases in N. P. K. elements according to infestation level with *B. tabaci* on Navel orange to reach 10.8, 27.7 and 30.04 %, respectively.

Mohamed (1999) recorded an increase in the level of P and K in olive leaves, when infested with *H. latania* as 11.83 and 28.91%, respectively compared with free ones.

Data presented in Table (3) clearly show that reduction in yield per tree (Kg) were 27.15 and 31.14 % for Naval and Valencia. Mohamed (2004) reported significant yield reduction of apple trees as result of infestation with *P. oleae*. The reduction reached 49.39%. Yield reduction was in correlation with the degree of infestation (using three levels and a control).

Results of the same Table reveal that the decrease in fruit weight (gm) was 25.3 and 27.24% for Naval and Valencia, respectively. Tawfik (1996) recorded reduction of 26.82 and 12.94% in fruit weight of two citrus varieties (Navel and Valencia oranges) as a result of sever infestation by *L. beckii*. respectively.

**Table (2): Effect of *A. aurantii* on leaf area and certain components of two orange varieties.**

| Orange variety | | Leaf area ($cm^2$) | | | N % | | | P % | | | K % | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mean | Loss % | t | Mean | Loss % | t | Mean | Loss % | t | Mean | Loss % | t |
| Navel | Uninfested | 26.48 | 12.4 | 4.231** | 2.743 | 10.45 | 4.47** | 0.161 | 14.44 | 3.382* | 0.87 | 11.03 | 4.68** |
| | Infested | 22.67 | | | 2.453 | | | 0.138 | | | 0.779 | | |
| Valencia | Uninfested | 31.03 | 18.25 | 6.298** | 2.977 | 13.81 | 7.13** | 0.167 | 19.32 | 3.818** | 0.919 | 21.8 | 16.86** |
| | Infested | 25.36 | | | 2.566 | | | 0.135 | | | 0.764 | | |

**Table (3): Effect of *A. aurantii* on yield and fruit quality of two orange varieties.**

| Orange variety | | Yield per tree (kg) | | | Fruit weight (gm) | | | Juice volume (ml/ fruit) | | | Total Soluble solids % | | | Ascorbic acid (mg / 100 ml) juice | | | Acidity % | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mean | Loss % | T | Mean | Loss % | t | Mean | Loss % | t | Mean | Loss % | t | Mean | Loss % | t | Mean | Loss % | t |
| Navel | Uninfested | 69.08 | 27.19 | 18.82** | 229.2 | 25.3 | 3.270* | 69.18 | 25.23 | 8.63** | 12.59 | 23.66 | 6.56** | 50.71 | 12.66 | 4.71** | 0.685 | -27 | 6.23** |
| | Infested | 50.32 | | | 171.2 | | | 51.73 | | | 9.61 | | | 44.29 | | | 1.121 | | |
| Valencia | Uninfested | 72.64 | 31.14 | 19.38** | 196.3 | 27.24 | 2.824* | 73.71 | 26.6 | 8.03** | 11.66 | 20.84 | 39.19** | 61.77 | 33.86 | 22.5** | 1.743 | -16.3 | 9.69** |
| | Infested | 50.74 | | | 142.5 | | | 54.38 | | | 9.23 | | | 50.85 | | | 2.213 | | |

Mohamed (2004) mentioned that fruit weight of apple trees was reduced as result of infestation with, *P. oleae*. Reduction was 19.23, 37.42 and 46.23 according to infestation level.

Also, Table (3) included that loss percent of juice volume (ml/fruit), total soluble solids (%) and ascorbic acid (mg/100 ml of juice) were affected by this level of infestation as 25.23, 23.66, 12.66 and 26.6, 20.84, 33.86 % for Naval and Valencia, respectively. Tawfik (1996) reported that reduction of juice volume, total soluble solids and ascorbic acid contents, were 20.89, 20.73 and 13% of Navel orange with infested by *L. beckii*, respectively. These values were 12.94, 10.79 and 8.38% in case of Valencia orange.

Fruit juice acidity increased as result of this level of infestation. The increase in acidity was 26.96 and 16.34 % for Naval and Valencia orange fruits, respectively. Tawfik (1996) reported an increase in acidity of orange juice with the increase in infestation level of *L. beckii* on two citrus varieties (Navel and Valencia oranges). Mohamed (2004) recorded the same results on apple trees infested with *P. oleae*. Opposite results were obtained for extracted olive oil from infested trees with *H. latania* or *P. oleae*. Infestation by both scale insects did not affect the extracted oil acidity (Mohamed (1999) and Mohamed (2002)).

Obtained results indicated that reduction of Valencia orange characters were more than Navel orange when infested with *A. aurantii*. Tawfik (1996) found that reduction of fruit weights, juice volume, total soluble solids and ascorbic acid of Navel orange was more than Valencia orange, infested with *L. beckii*

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## تأثيرالإصابه بالحشرة القشرية الحمراء على مكونات الورقة وصفات الثمرة لصنفي برتقال أبوسرة والصيفى.

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أجريت هذه الدراسة فى منطقتين بمحافظة بنى سويف فى الفترة من ٢٠٠١-٢٠٠٣ الأولى منزرعة بصنف برتقال أبوسرة والثانية منزرعة بصنف الصيفى ، لدراسة تأثير الإصابة بالحشرة القشرية الحمراء على مساحة الورقة ومحتوى الورقة الجافة من عناصر (النيتروجين، الفسفور والبوتاسيوم)، بالإضافة الى صفات الثمرة مثل (وزن الثمرة، حجم عصيرالثمرة ، نسبة المواد الصلبة الذائبة الكلية، نسبة فيتامين ج ونسبة الحموضة) ومحصول الشجرة.

ولقد أوضحت النتائج أن متوسط مستوى الإصابة بالحشرة القشرية الحمراء على كل من الصنفين أبوسرة والصيفى على مدار سنة قبل جمع المحصول كانت ١٨,٩٥ و١٩,٥٨حشرة/ ورقة على التوالى.

كما وجد أن نسب النقص فىالصنف أبوسرة كانت ١٢,٤ % فى مساحة الورقة، و١٠,٤٥، ١٤,٤٤و١١,٠٣%، فى نسب النتروجين، الفسفور، والبوتاسيوم على الترتيب. وكان النقص فى محصول الشجرة ٢٧,١٥%، أما النقص فى متوسط وزن الثمرة وحجم العصير والنسبة المئوية للمواد الصلبة الذائبة الكلية وفيتامين ج فكانت ٢٥,٣، ٢٥,٢٣، ٢٣,٦٦و١٢,٦٦%على الترتيب. ولكن حدث زيادة فى الحموضة مقدرها ١٦,٣٤% عند هذا المستوى من الإصابة بالحشرة القشرية الحمراء مقارنة مع أشجار أخرى غير مصابة.

أما عن نسب النقص فىالصنف صيفى كانت ١٨,٢٥ % فى مساحة الورقة، و١٣,٨١، ١٩,٣٢و٢١,٨%، فى نسب النتروجين، الفسفور، والبوتاسيوم على الترتيب. وكان النقص فى محصول الشجرة ٣١,١٤%، وأما النقص فى متوسط وزن الثمرة وحجم العصير والنسبة المئوية للمواد الصلبة الذائبة الكلية وفيتامين ج فكانت ٢٧,٢٤، ٢٦,٦، ٢٠,٨٤و٣٣,٨٦%على الترتيب. ولكن أيضا حدث زياده فى الحموضة مقدرها ٢٦,٩٦% عند هذا المستوى من الإصابة بالحشرة القشرية الحمراء مقارنة مع أشجار أخرى غير مصابة.

كما أوضحت النتائج أن نسب النقص فى صفات صنف الصيفى كانت أعلى منها فى صنف أبوسرة عند هذا المستوى من الإصابة بالحشرة القشرية الحمراء.