International Journal of Agriculture and Plant Science
www.agriculturejournal.in
Online ISSN: 2664-7664, Print ISSN: 2664-7656
Received: 22-03-2023, Accepted: 06-04-2023, Published: 22-04-2023
Volume 5, Issue 2, 2023, Page No. 11-17

Evaluation the efficiency of Lanthanum Chloride (LaCl3) and Triacontanol Hormone (TRIA) on the infestation by *Bactrocera zonata* on peach trees

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Abstract
Experiments were conducted on peach trees *Prunus persica* (Fam.: Rosaceae) at Nobariya region (Behera Governorate) throughout two seasons 2020 and 2021 to experiment different ways on controlling the serious pest Peach Fruit Fly (PFF) *Bactrocera zonata* (Saunders) (Diptera: Tephritidae) on peach trees through study the comparison between effect of two compounds, Lanthanum Chloride (LaCl3) and Triacontanol Hormone (TRIA) on the infestation degree by that insect. Experiments were carried out by two concentrations of Lanthanum Chloride (1 ppm and 5 ppm) and two concentrations of Triacontanol Hormone (35 ppm and 50 ppm). Peach trees were sprayed by the two successive substances three times at the same time, 21 days between each of them. As data obtained indicated to that Lanthanum Chloride were more efficiency than Triacontanol Hormone on controlling the successive insect whereas mean numbers of *B. zonata* was decreased on peach trees when treated by Lanthanum Chloride more than when treated by Triacontanol Hormone. The data obtained showed also the effect of the low concentration of both of the two successive substances were more efficiency than the high concentration of the same substances and vice versa, the high concentration of both of the two successive compounds led to negative effect of the infestation by the successive insect.

Keywords: peach trees, *Bactrocera zonata*, Lanthanum Chloride (LaCl3), Triacontanol Hormone (TRIA), population

Introduction

Peach trees *Prunus persica* (L.) (Fam.: Rosaceae) is one of the most important and popular fruits in Egypt and all over the world. Anthony and Minas (2021) [1] referred to that peach *P. persica* is ranked as 6th most important tree fruit crop in the world. Also, Mosa *et al.* (2021) [8] in Egypt showed that peach *P. persica* belongs to the family of Rosacea is considered as one of the most nutritionally and economically important fruits consumed worldwide, and the cultivated area in Egypt is constantly increasing annually.

Peach Fruit Fly (PFF), *Bactrocera zonata* (Saunders) considers one of the most serious fruit flies causes damaging to many fruits crops, Thompson (1999) [15]. Also, Duyck *et al.* (2004) [3] referred to The peach fruit fly, *B. zonata* is one of the most harmful species of Tephritidae and it causes large amounts of damage in Asia. And Ni *et al.* (2012) [10] reported that The peach fruit fly, *B. zonata* is one of the most harmful species of Tephritidae which it causes serious damages to peach fruits and some other fruits in many countries located along or near the Mediterranean Sea. Also, Mouhammed *et al.* (2013) studied the host preference and performance of fruit flies *B. zonata* for various fruits and vegetables and found throughout their experiments that the host preference of the *B. zonata* fruit fly arranged as follow: peach, mango and apple respectively.

Lanthanum (La) element belongs to a group chemical compound called Rare Earth Elements (REEs). Lanthanum (La) element has an active activity against insects, bacteria, fungs and other fine lives while it consider a save element to human, Weppner *et al.* (2007) [17] who studied the effects of Lanthanum (La) element on some plants and referred to the positive effect of this element to some crops in low concentrations. Tandra *et al.* (2018) [14] referred to the importance of Lanthanum Chloride (LaCl3) compound in improving and positive effects on the morphological and physiological adjectives of maize yield.

Triacontanol Hormone (TRIA) is one of known growth regulators hormones. It has a positive effect on different plants in special concentrations. It has an important role for growth regulators plants and its role stimulated in changes some morphological and physiological plant adjectives when used in special concentrations. Srikant (2005) [13] in India referred to the effect of Triacontanol Hormone on photosynthesis, growth total chlorophyll, plant height and other adjectives in *Papaver somniferum*. Heba (2013) [4] studied the potential role of triacontanol in certain physiological adjectives of *Zea mays* L. grown under normal and environmental stress conditions and referred to its positive effect on growth and planting.

This study was carried out to comparison between effect of Lanthanum Chloride (LaCl3) and Triacontanol Hormone (TRIA) on the infestation degree by *B. zonata* infesting peach trees.

Materials and Methods

Experimental design

This study was conducted on peach trees *Prunus persica* (L.) at Nobariya region throughout two seasons 2020 and 2021 to comparison between effect of two compounds, Lanthanum Chloride (LaCl3) and Triacontanol Hormone (TRIA) on the infestation degree by Peach Fruit Fly (PFF), *Bactrocera zonata* (Saunders). Cultivated area were at both of the two successive seasons divided into five parts, first part cultivated with peach trees which did not treated with any substance (control), second and third parts cultivated with peach trees which treated by low and high concentration of LaCl3 (1ppm and 5ppm) respectively and fourth and fifth parts cultivated with peach trees which treated by low and high concentration of TRIA (35ppm and 50ppm) respectively. Each part contains 15 peach trees at

the same age almost. Spraying the two compounds was done three times, 21 days between each one and the other. 25 Jackson traps baited with sex attractant were distributed at the five replects, 5 Jackson traps at both replect. The traps were injected with 4 ml mixture of 80% Methyl eugenol as a sex attractant. Traps were hanged on the peach trees at about 1.5-2 m height from the ground. The traps were inspected weekly, catches of each treatment were collected separately in plastic bags. Plastic bags were examined in the laboratory and the fruit fly were identified and counted. All agricultural operations were conducted in a manner quite similar at both of the two seasons. The normal and recommended agricultural practices were applied, also no chemical control against insects were used during the study. It is proven accurate observations of the infestation by the *B. zonata* numbers in all plants weekly. Directly counting was done weekly during the season at both the two seasons all over all plants.

Laboratory design

Laboratory studies were carried out to study effectiveness of both the two successive compounds at the different concentrations on the morphological adjectives of peach tree such as leaf length and peach tree height. And laboratory studies contain also effect of the successive compounds on the most important internal components of peach trees such as total protein, total sugars, starch, amino acids and total phenols.

Determination of total proteins

Preparation of sample

Protein was extracted from fruits and prepared for assay. 100g of fruits samples were homogenized in enough water for 5 minutes to obtain suitable homogenate. The tissues were ground in liquid nitrogen with a mortar and pestle according to the method protein content of fruits samples was estimated by spectro-photometricall by the method of Laemmli (1970) [7].

Preparation of protein reagents

100 mg Coomassie Brilliant Blue G-250 was dissolved in 50 ml 95% ethanol. 100 ml phosphoric acid 85% (w/v) was added. The resulting solution was diluted to a final volume of 1 liter. Final concentrations in the reagent were 0.01% (w/v) Coomassie Brilliant Blue G-250, 4.7% (w/v) ethanol and 8.5% phosphoric acid.

Determination

100 µl of sample preparation was added to 100 µl phosphate buffer (pH 6.6). Five ml of protein reagent were added to the test tube and the contents were mixed well either by inversion or vortexing. The absorbance at 595 mm was measured after 2 minutes and before 1 hour, against a blank prepared from 200 µl phosphate buffer (pH 6.6) and 5 ml of protein reagent.

Total carbohydrates, total sugars and total phenols

Principle simple sugars, oligosaccharides, polysaccharides, and their derivatives, including methyl ethers with free or potential free reducing groups, give an orange-yellow color when treated with phenol and sulfuric acid. The reaction is sensitive and the color is stable.

Sample preparation

Carbohydrates, total sugars and total phenols were extracted from fruits samples and prepared for assay. Hundred grams of fruits samples were homogenized in enough water for 5 minutes to obtain suitable homogenate.

Determination

Carbohydrates, total sugars and total phenols content were determined by phenol-sulfuric acid reaction according to Sheri *et al*. (1957) [12]. A sample of 100 µl was added to 0.25 ml of phenol (20% w/v) in colorimetric tube. Then 2.5 ml of concentrated sulphuric acid were added to the test tube rapidly with shaking, (the stream of acid being directed against the surface rather than the side of test tube in order to obtain good mixing.). The tube was allowed to stand for 10 minutes; then shaken for 10 to 20 minutes in a water bath at 25 to 30°C, before readings are taken. The absorbance of the characteristic yellow-orange colour was measured at 490 nm. Blanks are prepared by substituting distilled water from sugar solution.

Determination of acidity

Fruit juice acidity was determined using Jenway pH Meter 3510.

Statistical analysis

The mean number of Peach Fruit Fly (PFF), *B. zonata* was analyzed statistically using ANOVA which indicates that significant differences were found. The simple correlation (r) and regression coefficient value (b) were adopted to clarify the change in the successive insect population due to change in the treated peach trees with the successive substance in different concentrations and the mean values compared with the least significant differences (LSD) as well as, SAS program (SAS Institute 1988).

Results and Discussion

This study was carried out to comparison between effect of Lanthanum Chloride (LaCl3) and Triacontanol Hormone (TRIA) on the infestation degree by Peach Fruit Fly (PFF), *Bactrocera zonata* (Saunders) on peach trees and some morphological adjectives and internal components of peach trees.

Season 2020

Data tabulated in Table (1) show the population fluctuation of *B. zonata* on peach trees which treated by the two successive compounds Lanthanum Chloride (LaCl3) and Triacontanol Hormone (TRIA) at the different concentrations compared to control (peach trees did not treat with any compound).

Table 1: Weekly mean numbers of Peach fruit fly, *B. zonata* males captured by Jackson traps on peach trees at Noubariya (Behera Governorate) during season 2020

Date	Lanthanum Chloride (LaCl3)		Triacontanol Hormone (TRIA)		Control
	1 ppm	5 ppm	35 ppm	50 ppm	
1/3/2020	-	-	-	-	-
8/3/2020	-	-	-	-	-

15/3/2020	-	-	-	-	-
22/3/2020	-	11	2	7	4
29/3/2020	3	15	5	12	7
5/4/2020	15	40	15	30	25
12/4/2020	20	60	20	55	47
19/4/2020	25	80	30	75	75
26/4/2020	60	150	55	145	149
3/5/2020	25	80	30	85	68
10/5/2020	14	60	18	50	38
17/5/2020	20	70	25	60	47
24/5/2020	23	80	30	70	66
31/5/2020	30	95	40	102	89
7/6/2020	60	150	50	145	135
14/6/2020	125	325	175	320	275
21/6/2020	140	408	230	375	350
28/6/2020	410	675	507	680	640
5/7/2020	700	1103	850	1040	995
12/7/2020	258	596	410	580	520
19/7/2020	200	465	235	445	378
26/7/2020	62	180	67	263	150
2/8/2020	35	125	50	90	65
10/8/2020	25	40	35	40	19
17/8/2020	12	20	15	30	10
24/8/2020	4	9	4	15	7
31/8/2020	0	3	2	8	5
Total	2266	4840	2900	4722	4164
Mean	83.9	179.3	107.4	174.9	154.2

Results showed that in Table (1) the population density of PFF on peach trees in Noubraia started with few numbers 3 fly/ trap/ week on 29th of March. The population density increased gradually to reach first peak in 26th of April and made the second peak in 5th of July then the population decrease gradually until the end of August, which conceding with the end of late peach harvest.

Data tabulated in Table (2) and (Fig. 1) showed that peach trees which treated by low concentration of Lanthanum Chloride (LaCl3) (1ppm) were lower infestation by Peach fruit fly, *B. zonata* compared to control whereas the mean number of *B. zonata* on peach trees which treated by low concentration of the successive material was 83.9 fly/ trap/ week compared to control whereas it was 154.2 fly/ trap/ week (reduction percentage 42.3%). While peach trees which treated by high concentration of LaCl3 (5ppm) were higher infestation by *B. zonata* compared to control whereas the mean number of *B. zonata* on peach trees which treated by high concentration of the successive material was 179.3 fly/ trap/ week compared to control whereas it was 154.2 fly/ trap/ week (increasing percentage 13.9%). While when treated peach trees by the other successive material Triacontanol Hormone (TRIA) by low concentration 25ppm were lower infestation by *B. zonata* compared to control whereas the mean number of *B. zonata* on peach trees which treated by low concentration was 107.4 fly/ trap/ week compared to control whereas it was 154.2 fly/ trap/ week (reduction percentage 30.4%). While peach trees which treated by high concentration of (TRIA) (50ppm) were higher infestation by *B. zonata* compared to control whereas the mean number of *B. zonata* on peach trees which treated by high concentration was 174.9 fly/ trap/ week compared to control whereas it was 154.2 fly/ trap/ week (increasing percentage 11.8%).

Table 2: Statically analysis of weekly mean numbers of Peach fruit fly, *B. zonata* males captured by Jackson traps on peach trees at Noubariya (Behera Governorate) during season 2020

Parameter	Lanthanum Chloride (LaCl3)		Triacontanol Hormone (TRIA)		Control
	1 ppm	5 ppm	35 ppm	50 ppm	
Total	2266	4840	2900	4722	4164
Mean	83.9 ^{c}	179.3 ^{b}	107.4 ^{c}	174.9 ^{b}	154.2 ^{a}
Reduction %	42.3	13.9	30.4	11.8	-
F (0.05)	275.83		395.11		
L.S. D	1.025		1.032		

Means within columns bearing different subscripts are significantly different ($P<0.05$)

The statically analysis showed that were highly significantly differences between population of *B. zonata* infested peach trees which treated by different concentrations of Lanthanum Chloride (LaCl3) compared to control whereas F (0.05) value and L.S.D value were (275.83, 1.025). Also, the statically analysis showed that were highly significantly differences between population of *B. zonata* infested peach trees which treated by different concentrations of Triacontanol Hormone (TRIA) compared to control whereas F (0.05) value and L.S.D value were (395.11, 1.032).

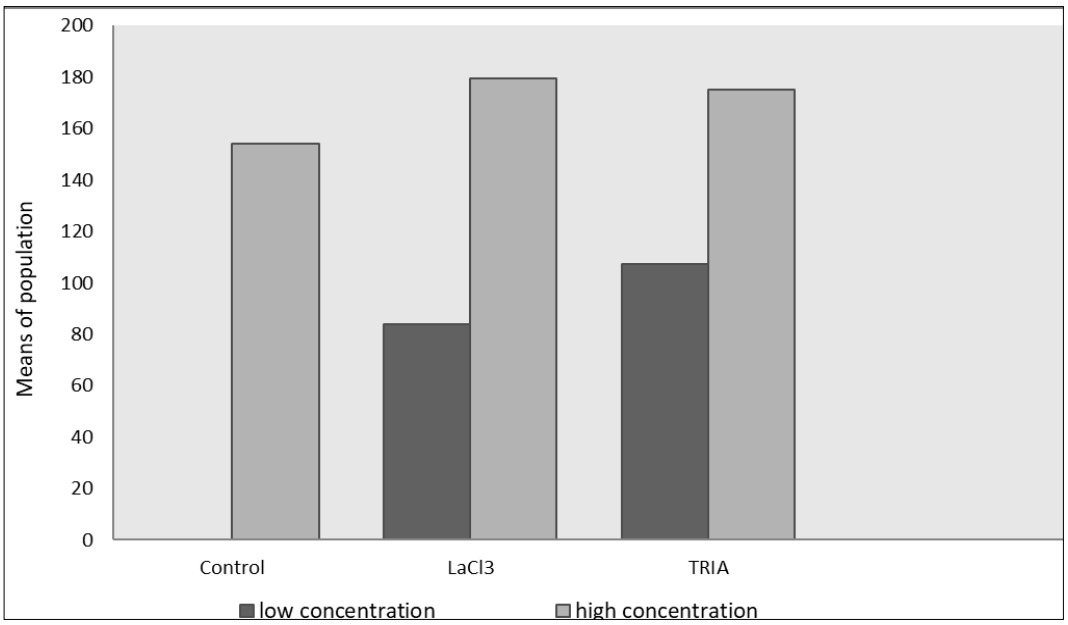

Fig 1: weekly mean numbers of Peach fruit fly, *B. zonata* males captured by Jackson traps on peach trees at Noubariya (Behera Governorate) during season 2020

Season 2021

Data tabulated in Table (3) show the population fluctuation of *B. zonata* on peach trees which treated by the two successive compounds at the different concentrations compared to control (peach trees did not treat with any compound) during season 2021 whereas data obtained showed that the population density began with few numbers and recorded 5 fly/ trap/ week on the 2nd of April. The population density increased gradually to reach recorded the one peak in 7th of May and made the second peak in 16th of July then the population decrease gradually until the beginning of September which conceding with the end of late peach harvest.

Table (3): Weekly mean numbers of Peach fruit fly, *B. zonata* males captured by Jackson traps on peach trees at Noubariya (Behera Governorate) during season 2021

Date	Lanthanum Chloride (LaCl3)		Triacontanol Hormone (TRIA)		Control
	1 ppm	5 ppm	35 ppm	50 ppm	
5/3/2021	-	-	-	-	-
12/3/2021	-	-	-	-	-
19/3/2021	-	-	-	-	3
26/3/2021	-	17	5	7	7
2/4/2021	5	22	9	12	10
9/4/2021	19	43	23	30	28
16/4/2021	26	65	29	55	52
23/4/2021	31	87	42	75	68
30/4/2021	52	108	55	115	109
7/5/2021	75	165	89	155	138
14/5/2021	23	95	45	80	73
21/5/2021	27	65	36	60	57
28/5/2021	25	85	41	70	64
4/6/2021	39	100	53	90	81
11/6/2021	71	175	62	145	135
18/6/2021	134	250	185	300	283
25/6/2021	154	390	242	375	365
2/7/2021	422	485	514	650	633
9/7/2021	525	635	765	810	790
16/7/2021	610	1374	805	1015	931
23/7/2021	333	534	341	625	389
30/7/2021	73	291	120	270	193
6/8/2021	49	175	78	130	103
13/8/2021	30	25	33	60	37
20/8/2021	12	19	17	20	15
27/8/2021	7	10	10	15	7
3/9/2021	3	5	6	8	3
Total	2745	5220	3605	5172	4574
Mean	101.7	193.3	133.5	191.6	169.4

Data tabulated in Table (4) and (Fig. 2) showed that peach trees which treated by low concentration of Lanthanum Chloride (LaCl3) (1ppm) were lower infestation by Peach fruit fly, *B. zonata* compared to control whereas the mean number of *B. zonata* on peach trees which treated by low concentration was 101.7 fly/ trap/ week compared to control whereas it was 169.4 fly/ trap/ week with reduction percentage 40.0%. While peach trees which treated by high concentration of LaCl3 (5ppm) were higher infestation by *B. zonata* compared to control whereas the mean number of *B. zonata* on peach trees which treated by high concentration was 193.3 fly/ trap/ week compared to control whereas it was 169.4 fly/ trap/ week with increasing percentage 12.4%. While when treated peach

Table 4: Statically analysis of weekly mean numbers of Peach fruit fly, *B. zonata* males captured by Jackson traps on peach trees at Noubariya (Behera Governorate) during season 2021

Parameter	Lanthanum Chloride (LaCl3)		Triacontanol Hormone (TRIA)		Control
	1 ppm	5 ppm	35 ppm	50 ppm	
Total	2745	5220	3605	5172	4574
Mean	101.7 [c]	193.3 [b]	133.5 [c]	191.6 [b]	169.4 [a]
Reduction%	40.0	12.4	28.4	10.4	-
F (0.05)	321.95		245.82		
L.S. D	1.078		1.092		

Means within columns bearing different subscripts are significantly different (P<0.05)

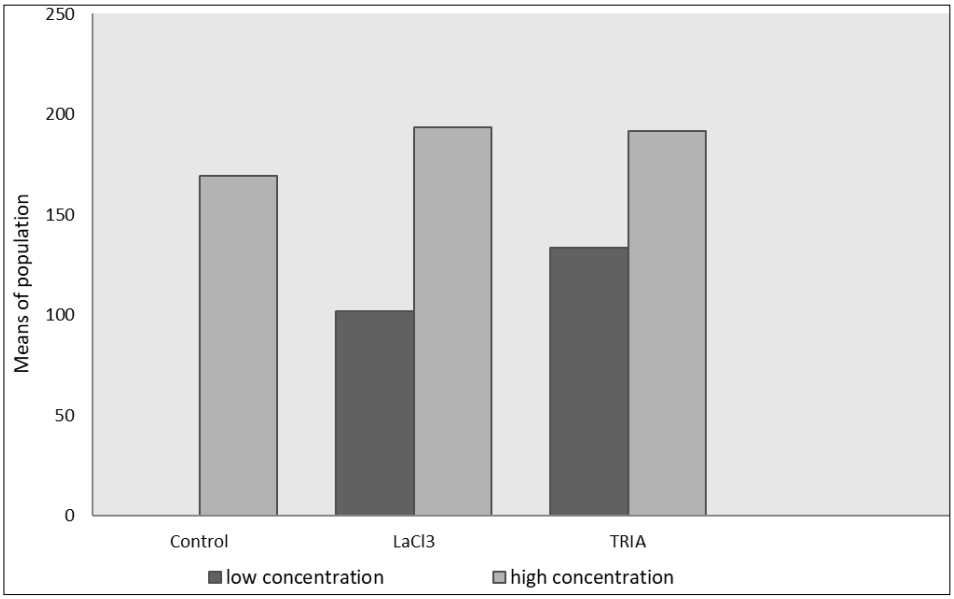

Fig 2: weekly mean numbers of Peach fruit fly, *B. zonata* males captured by Jackson traps on peach trees at Noubariya (Behera Governorate) during season 2021

trees by the other successive material Triacontanol Hormone (TRIA) by low concentration 25ppm were lower infestation by *B. zonata* compared to control whereas the mean number of *B. zonata* on peach trees which treated by low concentration was 133.5 fly/ trap/ week compared to control whereas it was 169.4 fly/ trap/ week with reduction percentage 28.4%. While peach trees which treated by high concentration of (TRIA) (50ppm) were higher infestation by *B. zonata* compared to control whereas the mean number of *B. zonata* on peach trees which treated by high concentration was 191.6 fly/ trap/ week compared to control whereas it was 169.4 fly/ trap/ week with increasing percentage 10.4%.

The statically analysis showed that were highly significantly differences between population of *B. zonata* infested peach trees which treated by different concentrations of Lanthanum Chloride (LaCl3) compared to control whereas F (0.05) value and L.S.D value were (321.95, 1.078). Also, the statically analysis showed that were highly significantly differences between population of *B. zonata* infested peach trees which treated by different concentrations of Triacontanol Hormone (TRIA) compared to control whereas F (0.05) value and L.S.D value were (245.82, 1.092). Data of seasonal fluctuation of population density of *B. Zonata* indicated that it had two peaks in the year and the population density in the second year was higher than in the first year.

Effect of Lanthanum Chloride (LaCl3) and Triacontanol Hormone (TRIA) on the morphological characteristics and internal components of peach trees

Data tabulated in table (5) show effect both of Lanthanum Chloride (LaCl3) and Triacontanol Hormone (TRIA) at both of the two tested concentrations of each compound on the morphological characteristics and internal components of peach trees.

Table (5): Effect of treated peach trees by different concentrations of Lanthanum Chloride (LaCl3) and Triacontanol Hormone (TRIA) on the morphological characteristics and internal components

Adjective	Control	Lanthanum Chloride (LaCl3)		F	LSD	Triacontanol Hormone (TRIA)		F	LSD
		1 ppm	5 ppm			35 ppm	50 ppm		
Leaf length (cm)	12.5 [a]	15.5 [c]	10.2 [b]	235.25	1.023	14.8 [c]	11.0 [b]	521.33	1.095
Plant height (m)	6.5 [a]	7.3 [c]	6.0 [b]	347.85	1.056	6.9 [c]	6.2 [b]	487.31	1.077
Total sugars (mg/100g)	25.37 [a]	29.45 [c]	21.87 [b]	421.86	1.077	27.21 [c]	22.85 [b]	385.22	1.032
Total protein (mg/100g)	15.56 [a]	19.35 [c]	12.25 [b]	312.77	1.082	17.33 [c]	13.21 [b]	235.57	1.075

Starch (mg/100g)	12.25 [a]	15.32 [c]	10.45 [b]	521.73	1.091	14.21 [c]	10.92 [b]	281.76	1.088
Amino acids (mg/100g)	9.35 [a]	12.15 [c]	7.53 [b]	298.77	1.055	11.5 [c]	7.98 [b]	377.82	1.093
Total phenol (mg/100g)	11.57 [a]	14.33 [c]	8.62 [b]	275.81	1.075	13.76 [c]	9.85 [b]	425.12	1.077

Means within columns bearing different subscripts are significantly different ($P<0.05$)

The results obtained at Table (5) showed as all that Lanthanum Chloride (LaCl3) material was more effectiveness than Triacontanol Hormone (TRIA) on improving the morphological characteristics of peach trees such as (leaf length and plant height) and also the internal components of peach fruits such as (total protein, starch, amino acids and total phenols) compared to control (peach trees which did not treat by any material). Data obtained showed also that the low concentration of Lanthanum Chloride LaCl3 (1ppm) which were (15.5cm and7.3m) and (29.45, 19.35, 15.32,12.15 and 14.33mg/100g) were more effectiveness than the high concentration of the same material (5 ppm) on improving the morphological characteristics and the internal components of peach trees compared to control. Also, the low concentration of Triacontanol Hormone TRIA (35 ppm) were (14.8 cm and 6.9m) and (27.21,17.33, 14.21 11.5 13.76 mg/100g) were more effectiveness was more effectiveness than the high concentration of the same material (50 ppm) on improving that characteristics of peach trees compared to control.

These results agreement with those obtained by Ismail (2012) in Egypt who indicated to The Peach Fruit Fly (PFF), *Bactrocera zonata* (Saunders) is an important agricultural pest in Egypt and referred to monitoring and control of this species is relating to collecting data of traps catching, and the efficiency of jackson traps attraction has an important role to decrease the population density of *B. zonata*. Emam *et al.* (2022) [2] who referred to the effectiveness of Lanthanum Chloride (LaCl3) on controlling The Rose Aphid, *Macrosiphum rosae* L. on rose plants through effect on that insect physiology. And indicated to the serious effect of that material at the low concentration (1ppm) on decreasing the population of the successive insect and vice versa, the population of the successive insect increased at the high concentration of that material (5ppm). Also, Heba and Azza (2020) [5] in Egypt studied effect of treated *Vigna ungiculata* seeds by two different concentrations of lanthanum nitrate (1 and 5 ppm) on the susceptibility of the plants to pathogen infection during germination stage, and found that the low concentration was the high positive effect on the germination. Tandra *et al.* (2018) [14] who indicated to Lanthanum element belong to a group of elements known as "Lanthanons" which also includes cerium, europium and promethium, and also indicated to the positive effect of lanthanum in the cellular systems in some plants at certain concentrations. Shukla *et al.* (2000) [16] in Netherlands indicated to effect of Triacontanol hormone (TRIA) at low concentrations on growth of some yields and found when treated plants with low concentration of (TRIA) led to positive effect on some plant adjectives such as plant height.

Conclusion

Results obtained indicated to that Lanthanum Chloride (LaCl3) was more efficiency than Triacontanol Hormone (TRIA) on controlling the successive insect Peach Fruit Fly (PFF) *Bactrocera zonata*. Whereas mean numbers of *B. zonata* was decreased on peach trees when treated by Lanthanum Chloride more than when treated by Triacontanol Hormone. The data obtained showed also the effect of the low concentration of both of the two successive substances were more efficiency than the high concentration of the same substances and vice versa, the high concentration of both of the two successive compounds led to negative effect of the infestation by the successive insect.

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