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The negative effects of *Parlatoria blanchardii* (Targ.) infestation on the morphological and chemical characters of certain varieties leaflets of date palm trees at Luxor governorate, Egypt.

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ABSTRACT

The present investigation was carried out at Esna distract, Luxor governorate on 15 September 2011 to evaluate the negative effects of the infestation by *Parlatoria blanchardii* (Targ.) on the mineral nutrients contents (macronutrient and micronutrient) of certain date palm varieties leaflets. Date palm varieties named White (local name), Seedy Balady, Gendeila, Malakaby and Shamia. The obtained results revealed that the uninfested date palm leaflets were significantly higher when found in fresh weight, weight after one hour of drying, dry weight, moisture content, epicuticular wax, leaflet area, specific leaflet area and photosynthetic pigments than the infested ones for the all tested varieties. In contrast, the dry matter, loss moisture content and specific leaflet weight were significantly increasing in the infested leaflets compared to uninfested ones. White date palm variety was considered the greatest infestation with *P. blanchardii*, exhibiting the highest percentage of reduction in the moisture content, epicuticular wax, leaflet area, specific leaflet area and chlorophyll (a) and carotenoids, and exposed the least percentage of reduction in the dry matter, % lost moisture and specific leaflet weight in the infested leaflets compared with the uninfested ones. The loss in the measured parameters was a summation of many factors including insect infestation, time of infestation and variety. The relative role of these factors may differ among different varieties.

Keywords: *Parlatoria blanchardii*, date palm varieties, epicuticular wax, leaflet weight, leaflet area, plant pigments and dry matter, moisture content and percentage of reduction.

INTRODUCTION

Among several pests, infest date palm trees, white date palm scale insects are the key pests. Adults and nymphs of this insect feed on leaves sap, sucking great amount of nitrogen and macro-and micro-elements. At high level of infestation with this scale insect, remarkable damage occurs, resulting in early leaves drop and yield reduction (El-Said, 2000). In addition to the insect secretion of the toxic saliva that resulted in malformed leaf and shoot growth (Fisheries and Foresty, 2008). Due to the great damage that can be done by the scale insect not only by sucking the plant sap that give low photosynthesis and respiration which leads to curling, yellowing, and dropping of leaves, but also malformations, dwarfing, decreasing or destroying chlorophyll, impairing photosynthesis and productivity and subsequently, causeing considerable quality and quantity yield losses and also marketing value of the fruits. A characteristic symptom of infestation with *P. blanchardii* is the appearance and accumulation of its scales on attacked palm parts (El-Said, 2000, El-Sherif *et al*., 2001 and Blumberg, 2008).

So this study was carried out to evaluate the adverse impact of the effect of *P. blanchardii* infestation on morphological and chemical characters of date palm leaflets of date palm trees. Therefore, this study was carried out to evaluate the adverse impact of the infestation with this scale insect on the epicuticular wax, leaflet weight (fresh and dry), leaflet area, specific leaflet area, specific leaflet weight, plant pigments and dry matter, moisture and loss moisture content percentage on leaflets of five date palm varieties.

MATERIALS AND METHODS

Study site:

The present investigation was conducted at Esna district, Luxor Governorate on 15 September 2011 to study the effect of *P. blanchardii* infestation on chemical physiological and morphological characters of date palm leaflets of five date palm varieties. These varieties named. White (local name), Seedy Balady, Gendeila, Malakaby and Shamia. Preliminary studies revealed that the months in autumn, which were more suitable for the insect activity. (El-Said, 2000 and El-Sherif *et al*. 2001). An orchard about three feddan was used to conduct this study. The selected date palm trees received the normal agricultural practices without pruning the fronds and application any chemical control measures before and during the period of investigation.

Six trees from each variety (three uninfested and three infested trees), ten leaflets were taken from every tree. However, some other trees are not infested. The uninfested and infested trees as uniform as possible and nearly similar in age (5 years), size, shape, height, vigor and homogeneous in their infestation with this scale were selected as representative of the whole orchard. All samples of leaflets were randomly taken from the all parts of tree and kept in the field under the natural environmental conditions and picked an (15 September 2011) from medium age leaflets (two year old). The young leaf age is more productive and efficient as well as contains higher chlorophyll content that resulted in maximizing accumulation of most nutrients. The visual symptoms of chlorosis appeared on the infested leaflets. The infested date palm leaflets as well as the uninfested ones were collected for chemical and morphological characters measurements.

1- Chemical measurements:

1.1- The moisture, dry matter and loss moisture content percentage were calculated using the following equations:

$$\text{- Moisture (\%)} = \frac{\text{Weight before drying} - \text{Weight after drying}}{\text{Weight before drying}} \times 100$$

$$\text{- Dry matter (\%)} = \frac{\text{Average dry weight (g)}}{\text{Average fresh weight (g)}} \times 100$$

Thus, Dry matter (%) = (100 - %Moisture).

- The lost moisture percentage:

The loss moisture percentage in leaflet was calculated, the fresh healthy (uninfested) and infested of leaflets were taken and washed with tap water and then with distilled water to remove the dust and any residues. The fresh weights of leaflets were recorded. After that dried in air for 1 hour and recorded the weight. After that

dried in an electric oven at 70ºC for 48 hour**.** The dry weights of leaflets were recorded. (According to Brainerd, and Fuchigami,1981).

$$\text{Lost moisture (\%)} = \frac{\text{Fresh weight – Weight after one hour}}{\text{Fresh weight -Weight after drying}} \times 100$$

1.2- Wax content in leaflet:

For quantitative of epicuticular waxes, the outermost fresh healthy (uninfested) and infested of leaflets of similar age were taken and washed in Chloroform for 15 seconds (Schuck, 1976). The chloroform extracts were filtered in order to calculate the wax content g/g of leaflet.

2- Leaf measurements and pigment determination:

2.1- Leaf measurements:

1. Leaflet area (m^2): was measured by using a leaflet area meter and was calculated according to the equation reported by Ahmed and Morsy (1999).

Leaflet area (cm^2) = 0.37 (Length x Width) + 10.29.

The area for the whole leaf (m^2) was obtained from multiplying the leaflet area by the number of leaflet per leaf.

2-Specific leaflet area (SLA):

$$\text{SLA (cm}^2\text{/g)} = \frac{\text{leaflet area (cm}^2\text{)}}{\text{leaflet dry weight (g)}}$$

3-Specific leaflet weight (SLW):

$$\text{SLW (g/cm}^2\text{)} = \frac{\text{leaflet dry weight (g)}}{\text{leaflet area (cm}^2\text{)}}$$

2.2- <u>Plant pigments</u>: The chlorophyll a, b and total carotenoids were extracted from one $inch^2$ of longitudinal sections of fresh leaflets in 85% acetone as reported by Lichtenthaler and Wellburn (1983). Chlorophyll a, b and carotenoids were measured by Spectrophotometer Double beam CECIL (CE 7400) England at wave lengths 663, 646 and 470 nm, respectively. Moreover, the concentrations of chlorophyll a, b and carotenoids were calculated using the following equation**:**

Chl. a = 12.21 A_{663}– 2.81 A_{646}.

Chl. b = 20.131 A_{646} – 5.03 A_{663}.

Total carotenoids = (1000 x A_{470} – 3.27 chl. a – 104 chl. b)/198

All samples of leaflets transferred to the central laboratory for Chemical Analysis, Horticulture Research Institute, A.R.C, Ministry of Agriculture in Giza. These analyses may be an indication that may attract the scale insect and be responsible to heavy scale infestation.

The amount of damage and losses of parameters due to scale insect was calculated according to the following equation**:**

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

Which: **A**= uninfested **B**= infested

Statistical analysis in the present work was carried out with Computer using (MSTATC Program).

RESULTS AND DISCUSSION

1- Real effect of infestation on the weight and chemical measurements in date palm leaflets:

1.1- Effect of infestation on the leaflet weight:

A- Effect of infestation on the fresh weight:

Results depicted in Table (1) showed that the fresh weight for infested leaflets of each date palm varieties. Malakaby and Shamia leaflets had the greater weight in fresh leaflets (3.56 and 3.40 g). In contrast, Seedy Balady was the less weight in fresh leaflets (3.197 g). The statistical analysis of data revealed that there were significant differences in the fresh weight between the infested leaflets for all tested varieties (L.S.D. was 0.180). Results in Table (2) showed that the uninfested date palm leaflets had significantly higher weight in fresh leaflets than the infested ones (3.57 compared to 3.37 g as a general average for the all tested varieties). Also, fresh weight from the infested leaflets lost about 5.8% from their weight as compared with the uninfested leaflets.

Table 1: Effect infestation by *Parlatoria blanchardii* (Targ.) (Homoptera: Diaspididae) on the leaflet weight, area, pigments and dry matter and moisture content in infested leaflets of five date palm varieties at Esna district, Luxor Governorate.

Parameters / Varieties	Mean of												
	Weight			Percentage			Wax content g/g of leaflet	Leaf measurements			Plant pigments (mg/ inch f.w) of leaflets		
	Fresh (g)	After hour (g)	Dry (g)	Dry matter	Moisture	% lost moisture		Leaflet area (cm2)	SLA (cm2/g)	SLW (g/cm2)	Chl (a)	Chl(b)	Carote--noids
White	3.35 b	3.08 b	1.61 a	48.16a	51.84 c	15.61 a	0.0203 b	42.79 a	26.48 a	0.0382 b	0.868 e	0.553e	0.327 e
Balady	3.19 b	2.94 b	1.51 a	47.24 a	52.76b	15.3 a	0.0232 a	28.85 c	19.11b	0.0524 a	0.988 d	0.631 d	0.526 c
Gendeila	3.33 b	3.08b	1.507b	45.25b	54.75b	13.96 b	0.0235 a	44.38 a	29.47a	0.0341 b	1.05 c	0.671c	0.492 d
Malakaby	3.56 a	3.28 a	1.58 a	44.4 b	55.61 a	14.4 a	0.0217 b	36.34 b	23.06b	0.0436 a	1.317 b	0.841a	0.701 a
Shamia	3.40 a	3.14 a	1.45b	42.8 b	57.19 a	13.45 b	0.0228 b	38.04 a	26.241a	0.0389 b	1.378 a	0.824 b	0.582 b
Mean	3.377	3.11	1.532	45.57	54.43	14.5467	0.0223	38.08	24.87	0.041	1.120	0.704	0.526
L.S.D. between varieties	0.180	0.167	0.104	2.749	2.738	1.577	0.00033	7.391	5.073	0.010	0.016	0.012	0.008

Table 2: Mean of the leaflet weight, area, pigments and the percentages of dry matter and moisture in uninfested leaflets of five date palm varieties at Esna district, Luxor Governorate.

Parameters / Varieties	Mean of												
	Weight			Percentage			Wax content g/g of leaflet	Leaf measurements			Plant pigments (mg/ inch^2 f.w) of leaflets		
	Fresh (g)	After hour (g)	Dry (g)	Dry matter	Moisture	% lost moisture		Leaflet area (cm2)	SLA (cm2/g)	SLW (g/cm2)	Chl (a)	Chl (b)	Carote--noids
White	3.593 a	3.336 a	1.657 a	46.28a	53.725 b	13.13 a	0.0215 d	57.926 a	35.028 a	0.0296 b	1.712 b	0.992 c	0.784 b
Balady	3.437 b	3.187 b	1.583 a	46.07 a	53.925 b	13.48 a	0.024 a	35.42 b	22.36 b	0.0462 a	1.562 d	1.044 b	0.704 d
Gendeila	3.48 b	3.234 b	1.545 a	44.41 a	55.59 a	12.73 a	0.0241 a	52.038 a	33. 7a	0.0299 b	1.266 e	0.766 d	0.516 e
Malakaby	3.752 a	3.50 a	1.607 a	42.79 a	57.20 a	11.7 a	0.0227 c	46.86 a	29.28 a	0.0343 a	2.403 a	1.6057 a	1.083 a
Shamia	3.607 a	3.36 a	1.5 b	41.58 b	58.421a	11.64 a	0.0234 b	43.763 b	29.23 a	0.034 a	1.594 c	1.0459 b	0.751 c
Mean	3.574	3.324	1.578	44.226	55.774	12.536	0.023	47.203	29.923	0.035	1.707	1.091	0.768
L.S.D. between varieties	0.219	0.177	0.132	4.163	4.163	3.831	0.0003	12.32	8.02	0.02	0.009	0.005	0.005

Significant differences among the uninfested leaflets were calculated for all tested varieties (L.S.D. was 0.219). It was also, noticed that the insect infestation exhausted about 6.98, 6.77, 5.68, 5.11 and 4.31 % in the fresh weight for the infested leaflets of Seedy Balady, White, Shamia, Malakaby and Gendeila varieties, respectively, (Table, 3 and Fig., 1).

B- Effect of infestation on weight after one hour of drying:

As shown in Table (1), data confirmed that the infested Malakaby and Shamia leaflets had the greater weight in dry leaflets after one hour in air (3.28 and 3.14 g). In contrast, the less weight was measured in White Gendeila and Seedy Balady date palm varieties (3.079, 3.076 and 2.938 g/g of leaflet). The statistical analysis of data revealed that there were significant differences in the weight in dry leaflets after one hour between the infested leaflets for all tested varieties (L.S.D. was 0.167). As well as, the uninfested leaflets for all tested varieties varied significantly (L.S.D. was 0.177), Table (2).

Results in Table (2) showed that the uninfested date palm leaflets had significantly higher weight in dry leaflets after one hour in air than the infested ones (3.324 compared to 3.102 g as a general average for the all tested varieties). Also, dry weight after one hour in air from the infested leaflets lost about 6.7% from their weight as compared with the uninfested leaflets (Table 3).

C- Effect of infestation on dry weight:

As reported in Table (1) showed that the dry weight for infested leaflets of each date palm varieties. White date palm leaflets had the greater weight in dry leaflets (1.613 g). In contrast, Shamia leaflets were the less weight in dry leaflets (1.453 g). Significant differences among in the infested leaflets were calculated for all tested varieties (L.S.D. was 0.104).

In all date palm varieties, uninfested leaflets smaller in dry weight (1.578 g) than the infested leaflets (1.533 g as a general average for the all tested varieties, Table, 2). Also, the dry weight of the infested leaflets was reduced by 2.9 % compared to the uninfested ones. The differences in the dry weight among uninfested date palm leaflets in all tested varieties were insignificant (expect Shamia variety), Table (2). Infestation by *P. blanchardii* caused a significant reduction in their dry weight by 4.63, 3.11, 2.62, 2.48 and 1.71 % in the infested leaflets of Seedy Balady, Shamia, White, Gendeila and Malakaby date palm varieties, respectively (Table 3 and Fig.1). This might be due to the drain of sucking sap assimilates towards the insect a way from the other pants parts which may contribute to metabolic reduction (Miles, 1989).

D- Effect of infestation on the dry matter content:

Dry matter refers to material remaining after removal of water. Data represented in (Table 1) cleared the relationship between the infestation by *P. blanchardii* and the percentage of dry matter in the infested leaflets for all date palm varieties. White date palm leaflets contained the highest percentage of dry matter (48.16 %) followed by seedy Balady (47.243 %). While, there were no significant differences between Gendeila, Malakaby and Shamia date palm varieties. The least percentage of dry matter was measured in Shamia date palm variety (42.81%).

White date palm variety was considered the greatest infestation with *P. blanchardii* (23.9 insect/leaflet) (Sabry, unpublished results), exhibiting the higher percentage (48.16% of dry matter) and exposed the highest percentage of increasing in dry matter (-4.07%) in infested leaflets compared with the uninfested ones.

Data obtained in Table (2) proved that in all varieties, the mean percentage of dry matter in the uninfested leaflets was lower (44.23 %) than the infested one (45.57 %). The percentage of dry matter was significantly higher in attacking leaflets by insect. The increasing was about 3 % in infested leaflets compared with the uninfested ones. There was insignificant difference between the uninfested leaflets in all tested varieties expect Shamia variety (L.S.D. value was 0.01), Table (2). Insect infestation caused increase the percentage of dry matter in infested leaflets for all tested varieties in the following descending order: White (-4.067 %), Malakaby (-3.722 %), Shamia

(-2.967 %), Seedy Balady (-2.53%), and Gendeila (-1.89%) (Table 3 and Fig. 1).

E- Effect of infestation on the moisture content:

The moisture content reflects the amount of water presence in the leaf ingredient. Because the moisture content affects the weight of the leaf, but does not provide nutrient value to the leaves. As shown in Table (1) revealed that the percentage of moisture in the infested leaflets of all date palm varieties. Shamia variety had the higher moisture content of leaflets (57.19%), followed by Malakaby (55.61%) than the other three date palm varieties. In contrast, White date palm leaflets were the less moisture content of leaflets (51.84 %).

However, this variety was considered the greatest infestation with *P. blanchardii* (23.9 insect/leaflet) (Sabry, unpublished results), exhibiting the smaller moisture content (51.8%) and exposed the highest percentage of reduction in moisture content of leaflets (3.5 %) in infested leaflets compared with the uninfested ones.

Significant differences among the infested leaflets were calculated for all tested varieties (L.S.D. was 2.76). Results in Table (2) showed that that the uninfested date palm leaflets had significantly higher moisture content than the infested ones (55.8 compared to 54.43 % as a general average for the all tested varieties). Also, moisture content from the infested leaflets lost about 2.4% as compared with the uninfested leaflets. Moreover, the feeding by *P. blanchardii* on date palm leaflets caused a significant reduction on the moisture content. The percentage of reduction in moisture content were 3.5, 2.78, 2.17, 2.11 and 1.51% in White, Malakaby, Seedy Balady, Shamia and Gendeila varieties, respectively (Table 3 and Fig. 1).

Table 3: The relationship between the rate of infestation by *Parlatoria blanchardii* (Targ.) and the percentage of reduction in each of the leaflet weight, area, pigments and dry matter and moisture content in infested leaflets of five date palm varieties at Esna district, Luxor Governorate.

Parameters / Varieties	Average number of insect per leaflet	Percentage of reduction in												
		Weight			Percentage			Wax content g/g of leaflet	Leaf measurements			Plant pigments (mg/ inch^2 fw) of leaflets		
		Fresh (g)	After hour (g)	Dry (g)	Dry matter	Moisture	% lost moisture		Leaflet area (cm2)	SLA (cm2/ g)	SLW (g / cm2)	Chl (a)	Chl (b)	Carote-noids
White	23.9	6.77	7.72	2.62	-4.07	3.50	-18.91	5.88	26.13	24.41	-29.14	49.30	44.25	58.31
Balady	15.7	6.98	7.80	4.63	-2.53	2.17	-13.57	3.07	18.57	14.53	-13.26	36.74	39.56	25.29
Gendeila	8.2	4.31	4.89	2.48	-1.89	1.51	-9.64	2.25	14.72	12.57	-13.98	17.12	12.45	4.48
Malakaby	17.2	5.11	6.43	1.71	-3.72	2.78	-23.11	4.44	22.46	21.23	-27.08	45.18	47.62	35.25
Shamia	12.9	5.68	6.59	3.11	-2.97	2.11	-15.56	2.76	13.08	10.24	-13.45	13.55	21.24	22.55
r =		0.71	0.80	-0.12	-0.90	0.97	-0.70	0.95	0.901	0.86	-0.80	0.87	0.85	0.99
b =		0.14	0.16	-0.02	-0.13	0.12	-0.63	0.24	0.84	0.89	-1.11	2.44	2.26	3.38
Standard Error		0.08	0.07	0.10	0.04	0.02	0.36	0.04	0.23	0.31	0.48	0.81	0.81	0.25
T value		1.77	2.29	0.20	3.52	7.00	1.72	5.52	3.60	2.92	2.34	3.00	2.78	13.3
Probability		0.15	0.08	0.85	0.02	0.00	0.16	0.005	0.02	0.04	0.08	0.04	0.05	0.00
y = a + bx		3.56 + 0.14 x	4.14 + 0.16 x	3.27 - 0.02 x	-1.00 - 0.13 x	0.50 + 0.12 x	-6.41 – 0.63 x	-0.11 + 0.24 x	5.88 + 0.84 x	2.71+ 0.89 x	-2.03 – 1.11 x	-5.56+ 2.44 x	-2.13 + 2.26 x	-23.55 + 3.38x
R^2		0.50	0.64	0.00	0.81	0.96	0.50	0.91	0.81	0.74	0.65	0.75	0.72	0.98
E.V.%		50.27	63.79	0.39	80.61	95.65	49.59	90.93	81.22	74.00	64.60	74.9	72.0	98.3

F- Effect on lost moisture content:

Concerning, the relationship between the infestation by *P. blanchardii* and the lost moisture content calculated in the infested leaflets for all tested varieties, Table (1).

White date palm leaflets contained the highest percentage of lost moisture (15.61%), followed by Seedy Balady was (15.3 %). While, the Shamia variety contained the smaller percentage of lost moisture (13.45%). The statistical analysis of data revealed that there were significant differences among infested leaflets were calculated for all tested varieties (L.S.D. was 1.58). Results in Table (2) cleared that uninfested leaflets had less percentage of lost moisture (12.54%) than the infested leaflets (14.5%). The increasing was about 16.2 % in infested leaflets compared with

the uninfested ones. Also, there were insignificant differences among uninfested leaflets for all tested varieties. As regarded to the effect of insect infestation on the lost moisture content, data published that this insect invasion promote lost moisture content by -23.11, -18.9, -15.56, -13.57 and -9.64 % increase in the infested leaflets of Malakaby, White, Shamia, Seedy Balady and Gendeila varieties, respectively (Table 3 and Fig. 1).

G- Effect on wax content in leaflet:

Plant protect themselves by the formation of a layer of lipid material called thick cuticle (a waxy outer layer) which reduce water loss and work as a defense against some insects (Taiz and Zeiger, 1998). Data in Table (1) revealed that the Gendeila leaflets were found to contain significantly higher in the wax content in leaflet (0.0235 g/g of leaflet) followed by Seedy Balady (0.0232 g). The least quantity was measured in Shamia, Malakaby and White (0.02275, 0.0217 and 0.02025 g/g of leaflet).

White date palm variety was considered the greatest infestation with *P. blanchardii* (23.9 insect/leaflet) (Sabry, unpublished results), exhibiting the smaller quantity in the wax content (0.02025 g) and exposed the highest percentage of reduction in the wax content (5.88%) in infested leaflets compared with the uninfested ones. The statistical analysis of data revealed that there were significant differences in wax content between all tested varieties in infested leaflets of date palm (L.S.D. was 0.0003). Results depicted in Table (2) showed that the infested date palm leaflets exhibited a decline in the quantity of epicuticular wax as compared to that of uninfested one (0.0223 compared to 0.0231 g/g of leaflet as a general average for the all tested varieties). Also, the infested leaflets lost about 3.7 % from wax content as compared with the uninfested ones. Significant differences among in the uninfested leaflets were calculated for all tested varieties (L.S.D. was 0.0003). Results revealed that the infestation with this insect caused a reduction in the wax content in leaflet of infested leaflets in all tested varieties in the following descending order: White (5.88%), Malakaby (4.44%), Seedy Balady (3.07%). Shamia (2.76%) and Gendeila (2.25%) (Table 3 and Fig. 1).

2- Side effect of infestation by *P. blanchardii* on date palm leaflet area and pigments:

2.1- Effect on date palm leaflet area:

As reported, Table (1) revealed that the infested Gendeila leaflets had bigger leaflet area (44.38 cm^2) than the other four varieties, leaflets in all varieties. The differences in leaflet area among infested date palm leaflets in all tested varieties were significant. In all tested varieties, the infested leaflets had smaller leaflet area (38.08 cm^2) than the uninfested leaflets (47.203 cm^2 as a general average for the all tested varieties) (Table 2). Also, the leaflet area of the infested leaflets was reduced by 19% compared to the uninfested leaflets. Moreover, the analysis of variance for uninfested leaflets indicated significant differences among tested varieties (L.S.D. was 12.32). It was obvious that the infestation by *P. blanchardii* reduced the leaflet areas by 26.13, 22.46, 18.57, 14.72 and 13.08 % in the varieties of White, Malakaby**,** Seedy Balady**,** Gendeila and Shamia varieties, respectively (Table 3 and Fig. 1). Statistical analysis of data in the same Table, revealed that strongly positive significant correlation between the rate of infestation by *P. blanchardii* and the percentage of reduction in leaflet areas of five date palm varieties (r=+0.901). The unit effect regression coefficient (b), indicates that an increase of one insect per leaflet decreased the percentage of reduction in leaflet area by 0.84%. In an agreement with the obtained data, Mohamed and Asfoor (2004) studied the effect of *A. aurantii* infestation on

orange leaves, they reported that the percentage of reduction in leaf area was 12.4 and 18.25%, respectively for Navel orange and Valencia orange.

2.2- Effect on date palm specific leaflet area (SLA):

Specific leaflet area (SLA) is defined as the ratio of leaflet area to dry weight. Specific leaflet area (SLA) is one of the most widely accepted key leaflet characteristics used during the study of leaflet traits. Data in Table (1) revealed that infested leaflets of Gendeila had bigger specific leaflet area (29.47 cm^2/g), followed by white date palm variety (26.478 cm^2/g), then Shamia (26.24 cm^2/g), followed by Malakaby (23.06 cm^2/g), while Seedy Balady leaflets were smaller in (SLA) (19.11 cm^2/g). Statistical analysis of data revealed that there were significant differences among infested leaflets were calculated for all tested varieties (L.S.D. was 5.073).

The infested leaflets had smaller specific leaflet area (24.87cm^2/g) than the uninfested leaflets (29.92 cm^2/g as a general average for the all tested varieties). Also, leaflets of date palm from the infested leaflets lost about 16.6% of (SLA) compared the uninfested ones. Specific leaflet area did not significantly differ among uninfested date palm varieties except seedy Balady. Insect infestation by *P. blanchardii* caused decrease on the specific leaflet area in the infested leaflets for all tested varieties in the following descending order: White (24.41%), Malakaby (21.23%), Seedy Balady (14.53%), Gendeila (12.57%) and Shamia (10.24%) in (Table 3 and Fig. 1).

2.3- Effect on date palm specific leaflet weight (SLW):

Specific leaf weight as an indicator of leaf toughness and photosynthesis velocity. Relationship between the infestation by *P. blanchardii* and specific leaflet weight calculated in the infested leaflets for all tested date palm varieties, Table (1). Seedy Balady date palm leaflets contained the highest in (SLW) 0.0524 g/cm^2. While, leaflets of Gendeila variety contained the smallest in (SLW) (0.0341 g/cm^2). Significant differences between the infested leaflets were calculated for all tested varieties (L.S.D. was 0.1).

Results in Table (2) revealed that uninfested leaflets had less specific leaflet weight (0.035 g/cm^2) than the infested ones (0.041 g/cm^2 as a general average for the all tested varieties). The increasing in (SLW) was about 19.4 % in infested leaflets compared with the uninfested ones. Also, there were significant differences among uninfested leaflets for all tested varieties (L.S.D. was 0.02). As regarded to the effect of insect infestation on (SLW), data published that this insect invasion promote (SLW) by -29.14, -27.08, -13.98, -13.45 and -13.26 % increase in the infested leaflets of White, Malakaby, Gendeila, Shamia and Seedy Balady varieties, respectively (Table 3 and Fig. 1).

2.4- Effect on the photosynthetic pigments:

A- Effect on chlorophyll (a):

Results depicted in Table (1) showed that the infested leaflets of Shamia variety had highest quantity of chlorophyll (a) (1.378 mg/ $inch^2$ f.w). While, leaflets of White variety contained the least in chlorophyll a concentration (0.868 mg/ $inch^2$ f.w). The statistical analysis of data, revealed that there were significant differences in chlorophyll (a) content between the infested leaflets for all tested varieties (L.S.D. was 0.016).

Chlorophyll (a) concentration in the infested leaflets was less than that in uninfested ones (1.12 mg/ $inch^2$ f.w versus 1.71 mg/ $inch^2$ f.w) as a general average of all date palm varieties. Also, leaflets from the infested leaflets lost about 32.4% of chlorophyll (a) compared with the uninfested leaflets. Generally and regardless of that, the differences were significant among uninfested leaflets in all tested varieties in the quantity of chlorophyll (a) (L.S.D. was 0.009).

The infestation by *P. blanchardii* caused a significant reduction in the quantity of chlorophyll (a) in the following descending order: White (49.30%), Malakaby (45.18%), seedy Balady (36.74%), Gendeila (17.12%) and Shamia (13.55 %), (Table 3 and Fig. 1).

B- Effect on chlorophyll (b):

The infestation by this insect on infested leaflets for all tested varieties revealed that, leaflets of Malakaby had the highest quantity of chlorophyll (b) (0.841 mg/ inch^2 f.w). While, leaflets of White variety contained the lesst in chlorophyll (b) concentration (0.553 mg/ inch^2 f.w). Chlorophyll (b) significantly differs among infested leaflets for all tested date palm varieties (L.S.D. was 0.012).The uninfested date palm leaflets had significantly more chlorophyll (b) than the infested ones (1.0907 compared to 0.7039 mg/ inch^2 f.w as a general average of all date palm varieties). Also, the infested leaflets lost about 33% from chlorophyll (b) as compared with the uninfested ones. The analysis of variance for uninfested leaflets revealed significant differences in quantity of chlorophyll (b) among tested varieties (L.S.D. was 0.005).

Moreover, the feeding by *P. blanchardii* on date palm leaflets caused a significant reduction on the quantity of chlorophyll (b). The percentage of reduction in chlorophyll (b) were 47.62, 44.25, 39.56, 21.24 and 12.45% in Malakaby, White, seedy Balady, Shamia and Gendeila date palm varieties, respectively (Table 3 and Fig.1).

C- Effect on carotenoids:

The data represented in (Table 1) cleared the relationship between the infestation by *P. blanchardii* and the quantity of carotenoids in the infested leaflets for all tested varieties. Malakaby variety had the highest quantity of carotenoids (0.701 mg/ inch^2 f.w), followed by Shamia (0.582 mg/ inch^2 f.w), then Seedy Balady leaflets (0.526 mg/ inch^2 f.w), followed by Gendeila (0.492 mg/ inch^2 f.w), while White date palm leaflets were smaller in quantity of carotenoids (0.327 mg/ inch^2 f.w). Statistical analysis of data revealed that there were significant differences among infested leaflets were calculated for all tested varieties (L.S.D. was 0.008) (Table 1). The results showed that the uninfested date palm leaflets had significantly higher concentrations of carotenoids (0.768 mg/ inch^2 f.w) than the infested ones (0.526 mg/ inch^2 f.w as a general average of all date palm varieties). Also, it was noticed that insect infestation reduced carotenoids by 29.2% in the infested leaflets as compared with the uninfested leaflets. For all varieties, the difference among uninfested leaflets was significant (L.S.D. value was 0.005). It was also, noticed that the insect infestation by *P. blanchardii* exhausted about 58.31, 35.25, 25.29, 22.55 and 4.48 % in the quantity of carotenoids for the infested leaflets of White, Malakaby, Seedy Balady, Shamia and Gendeila varieties, respectively, (Table 3 and Fig. 1).

2- The relationship between the rate of infestation by *P. blanchardii* and the percentage of reduction in each of the morphological and chemical characters in the infested leaflets of five date palm varieties.

Statistical analysis of data in Table (3) revealed that strongly significant positive correlation between the rate of infestation by *P. blanchardii* and the percentage of reduction in % moisture, wax content and carotenoids in the infested leaflets of five date palm varieties (r = +0.97, +0.95 and +0.99), respectively. Also, there was significant positive correlation between the rate of infestation and the percentage of reduction in leaflet area, SLA (cm^2/g), the quantity of Chl (a) and Chl (a) of five date palm varieties (r = +0.901, +0.86, +0.87 and +0.85), respectively. While, there was insignificant positive correlation between insect infestation and the percentage of

reduction in fresh weight and weight after one hour of drying (r = +0.71 and +0.81), respectively, Table (3) and Fig. (1).

In contrast, there was insignificant negative correlation (r = -0.12, -0.7 and -0.8) between insect infestation and the percentage of reduction in dry weight, % lost moisture and SLW (g/cm^2), respectively. While, there was strongly significant negative correlation between the insect infestation and the percentage of reduction in % dry matter (r = -0.90) (Table 3 and Fig.1).

From the obvious results, it could be concluded that the White date palm variety considered the greatest infestation with *P. blanchardii*, was exhibiting the highest reduction in the moisture content, epicuticular wax, leaflet area, specific leaflet area and Chlorophyll (a) and Carotenoids, and exposed the least percentage of reduction in the dry matter and specific leaflet weight in the infested leaflets compared with the uninfested ones.

These results are in agreement with those obtained by Reddy, Seshu and Sum (1991) who found a linear relationship between infestation and yield loss, and more increasing in yield loss as a result of the earlier infestation. Chlorosis is the most obvious plant injury symptom on date palm leaflets after *P. blanchardii* feeding and is indicative of chlorophyll loss. Such effect may be cleared by the significant reduction in chlorophyll a and b contents as well as carotenoids determined in the infested date palm leaflets (Table, 3). The decrease in the photosynthetic pigments may be due to the inhibition of pigment biosynthesis which may result from the alteration in mineral nutrition or lack of assimilates which drain towards the insect or to the effect of reactive oxygen species on these pigments (Stacey and Keen, 1996).

The pest may affect the normal photosynthesis by reducing pigment contents as noticed by Welter (1989). The first effect produced from feeding behavior, the continued piercing to leaves stomata by insect mouth parts may increase stomata resistance. This indicates malfunction of stomata responses. Which leads to restriction in gas exchange, and recession in photosynthesis. Also when insect sucks leaf sap, the leaf moisture stress recedes so the function of guard cells was impaired causing stomata closure. As well as, it was found that the scale insect that infested leaves and feed on sap reduced leaf chlorophyll content, carotenoids and photosynthesis. Also, Tawfik (1996) studied the relation between population density of *lepidosaphes beckii* and the photosynthesis pigments of orange leaves which, reductions percentages reached 47.14, 66.02 and 55.08% for chlorophyll (a), chlorophyll (b) and carotenoids, respectively. Al-Whaibi (1997), reported a significant decrease of total chlorophyll content in yellowing leaflets showing either infection by the green scale insect *Asterolecanium phoenix* or unknown pathogen (s) compared with healthy green leaflets. Youssef (2002) studied the effect of white date palm scale insect, *Parlatoria blanchardii* (Targ.) infesting date palm leaves, he reported that a significant decrease of total chlorophyll content in infested leaflets compared with uninfested ones. Also, the percentage of reduction in total chlorophyll content was 66.6%. Heng-Moss *et al*., (2003), however with different insect species and different host, also studied the feeding effect of aphids on wheat leaves and recorded that aphid was adversely affecting chlorophyll content and producing remarkable decline in chlorophyll concentration compared to the uninfested leaves.

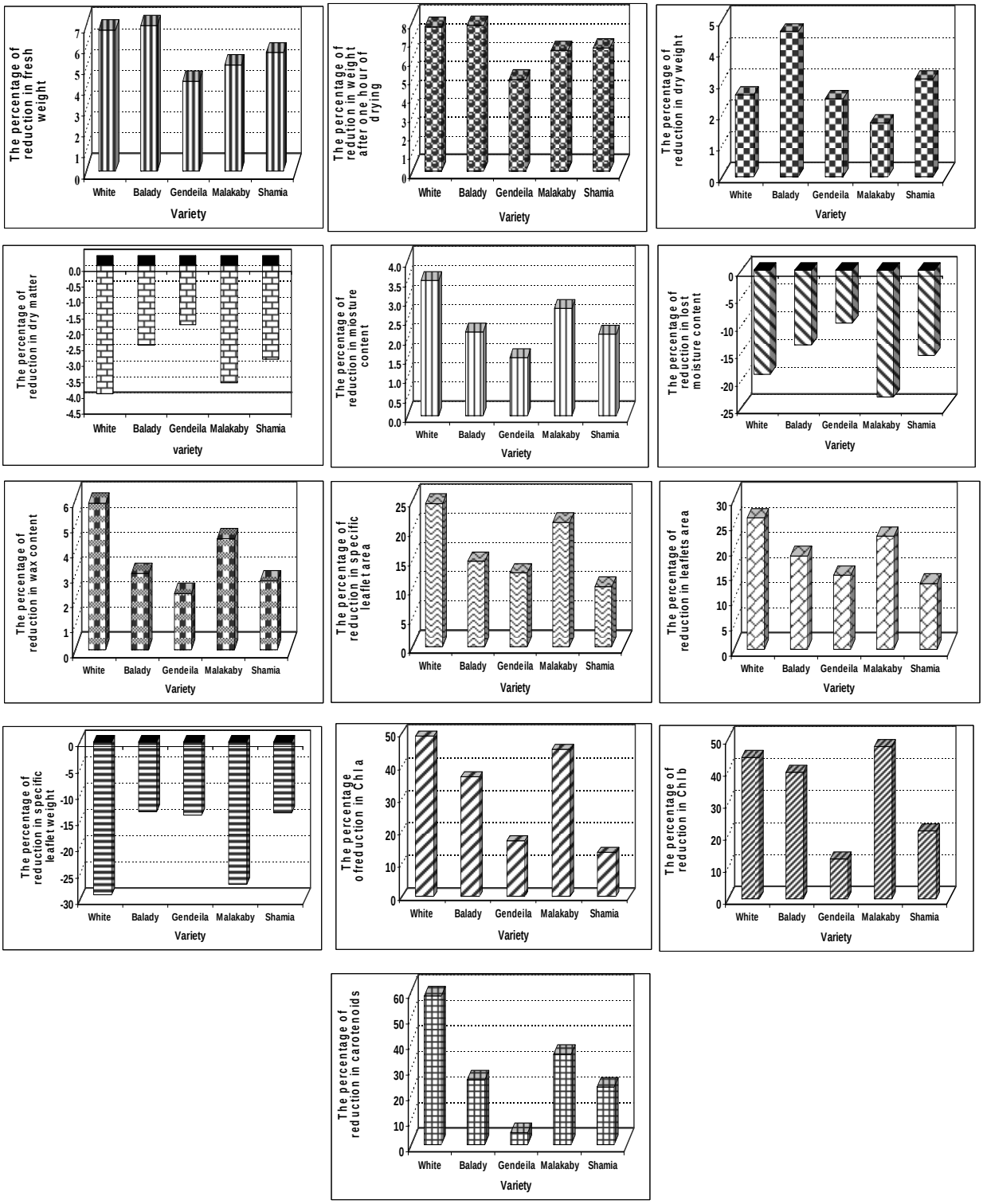

Fig. 1: Percentages of reduction in each of the leaflet weight, area, pigments and dry matter and moisture content in infested leaflets of five date palm varieties at Esna district, Luxor Governorate.

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ARABIC SUMMARY

التأثيرات السلبية للإصابة بحشرة نخيل البلح القشرية البيضاء على الخصائص المورفولوجية والكيميائية لوريقات عدة أصناف من أشجار نخيل البلح فى محافظة الأقصر- مصر.

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تعتبر حشرة نخيل البلح القشرية البيضاء من أهم الآفات الاقتصادية التي تصيب أشجار نخيل البلح فى محافظة الأقصر .تمتص هذه الآفة العصارة النباتية مما يؤدى الي التأثير على نمو الوريقات ومحتواها من الصبغات النباتية. ولذلك تم دراسة العلاقة بين التباين فى قابلية خمسة أصناف نخيل البلح للإصابة بالحشرة على خصائصها المورفولوجية والكيميائية.

أوضحت النتائج أن وريقات نخيل البلح السليمة أعلى فى محتواها فى (الوزن الطازج والوزن الجاف بعد ساعة والوزن الجاف ونسبة الرطوبة ومحتواها من الشمع ومساحة الورقة والمساحة النوعية للورقة والصبغات النباتية) من الوريقات المصابة بالحشرة لخمسة أصناف نخيل البلح. على العكس نسبة المادة الجافة والرطوبة المفقودة والوزن النوعى فى الوريقات المصابة أعلى من الوريقات السليمة. كما وجد أن الصنف نخيل البلح الأبيض أعلى إصابة بالآفة وذا أعلى نسبة مئوية للخفض فى (محتوى الرطوبة والشمع ومساحة الوريقة والمساحة النوعية للوريقة والكلوروفيل (أ) والكاروتينات) و وذا أقل نسبة المئوية للخفض فى محتواها من المادة الجافة ونسبة الرطوبة المفقودة والوزن النوعى للوريقة المصابة مقارنة بالسليمة. وبناء عليه أن تأثير حشرة نخيل البلح القشرية البيضاء على القياسات المدروسة هى محصلة لعدة عوامل (أولها الإصابة الحشرية وتوقيت الإصابة والصنف) وان الدور النسبى لكل عامل من هذه العوامل ربما يختلف من صنف الى أخر.