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Flowering, yield and fruit quality of Balady mango seedling trees as influenced by *Parlatoria oleae* (Colvee) infestation rate.

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The present study was conducted to investigate some flowering, yield and fruit quality (fruit physical and chemical properties) measurements of twelve years old Balady mango seedling trees grown in clay- loamy soil under surface irrigation system of private orchard located at Esna district, Luxor Governorate as affected by Parlatoria oleae infestation rate during two successive experimental seasons through duration from early September 2016 till mid August 2018 years. Data obtained during both (2016/2017) and (2017/2018) seasons revealed that dates of first, full bloom and harvesting took place earlier in the uninfested trees (control) as compared to the analogous measurements of either slightly or severely infested ones. Moreover, two yield parameters i.e., number and weight (kg.) of mature fruits harvested per each individual tree were obviously decreased by both *P. oleae* infestation rates as compared to those of the uninfested trees (control). As for the impact on both fruit physical and chemical characteristics, the uninfested trees exhibited an obvious improve in (average fruit dimensions, volume and weight) and (total soluble solids, total soluble solids / acidity ratio, total sugars, reducing sugars and sucrose contents) associated with lower total acidity %. On the other side, the heavily *P. oleae* infested trees showed significantly the highest reduction in all studied yield and fruit qualities measurements, except with total acidity %, whereas the trend took the other way around as compared to the free and slightly infested trees. Besides, *P. oleae* was more active through autumn months particularly during October and November of 1st and 2nd seasons, respectively. However, the reverse was true during winter months whereas the least values of *P. oleae* total population density were detected in both seasons, regardless of infestation rate. Concerning, the relationship between the differences in reduction % in a given desirable parameters from one hand and different infestation rate from the other estimated values of the simple correlation and regression coefficient pointed out the highly significant positive relationship whereas the increase of one insect per leaf and the increase in reduction of all tested yield and fruit qualitites, except total acidity percentage.

Key words: *Parlatoria oleae*, mango, yield, fruit physical and chemical properties

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INTRODUCTION

In Egypt, mango (*Mangifera indica* L.) occupies the third place in acreage after citrus and grapes. Mango fruits are desirable and popular fruits for the Egyptian consumers due to its good flavour, delicious taste, nutritive value and other fruit attractive features (El-Said, 2006). Among several pests of mango trees, *Parlatoria oleae* is considered one of the most main destructive ones (Bakr *et al*., 2009). This pest injures the shoots, twigs, branches, leaves and fruits by sucking the plant sap with the mouth parts, causing thereafter deformations, defoliation, dryness of young shoots twigs, dieback, poor blossoming, death of twig by the action of the toxic saliva and subsequently affecting the commercial value of fruits. Infestation causes conspicuous pink blemishes around the feeding sites of the scales (El-Amir, 2002). A characteristic symptom of infestation by this pest is the appearance and accumulation of its scales on attacked mango parts (Hassan *et al*., 2009).

Mango trees exhibit variable reactions to the insect infestation depending on plant physical properties or chemical components of plant leaves. As bio-chemical factors, to a large extent, affect the behaviour and metabolic processes of the pest, while morphological factors mostly influence the mechanisms of locomotion, feeding, oviposition, ingestion and digestion of the pest **(**McAuslane, 1996). There are many factors, which affect the attraction of scale insect for feeding. One of these factors inside plant itself, which makes the plant resistant or susceptible and may be genetic factors, or phenotypic due to differences in environmental conditions such as the nutritional status of the soil (Dale, 1988).

Having information about density and changes in population of *P. oleae* throughout the season and determination of their periods of activity will help in management of this pest. Because of the lack of the adequate informations concerning the effect of different infestation rates by *P. oleae* on the yield and fruit quality i.e., physical and chemical properties of the mango fruits. So, it was too necessary to study this point in Luxor region where there is no reports about any similar research. Accordingly, the objective of this study was aimed to find out the relationship between the population density of *P. oleae* from one hand and both yield and fruit qualities (physical & chemical properties) of the mango from the other.

MATERIALS AND METHODS

This study was carried out on twelve years old Balady mango seedlings trees grown on clay loamy soil under surface irrigation system in a private orchard located at Esna district, Luxor Governorate, Upper Egypt during two successive seasons throughout duration from early September 2016 till mid August 2018 year. It was aimed to investigate the impact of *P. oleae* infestation rate on some flowering, productivity and fruit quality of such mango trees. Two *P. oleae* infestation levels (light and severe), besides the free / uninfested trees were studied.

Two limits of infestation rates were decided according to the total number of alive scale exited on both lower and upper leaf surfaces after (Salem *et al.*, 2015). Hence, at low infestation rate number of scales per leaf (upper and lower surfaces) ranged from 10 to 70 individuals, while with the severe infestation rate the number was above 70 individuals.

The complete randomized block design with five replications was employed, whereas each replicate was represented by two mango trees. So thirty fruitful diseases free trees were carefully selected as being healthly and similar to great extent in their vigour. Taking into consideration that all chosed trees were subjected to the same horticultural practices and NPK fertilization adopted in the region, the nitrogen fertilization (in form of ammonium nitrate 33.5%) was used with a rate of 3 Kg/tree/year, Potassium fertilization (in form of Potassium sulfate 44%) was added with a rate of 2 Kg/tree/year and phosphorus fertilization (in form of calcium super phosphate 18.5 % P_2O_2) was used with a rate of 1.5 Kg/tree/year after the recomentedation of the Ministry of Agriculture.

In this experiment three fields of study were included i.e., a- Population size of the pest and the monthly changes in numbers of total alive *P. oleae* individuals per leaf (upper and lower surfaces), b- the response of flowering, yield and fruit quality of Balady mango trees to *P.oleae* infestation rate and c- the relationship between the changes in number of alive *P. oleae* individuals and the reduction or increasing % in different yield and fruit quality (physical and chemical properties) measurements as follows:

A- Population size of *P. oleae* and changes in total numbers of its alive individuals:

Regular fortnightly samples each consisted of 20 leaves were randomly picked from four geographical directions and heights of every individual tree along the year around. Collected leaves samples were placed in polyethylene bags and immediately transferred to the laboratory, then leaves of each sample was individually inspected using a binocular microscope whereas the total number of alive *P. oleae* individuals on both upper and lower surfaces were counted and recorded. Thereafter, the monthly mean number of total population of *P. oleae* per every leaf for each tree was concerned in this study to express the pest population size.

B- Flowering, harvesting dates, yield and fruit quality of Balady mango trees in response to *P. oleae* infestation level:

In this regard, the following measurements were included.

B.1- Flowering measurements:

At blooming stages, dates of first and full bloom were recorded for each tree, then anthesis duration in days was also estimated as the difference between the first and full bloom dates (in days).

B.2- Harvesting date and yield measurements:

As fruits of each tree reached maturity i.e., fruit flesh becomes yellowish, rind colour changes from dark green to light green or straw colour and the fruit shoulder tended to become rounded or flattened, then fruits per each single tree were harvested. Durations needed for fruits development until maturation (in days) were estimated as the difference between full bloom and harvesting dates. Herein, dates of harvesting and yield estimated as number or weight (Kg.) per each individual tree were recorded. Thereafter, twenty fruits were randomly chosed from every tree for carrying out the following fruit quality measurements.

B.3- Fruit quality measurements:

B.3.1- Fruit physical characteristics:

In this respect average fruit weight (g.), fruit size / volume (cm^3), fruit dimensions (length and width in cm.), using vernier caliper with the last two measurements and the fruit shape index (fruit length / its width ratio) were determined and average mean of each parameter was estimated.

B.3.2- Fruit chemical properties:

The following mango fruit chemical properties were determined in the laboratory:

- Total soluble solids % (TSS%) of fruit flesh: using refractometer as described by Payane (1968).
- Flesh total acidity % as g. citric acid per 100 g. pulp: was determined by titration with 0.1 N NaOH using phenolphthalein indicator according to A.O.A.C. (2000).
- Total soluble solids % / total acidity % (TSS / Acidity ratio).
- Total sugars %: was volumetrically determined according to Lane and Eynon (1965).
- Sucrose %: was determined by using Saccarometer according to (A.O.A.C., 1995).
- Reducing sugars % = (Total sugars % - Sucrose %)

C- The relationship between the changes in number of alive *P. oleae* individuals and the reduction or increasing % in different investigated yield and fruit quality (physical and chemical properties) measurements:

The amount of losses due to pest infestation in any investigated parameter was calculated according to the following equation:

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

Where, A= mean of a given measurement of the uninfested trees, while B= mean of the same parameter of the infested trees.

The averages of total alive insect population and the measurements of either yield or fruit quality (physical and chemical properties) of Balady mango trees were calculated by Excel sheets program.

Meanwhile, the relationships between the percentage of changes (±) in investigated parameters of mango trees represented as a dependent variable (Y) and the different infestation rates with *P. oleae* representative of the independent factor (X) were determined during two successive (2016/2017 and 2017/2018) experimental seasons. Herein, the simple regression was used to show the variability in percentages of reduction in the measured parameters that could be caused by the pest at various infestation levels. The equation of linear regression was calculated according to the following formula of Fisher (1950) and Hosny *et al*. (1972):

$$Y = a \pm bx$$

Where:

Y = Prediction value (Dependent variable)
a = Constant (y - intercept)
b = Regression coefficient
x = Independent variable

This method was helpful for demonstrating basic information about the amount of variability in the reduction % in the desirable studied parameters, and also to find out the explained variance (E.V.%).

Obtained data were subjected to statistical analysis of variance as complete randomized block design and means were compared according to the LSD test at 0.05 level using the letters for distinguishing between rates of infestation. All statistical analysis of the obtained data were carried out by computer (MSTATC Program software, 1980).

RESULTS AND DISCUSSION

A- Population size of *P. oleae* and changes in total numbers of its alive individuals:

Obtained data during both (2016/2017) and (2017/2018) experimental seasons regarding the monthly changes in means number counted of alive *P. oleae* individuals per each single Balady mango leaf are presented in Table (1).

It is quite clear that the general average of alive *P. oleae* individuals per leaf of infested Balady mango trees at two rates was considerably varied as both compared each other. Herein, the infested trees showed general average of (30.67 ± 0.80 and 36.15 ± 0.96) and (105.07 ± 2.54 and 119.78 ± 2.81) alive *P. oleae* individuals for the light and heavy infested trees during the first and second seasons, respectively. Table (1) reveals also that the increase in *P. oleae* population density in leaves of the severe infested mango trees over the analogus one of the low infestation rate reached approximately 3.31 to 3.43 times during (2016/2017) and (2017/2018) experimental seasons, respectively.

As for the activity of *P. oleae* individuals along each year around obtained data declared also that the highest total population density of *P. oleae* was recorded through the autumn months particularly October and / or November during the first and second experimental seasons, respectively. The reverse was true during winter months, whereas the least values were recorded in both experimental seasons. In addition, activities of *P. oleae* during both summer and spring seasons were in between the abovementioned two extremes with an obvious tendency to be more active during summer than spring months. Such trend was true during both seasons, regardless of infestation rates.

B- Flowering, harvesting dates, yield and fruit quality measurements of Balady mango seedling trees in response to *P. oleae* infestation rates:

In this regard blooming dates (first and full bloom), anthesis duration in days, harvesting date, duration needed for fruits development till maturation and yield expressed either as number or weight of fruits (kg) per tree in response to *P. oleae* infestation rates were investigated. Data obtained during both (2016/2017) and (2017/2018) seasons are represented in Table (2).

B.1- Flowering measurements:

Table (2) shows that blooming dates (first and full bloom) were obviously delayed by two *P. oleae* infestation rates with comparison to the uninfested trees (control). However, such delay was more prolonged for the full bloom parameter from one hand and the severe infestation rate was more effective for both blooming measurements from the other. Anyhow, first bloom took place early in the uninfested Balady mango seedling trees (control) with approximately (5 & 14) and (5 & 11) days than the (light and severe infested trees) during 1st and 2nd seasons, respectively. Meanwhile, full bloom of the *P. oleae* infested trees had been taken place later than the control (uninfested ones) with (10 & 9) and (25 & 21) days for the light and heavy infested trees during1st and 2nd seasons, respectively. The anthesis duration (time extended from first till full bloom) was also influenced by *P. oleae* infestation, whereas it was prolonged in the infested trees than control with (5 & 10) and (4 & 10) days for the (light and severe) infested trees during1st and 2nd seasons, respectively.

B.2- Harvesting date and yield measurements:

Referring, the response of harvesting date and duration needed for fruits development till maturation, Table (2) reveals clearly that the abovementioned trend previously detected with blooming dates was directly reflected on both measurements. However, differences in harvesting dates were quality evident than those exhibited in duration till fruits maturation. Herein, harvesting date was delayed in the light and severe *P. oleae* infested trees than control with approximately (12 & 29) and (12 & 25) days during 1st and 2nd seasons, respectively.

Moreover, duration from full blooms till maturation showed relatively less pronounced response *i.e*., it was delayed in the *P. oleae* infested trees than control (the uninfested ones) with (2 & 4) and (3 & 4) days during 1st and 2nd seasons for the light and severe infested trees, respectively.

Concerning, the response of Balady mango yield, Table (2) displays obviously that the uninfested trees (control) yielded the greatest number and heaviest weight (kg.) of fruits per tree as compared to the *P. oleae* infested ones, regardless of infestation level. Such increase was more noticeable and significant when yield was estimated as weight of harvested fruits per tree, while significance was absent and differences could be safety neglected with estimating yield as number of harvested fruits per tree. In addition, the severe *P. oleae* infestation level tended to be more depressive in this regard however it didn't significantly differ than the light infestation rate during both seasons of study.

The present result goes partially with Bakry (2009) on mango trees, who found that number of mango fruits was decreased by the scale insects (*I. pallidula* and *A. aurantii*). Moreover, findings of Mohamed and Asfoor (2004) on yield of Navel and Valencia sweet orange cvs. pertaining the effect of *A. aurantii* are in congeniality with our results of yield response.

Table (1): Monthly mean numbers of total alive *P. oleae* individuals per mango leaf at Esna district, Luxor Governorate during 2016/2017 and 2017/2018.

Season	Date of inspection	Mean number of individuals per leaf ± S.E.			
		Light infestation		Heavy infestation	
		First season	Second season	First season	Second season
Autumn	**Sept.**	33.50 ± 0.92	33.16 ± 0.78	120.60 ± 2.63	125.60 ± 2.52
	Oct.	43.92 ± 0.70	44.83 ± 0.49	151.39 ± 2.15	146.07 ± 1.92
	Nov.	30.52 ± 0.59	48.94 ± 0.90	133.12 ± 2.55	154.73 ± 2.83
	Average	**35.98 ± 1.14**	**42.31 ± 1.31**	**135.03 ± 2.72**	**142.13 ± 2.65**
Winter	**Dec.**	19.99 ± 0.27	33.33 ± 0.46	95.43 ± 1.30	147.45 ± 2.04
	Jan.	18.03 ± 0.23	18.13 ± 0.14	69.05 ± 0.94	69.52 ± 0.47
	Feb.	14.79 ± 0.19	16.82 ± 0.39	61.14 ± 0.78	60.48 ± 1.50
	Average	**17.60 ± 0.42**	**22.76 ± 1.41**	**75.21 ± 2.78**	**92.49 ± 7.30**
Spring	**Mar.**	30.65 ± 0.70	29.13 ± 0.69	71.60 ± 1.65	112.52 ± 2.65
	April	33.19 ± 0.71	39.38 ± 0.86	106.46 ± 2.28	131.46 ± 2.88
	May	30.22 ± 0.58	35.61 ± 0.51	96.50 ± 1.79	103.89 ± 1.49
	Average	**31.35 ± 0.45**	**34.71 ± 0.88**	**91.52 ± 2.93**	**115.96 ± 2.53**
Summer	**June**	36.94 ± 0.34	43.94 ± 0.26	117.80 ± 0.69	139.80 ± 0.87
	July	41.61± 0.25	48.26 ± 1.13	136.59 ± 1.25	147.19 ± 2.11
	Aug.	34.71 ± 0.49	42.30 ± 0.62	101.20 ± 1.39	98.64 ± 2.31
	Average	**37.76 ± 0.65**	**44.83 ± 0.63**	**118.53 ± 2.87**	**128.54 ± 4.10**
General average		**30.67± 0.80**	**36.15 ± 0.96**	**105.07 ± 2.54**	**119.78 ± 2.81**

B.3- Fruit quality measurements:

B.3.1- Fruit physical characteristics:

The average fruit weight (g.), fruit size (cm^3), fruit dimensions (length & width in cm.) and fruit shape index (length: width ratio) of Balady mango seedling trees were the investigated five fruit physical properties pertaining their response to *P. oleae* infestation rates. Data obtained during both seasons are tabulated in Table (3).

It is quite evident as shown from Table (3) that the evaluated four fruits physical properties dealing with fruit weight, size and its dimensions (polar diameter / length & equatorial diameter / width) of the Balady mango seedling trees responded significantly to both *P. oleae* infestation levels during two experimental seasons. Hence, the greatest values of these concerned four fruit physical parameters were significantly in closed relationship to the uninfested trees (control) during both seasons of study.

On the contrary, the least values of the aforesaid four fruit physical characteristics were statistically coupled with the severe *P. oleae* infested trees during both experimental seasons. In addition, the lower *P. oleae* infested trees were in between the abovementioned two extremes.

Moreover, differences between the light and heavy *P. oleae* infested trees were also significant as mean value of a given fruit physical property at low *P. oleae* infestation level was compared to the analogous one of Balady mango trees under the severe infestation rate during both seasons of study.

As for the fruit shape index, Table (3) reveals that such parameter is the unique exception of the investigated fruit physical characteristic which didn’t statistically respond to the *P. oleae* infestation. Hence, differences between the uninfested trees (control) and the infested ones at either lower or higher levels were so slight to reach level of significance and consequently could be salely neglected. Absence of significance in fruit shape index values (fruit length: its width ratio) due to *P. oleae* infestation may be attributed to the paralleled rate of reduction in both fruit dimensions in the *P. oleae* infested trees.

Table (2): Dates of some (blooming & harvesting) measurements and yield of Balady mango seedling trees as affected by *P. oleae* infestation rates during two consecutive seasons (2016/2017 and 2017/2018).

Treatments / *P. oleae* infestation rate	Blooming dates and anthesis duration			Harvesting date and duration till maturation		Yield (harvested mature fruits) per tree			
	First bloom date	Full bloom date	Anthesis period (days)	Harvest date	Duration for fruit maturation (days)	Number of fruits /tree		Weight of fruits / tree	
						Number of fruits	± (%)	Weight of fruits (kg.)	± (%)
2016/2017 season									
Free (Control)	01/01/2017	14/02/2017	45 days	17/06/2017	123 days	1357.80 a	-----	240.80 a	-----
Low	06/01/2017	24/02/2017	50 days	29/06/2017	125 days	1257.20 a	(-) 7.41	210.40 b	(-) 12.62
Severe	15/01/2017	11/03/2017	55 days	16/07/2017	127 days	1228.00 a	(-) 9.56	198.00 c	(-) 17.77
L.S.D. at 5%	-------	-------	-------	-------	-------	N.S.	------	29.15 *	------
2017/2018 season									
Free (Control)	07/01/2018	21/02/2018	45 days	24/06/2017	123 days	1463.40 a	-----	259.80 a	-----
Low	12/01/2018	02/03/2018	49 days	06/07/2017	126 days	1324.00 a	(-) 9.53	224.10 b	(-) 13.74
Severe	18/01/2018	14/03/2018	55 days	19/07/2017	127 days	1306.30 a	(-) 10.74	209.60 b	(-) 19.32
L.S.D. at 5%	-------	-------	-------	-------	-------	N.S.	------	16.14 **	------

± (%) refers to the percentage of increase (+) or reduction (-) in studied measurements exhibited by infestation two rates as compared to control (infestation free).
Means followed by the same letter/s within each column did not significantly differ at 5% level.

Table (3): Some Fruit physical characteristics of Balady mango seedling trees in response to *P. oleae* infestation rates during two consecutive seasons (2016/2017 and 2017/2018).

Parameters / *P. oleae* infestation rate	Fruit weight		Fruit size		Fruit length		Fruit width		Fruit shape index	
	Weight (g)	± (%)	Size (cm^3)	± (%)	Length (cm)	± (%)	Width (cm)	± (%)	Fruit shape	± (%)
2016/2017 season										
Free (Control)	202.00 a	-------	206.42 a	-------	9.15 a	-------	7.19 a	-------	1.28 a	-------
Low	180.00 b	(-) 10.89	186.35 b	(-) 9.72	8.60 b	(-) 6.01	6.90 b	(-) 4.03	1.25 a	(-) 2.22
Severe	164.00 c	(-) 18.81	169.02 c	(-) 18.81	8.18 c	(-) 10.60	6.58 c	(-) 8.40	1.24 a	(-) 2.50
L.S.D. at 5%	9.45 **	-------	7.70 **	-------	0.28 **	-------	0.22 **	-------	N.S.	-------
2017/2018 season										
Free (Control)	204.00 a	-------	209.94 a	-------	9.23 a	-------	7.25 a	-------	1.28 a	-------
Low	181.00 b	(-) 11.27	187.91 b	(-) 10.49	8.62 b	(-) 6.61	6.94 b	(-) 4.28	1.24 a	(-) 2.59
Severe	165.00 c	(-) 19.12	170.20 c	(-) 18.93	8.20 c	(-) 11.16	6.61 c	(-) 8.83	1.24 a	(-) 2.71
L.S.D. at 5%	6.81 **	-------	6.32 **	-------	0.24 **	-------	0.19 **	-------	N.S.	-------

± (%) refers to the percentage of increase (+) or reduction (-) in studied measurements exhibited by infestation two rates as compared to control (infestation free).
Means followed by the same letter/s within each column did not significantly differ at 5% level.

Our data regarding the respond of the investigated fruit physical properties are in general agreement with the findings of Mohamed and Asfoor (2004) on some sweet orange cvs., Tawfik (1985) on orange and Bakry (2009) on mango trees, all found that several scale insects depressed the fruit weight, size and dimensions, respectively.

B.3.2- Fruit chemical properties:

Flesh TSS %, total acidity%, TSS / Acidity ratio, total sugars, reducing sugar and sucrose content as influence by *P. oleae* infestation level were the six investigated fruit chemical characteristics of Balady mango trees during both (2016/2017 and 2017/2018) seasons. Data obtained during two seasons are presented in Table (4).

It is quite evident as shown from tabulated data in Table (4) that all six studied fruit chemical properties responded significantly to the *P. oleae* infestation. However, the rate of difference in these chemical characteristics varied not only from one chemical component to another but the *P. oleae* infestation level declared also its own influence in this concern. Anyhow, data obtained during both (2016/2017) and (2017/2018) experimental seasons pointed out clearly that the response of all the aforesaid investigated fruit chemical properties to the *P. oleae* infestation followed two conflicted trends. First trend is dealing with the investigated five flesh chemical properties which including percentages of total soluble solids (TSS), total sugars, reducing sugars, sucrose and TSS / acid ratio, whereas an obvious reduction in their values were exhibited by two *P. oleae* infestation levels. On the other hand, 2nd trend was representive of the flesh total acidity %which took the other way around whereas total acidity % was increased by *P. oleae* infestation.

The decrease in fruit flesh TSS % of *P. oleae* infested trees below control was more pronounced and significant in fruits of the severe infested ones it was too few to be significant as compared to that of control during two seasons. The reduction % in flesh TSS % exhibited by the (light & severe infestation rates) below the control during 1st and 2nd seasons were (1.99 & 7.95 %) and (3.29 & 9.87 %) respectively. Meanwhile, the depressive effects of two *P. oleae* infestation rates on the flesh TSS / acid ratio, total sugars, reducing sugars and sucrose values were more pronounced and significant as fruits of three investigated treatments *i.e*., uninfested trees (control), light and severe infested ones were compared each other during both experimental seasons. Hence, the reduction in such four fruit chemical properties of the light infested trees below those of the uninfested ones (control) ranged (9.40 & 10.71), (14.55 & 14.57), (13.78 & 13.88) and (15.30 & 15.25), for (TSS / acid ratio), (total sugars %), (reducing sugars %) and (sucrose content %) during two seasons, respectively. However, the reduction % in such four fruit chemical properties of the severe infested tress below control ranged (24.12 – 25.43), (26.91 – 27.52), (26.29 – 27.23) and (27.52 – 27.81) for the (TSS / acid ratio), (total sugars %), (reducing sugars %) and (sucrose content %) during two seasons, respectively.

On the contrary, fruit flesh total acidity % followed its own specific conflicted trend to the above discussed one detected with the four other fruit chemical properties. Table (4) reveals an obvious increase was detected in the fruit flesh total acidity % of the *P. oleae* infested trees over that of the uninfested ones (control).

Differences were significant as the three treatments of control, lightly and heavily infested trees were compared each other during both (2016/2017) and (2017/2018) experimental seasons. Raising % in flesh total acidity % of the light and severe *P. oleae* infested trees over control were approximately (8.03 & 21.17 %) and (8.63 & 20.86 %) during 1st and 2nd seasons, respectively. the present results of the fruit chemical properties in response to *P. oleae* infestation go generally in the time of findings of Bakry (2009) on mango, Mohamed and Asfoor (2004) on Navel and Valencia orange and Bakry and Abdel-Mageed (2014) on grapes as flesh TSS%, total acidity % and total sugars contents were respectively concerned.

C- The relationship between the changes in number of alive *P. oleae* individuals and the reduction or increasing % in different investigated yield and fruit quality (physical and chemical properties) measurements:

Concerning, the relationship between the percentages of reduction in the measured parameters for mango trees represented as dependent variable (Y) and the different infestation rates by *P. oleae* represented as independent factor (X) data obtained during two successive seasons of (2016/2017 and 2017/2018) are tabulated in Table (5).

Results revealed a strong high significant positive correlations between the rates of infestation with *P. oleae* and percentages of reduction in some fruit physical properties *i.e.* length, width, shape, size and weight (r values; +0.98, +0.95, +0.94, +0.91 and +0.89) for the first season and (+0.95, +0.94, +0.95, +0.89 and +0.97) during the second season was detected. As well, the calculated regression coefficient (b) indicated that an increase of one insect per mango leaf, would increase the percentages of reduction in such fruit physical properties i.e., length by (1.52 and 1.08%), width (1.41 and 1.05%), shape index (2.42 and 2.01%), size (1.62 and 0.97%) and fruit weight (1.97 and 1.32%) for two seasons, respectively (Table, 5).

Table (4): Some fruit chemical properties of Balady mango seedling trees as influenced by *P. oleae* infestation rates during two successive seasons (2016/2017 and 2017/2018).

Parameters / *P. oleae* infestation rate	TSS content		Total acidity content		TSS / Acidity ratio		Total sugars content		Reducing sugars content		Sucrose content	
	TSS %	± (%)	Total acidity %	± (%)	TSS / Acidity ratio	± (%)	Total sugars %	± (%)	Reducing sugars %	± (%)	Sucrose %	± (%)
2016/2017 season												
Free (Control)	15.10 a	-------	0.55 c	-------	27.61 a	-------	13.11 a	-------	6.49 a	-------	6.61 a	-------
Low	14.80 a	(-) 1.99	0.59 b	(+) 8.03	25.01 b	(-) 9.40	11.20 b	(-) 14.55	5.60 b	(-) 13.78	5.60 b	(-) 15.30
Severe	13.90 b	(-) 7.95	0.66 a	(+) 21.17	20.95 c	(-) 24.12	9.58 c	(-) 26.91	4.79 c	(-) 26.29	4.79 c	(-) 27.52
L.S.D. at 5%	0.63 **	-------	0.02 **	-------	1.14 **	-------	0.33 **	-------	0.20 **	-------	0.18 **	-------
2017/2018 season												
Free (Control)	15.20 a	-------	0.56 c	-------	27.36 a	-------	13.16 a	-------	6.55 a	-------	6.61 a	-------
Low	14.70 a	(-) 3.29	0.60 b	(+) 8.63	24.43 b	(-) 10.71	11.24 b	(-) 14.57	5.64 b	(-) 13.88	5.60 b	(-) 15.25
Severe	13.70 b	(-) 9.87	0.67 a	(+) 20.86	20.40 c	(-) 25.43	9.54 c	(-) 27.52	4.76 c	(-) 27.23	4.77 c	(-) 27.81
L.S.D. at 5%	0.50 **	-------	0.02 **	-------	1.33 **	-------	0.31 **	-------	0.16 **	-------	0.24 **	-------

± (%) refers to the percentage of increase (+) or reduction (-) in studied measurements exhibited by infestation two rates as compared to control (infestation free).
Means followed by the same letter/s within each column did not significantly differ at 5% level.

Table (5): Simple correlation, regression values and linear regression equation when the counts of the mean population density of *P. oleae* were plotted versus the percentages of reduction in each of the yield and fruit quality (physical & chemicals) properties of the Balady mango seedling trees through the two successive seasons (2016/2017 and 2017/2018).

Parameters		First season (2016/2017)						Second season (2017/2018)					
		r	b	S.E	T-test value	Y = a ± bx	E.V. %	r	b	S.E	T-test value	Y = a ± bx	E.V. %
Yield	No. of fruits /tree	0.96	5.38	0.53	10.12**	– 559.39 + 5.38 x	92.78	0.95	4.59	0.51	8.95**	– 539.81 + 4.59 x	90.90
	Weight of fruits/tree	0.91	1.88	0.31	6.13**	– 179.61 + 1.88 x	82.46	0.94	2.37	0.31	7.66**	– 264.14 + 2.37 x	87.96
Fruit physical properties	Fruit weight	0.89	1.97	0.36	5.48**	– 188.52 + 1.97 x	78.97	0.97	1.32	0.11	12.01**	– 139.49 + 1.32 x	94.75
	Fruit size	0.91	1.62	0.27	6.09**	– 151.87 + 1.62 x	82.29	0.89	0.97	0.18	5.44**	– 97.22 + 0.97 x	78.72
	Fruit length	0.98	1.52	0.10	15.30**	– 149.51 + 1.52 x	96.70	0.95	1.08	0.13	8.43**	– 118.17 + 1.08 x	89.89
	Fruit width	0.95	1.41	0.16	9.10**	– 139.69 + 1.41 x	91.18	0.94	1.05	0.14	7.46**	– 117.00 + 1.05 x	87.44
	Fruit shape index	0.94	2.42	0.30	8.09**	– 252.32 + 2.42 x	89.11	0.95	2.01	0.23	8.85**	– 237.81 + 2.01 x	90.72
Fruit chemical properties	TSS %	0.87	1.31	0.26	4.96**	– 130.01 + 1.31 x	75.48	0.96	1.41	0.15	9.38**	– 159.55 + 1.41 x	91.64
	Total acidity %	– 0.79	– 1.64	0.45	3.62**	150.84 – 1.64 x	62.07	– 0.88	– 1.41	0.27	5.32**	147.89 – 1.41 x	78.01
	TSS / Acidity ratio	0.93	1.22	0.18	6.96**	– 104.74 + 1.22 x	85.79	0.96	1.55	0.17	9.21**	– 160.64 + 1.55 x	91.36
	Total sugars %	0.96	1.09	0.12	9.48**	– 87.93 + 1.09 x	91.84	0.97	0.92	0.08	12.23**	– 83.18 + 0.92 x	94.94
	Reducing sugars %	0.98	1.35	0.11	12.56**	– 116.08 + 1.35 x	95.19	0.98	0.96	0.07	13.32**	– 88.18 + 0.96 x	95.68
	Sucrose %	0.94	1.11	0.14	7.80**	– 89.20 + 1.11 x	88.39	0.98	0.95	0.08	12.61**	– 85.95 + 0.95 x	95.22

r = Simple correlation S.E = Standard error Y = a ± bx (Regression linear equation)
b = Simple regression T-test = T-test calculated E.V.% = Explained variance

Also, the calculated r values between different infestation rates and percentages of reduction in the chemical properties of fruit *i.e.* total soluble solids, total soluble solids / total acidity, total sugars, reducing sugars and sucrose were highly significant positive; being (+0.87, +0.93, +0.96, +0.98 and +0.94) and (+0.96, +0.96, +0.97, +0.98 and +0.98) during 1st and 2nd seasons, respectively. The calculated regression coefficient (b) indicated that an increase of one insect per mango leaf, would increase the reduction percentages in total soluble solids, total soluble solids / total acidity, total sugars, reducing sugars and sucrose contents of fruits by (1.31, 1.22, 1.09, 1.35 and 1.11%) and (1.41, 1.55, 0.92, 0.96, 0.95%) for two seasons, respectively (Table, 5).

On the contrary, correlation between the effect of different infestation rates by pest and the percentages of increasing in the acidity content of fruits as shown in Table (5) which reveals highly significant negative values (r were -0.79 and -0.88) through two seasons, respectively. As well, the calculated regression coefficient (b) indicated that an increase of one insect per mango leaf, would increase the percentage of raising fruits acidity content by 1.64 and 1.41% for the two seasons data, respectively (Table, 5).

Furthermore, the statistical analysis of simple correlation (Table, 5) showed that highly significant positive correlations between the different infestation rates by pest and the percentages of reduction in the weight of fruits (Kg) and number of fruits per tree (r values; +0.91 and +0.96) and (+0.94 and +0.95) during both seasons of study, respectively. As well, the simple regression coefficient (b) indicated that an increase by one insect per mango leaf, would increase the reduction percentages in weight of fruits by (1.88 and 2.37%) and (5.38 and 4.59%) in number of fruits per tree for two seasons, respectively.

Based on the data summarized in Tables (2–4), it could be concluded that the percentages of abnormality (% increase or % decrease) in relation to the standard measurements for the infested trees (light and heavy) must be compared between uninfested trees. General averages of population overall the every season were compared among the different infestation rates by *P. oleae* and were also linked with the qualitative and quantitative loss of various fruiting measurements (Table, 5). It was clear that the reflection of the insect infestation levels on the physical properties was strongly positive that refers to the proportional increase in the percentages of loss in any of the measured parameter as infestation rate was increased. As well, the reduction in fruit quality was also compared among the different infestation rates by *P. oleae* (Table, 5). Fruits collected from infested trees (light and heavy) must be compared and the fruits in uninfested trees that exhibited remarkable loss or increase in their qualitative characters.

The results revealed that the dates of first and full bloom as well as harvesting date in uninfested mango trees was earlier than those of the light and heavy infested mango trees, this may be due to the infestation by *P. oleae*. As well, fruits of the uninfested mango trees had better qualities i.e., physical properties (length, width, shape, size and weight) and chemical properties (total soluble solids, total soluble solids / total acidity ratio, total sugars, reducing sugars and sucrose content), as well as higher yield (weight and number of fruits per tree) as compared to the light and heavy infested trees. While, in contrast, the percentage of acidity of fruits increased significantly in the fruits of infested trees (light and heavy) as compared to the uninfested ones.

The harmful / destructive effects of the *P. Oleae* infestation on the dufferential investigated flowering / productivity and fruit qualities (physical & chemical characteristics) of Balady mango seedlings trees it could be logically explained / discussed depending upon the depletion / exhausting of the photosynthetics substances and other nutritive materials exhibuted in the infested plants through sucking the cell sap with the pest mouth. Consequently a considerable shortage of such important nutritive components in tissues of various infested plants, organs han been taken place and induced some interruption in diffrent bio-physical processes to take place normally. So, *P. Oleae* infestation was reflected negatively on most / all the desirable mango measurements partically flowering, yield and fruit quality aspects.

Remarkable points must be taken into consideration:

Obtained results of our present research paper threw a green light towards the necessity for planning an applicable environmentally safe approaches to control such harmfull scale insects and like other pests through on integrate program, the giving guaranty to:

1- Avoid fruits pollution, 2- Preventing the intensive total population density of *P. oleae* during autumn months and 3- Allow tree activity *i.e.* bud (formation, induction and differentiation), fruit set and their development to take place well properly. So, such *P. oleae* controlling program must be investigated to be applied just after harvesting and before the most active stages / rings of both pest and tree life cycle.

From the explained results, it could be concluded that the *P. oleae* heavily infested trees exhibited the highest reduction in all studied measurements, except those of (the percentage of acidity of fruit) as compared with the free and light infested trees.

Generally, it seems that the loss in the measured parameters was a summation of many factors including not only the investigated one (rate of infestation) but also others such as irrigation, nutritional programs adopted in the orchard and climatic condition prevailing in the region.

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