IMPACT CERTAIN PLANT EXTRACTS ON TOXICITY, BIOCHEMICAL EFFECTS AND SOME BIOLOGICAL MEASUREMENTS OF PEACH FLY, *Bactrocera zonata* (SAUNDERS)

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ABSTRACT

*Bactrocera zonata* (Saunders) flies are the dangerous insect pests of fruit, vegetables, and nuts over the world. This study provides the published information on toxicity, biochemical effects and some biological measurements of the peach fly, *B. zonata* by using some plant extracts (phytochemicals) namely *Moringa oleifera* oil, lemon peel oil and *M. oleifera* leaf extract, which would be more informative for publication facilitating related to integrated pest management (IPM) strategies of *B. zonata*.

Effect of different concentrations of *M. oleifera* oil, lemon peel oil and *M. oleifera* leaf extract on biochemical effects (total proteins, total carbohydrates and acetylcholine esterase enzyme) and some biological aspects (pupal mortality, pupal duration, adult emergence, emerged deformed adult and malformation score) of the peach fly, *B. zonata* were studied. Results showed that *M. oleifera* oil is highly toxic to pupae of the peach fly, *B. zonata* with LC₅₀ of 2.569, 2.773 and 2.370ml/L and LC₉₀ of 85.459, 92.171 and 18.314ml/L in yellow, sandy and clay soils respectively. Whereas lemon peel oil come in the second position in order of toxicity and *M. oleifera* leaf extract was the least toxic compound.

These results cleared that concentrations of total proteins, total carbohydrates and acetylcholine esterase enzyme activity markedly decreased in pupae of *B. zonata* after exposure to *M. oleifera* oil, lemon peel oil and *M. oleifera* leaf extract with highly significant effects compared with control. Obtained results showed that an inhibitory action of *M. oleifera* oil, lemon peel oil and *M. oleifera* leaf extract at all each of concentration levels when mixed with three types of soils namely, yellow soil, sandy soil and clay soil compared with untreated. These results suggest that three tested plant extracts has the probably to be used as a natural plant productions to control of the peach fly, *B. zonata*.

Keywords: Plant extracts; Biochemical effects; Biological aspects; *Bactrocera azonata*

INTRODUCTION

Peach flies, *Bactrocera* spp. (Diptera: Tephritidae) prevalent in the tropics and subtropics (Drew & Hancock, 1994), and are considered as one of the most serious insect pests of fruits and vegetables world over. However, the maintain and protection of food crops from insect pest especially *Bactrocera zonata* (Diptera: Tephritidae) are most important in agricultural sectors (Paul et al 2009; Ekesi et al 2016). Peach fruit fly is considered polyphagous insect, which infested numerous types of fruit species such as peach, mango, guava and apple (Hashem et al 2001). Direct fruit damage, falling fruit, and loss of markets of export through quarantine constraints are the mechanisms by which infestation of fruit fly causes economic losses to the farmers. Due to dispersal capacity, high mobility, and fecundity, a lot of fruits and vegetables viz., peach, mango, guava, citrus, tomato, cucurbits etc. are infested by fruit flies which affecting the produce both qualitatively and quantitatively. *B. zonata* was recorded in Egypt in 1999, and caused several losses to a wide range of fruits including peach, mango, guava and apricot (El-Minshawy et al 1999).
Natural products in the form of plant solvent extracts have been suggested for the fruit flies control, however some of them have weak activity thus. Preserving above in view, the present investigation was proposed with the following objectives:

1) To know toxicity and biochemical effects of the three plant extracts against peach fly pupae, *B. zonata*.
2) To evaluate the same plant extracts mixed with three types of soils in the laboratory against peach fly pupae, *B. zonata*.

**MATERIALS AND METHODS**

The present investigation was conducted under laboratory condition. The materials used and methodology adopted for these experiments are described below:

1- *Raising and Maintenance of Laboratory Culture*

The general culture of fruit fly, *B. zonata* was raised from the laboratory colony reared in the Horticulture Insects Department, Plant Protection Research Institute, Dokki, Giza, Egypt. Peach fly was reared under laboratory conditions of 25 ± 3°C and 60 ± 5 % R.H. Larvae were reared on an artificial diet consisting of 500 ml water, 3 g sodium benzoate, 3 g citric acid, 84.50 g sugar, 84.50 g brewer’s yeast and 330 g wheat bran. These constituents of were carefully mixed in a large plastic container. Then eggs were scattered on the surface of the diet which was placed in plastic plates of 175mL plastic cups (4.5 cm base diameter, 7.0cm top diameter, and 8.5cm height) that were tightly covered with muslin. After that, the plates were placed in a wooden cage with sand at the bottom to allow the jumping larvae to pupate (*Shehata et al* 2006).

Adults of *B. zonata* were reared in a cage (100 × 30 × 30 cm) with wooden frames covered on each side with a metal screen. Flies were fed on sugar and enriched protein hydrolysate at a ratio of 3:1, respectively. The cage was supplied with plastic fruits that had several small pores (as an oviposition vessel). These plastic fruits were filled with about 3 ml water to receive and prevent drying of the eggs. Also, at the top of these plastic fruits, small plastic vials containing cotton priming soaked with guava juice were put to enhance egg laying within these false fruits. In order to meet their water requirements the flies were also provided with water saturated cotton swabs in a 20 ml plastic phial filled with water inside the cages. Plastic cups filled with water were placed below the legs of cages to avoid the entry of ants.

2. *Laboratory evaluation of Moringa oleifera oil, Lemon peel oil and M. oleifera leaf extract as singly tested against pupal stage of peach fly, Bac- trocera zonata*

Different plant extracts, namely *M. oleifera* oil, lemon peel oil and *M. oleifera* leaf extract were evaluated against *B. zonata* pupae in the laboratory. The list of products along with the other details of source of availability is given in Table (*1*).

**Table 1.** List of different test materials used in the present study

| Test material | Source |
|---------------|--------|
| Lemon peel oil | Institute of Food Technology, Agricultural Research Center |
| *Moringa oleifera* oil | National Research Center, Moringa Production Unit |
| *Moringa oleifera* leaf extract | National Research Center, Moringa Production Unit |

3. *Extraction*

The collected plant parts (seeds, peels and leaves) of *M. oleifera* oil, lemon peel oil and *M. oleifera* leaf, respectively were washed under tap water followed by distilled water and dried under shade. Dried samples were powdered in mixer/grinder. Powder of leaves was mixed with distilled water in a ratio of 1:1 (w/v) and left overnight to allow the constituents to get dissolved in water, then filtered through muslin cloth and 100% plant extract solution was prepared according to El–Mohamedy and Abdalla (2014). Extraction of seeds and peels oil were prepared according to Harvey and John (1898) protocol. Each was used with three concentrations. 1.5ml of *M. oleifera* oil and lemon peel oil dissolved in 1L. distilled water to prepare a concentration of 1.5ml/L by adding tween 80 to disperse the oil in the solution and 3ml to prepare a concentration of 3ml/L; and so the remaining concentration to 6ml/L. By the same way the other concentrations of *M. oleifera* leaf extract (1.5, 3 & 6ml/L), were prepared without tween 80.
4. Biochemical Assays

Four hundred and five individuals of 1-day-old pupae were dipped for 10 seconds in three concentrations of each of the three tested extracts (M. oleifera oil, lemon peel oil and M. oleifera leaf extract) were collected and immediately kept in a deep freezer for biochemical analysis. Biochemical assay has been carried out to determine the effect of the concentrations of the three tested plant extracts on (total proteins, total carbohydrates and acetylcholine esterase enzyme) of, B. zonata pupae.

Total proteins were determined according to the method described by Bradford (1976). The total carbohydrates were estimated in acid extract of pupae by the phenol-sulphuric acid reaction of Dubois et al (1956) and were extracted and prepared for assay according to Crompton and Birt (1967). AchE (acetylcholine esterase) activity was measured according to the method described by Simpson et al (1964), using acetylcholine bromide (AchBr) as substrate.

Data of latent effects and biochemical analysis were statistically analyzed according to completely randomized design (Finney, 1971 & Snedecor and Cochran, 1972).

5. Treated types of soils

Three concentrations of each M. oleifera oil, lemon peel oil and M. oleifera leaf extract were used in toxicity determination. Concentrations, 1.5, 3 and 6 ml/L of the three tested extracts were mixing with three types of soils namely, yellow soil, sandy soil and clay soil. The concentrations were replicated 3 times. Each type of soil (150g) was thoroughly mixed with 15 mL of previously prepared concentration as mentioned above. Each soil with the previously indicated concentrations were individually transferred into 175 mL plastic cups (4.5 cm base diameter, 7.0 cm top diameter, and 8.5 cm height) provided with perforated lids. The treated soil made a height of 5 cm in cups with 15 gr. Ten pupae of B. zonata were exposed to each concentration. All concentrations were replicated 3 times. Untreated soil was used as a control with the same number of pupae and replicates. Numbers of pupae died were recorded after adult emergence. Mortality percentages were corrected for each concentration with control according to Abbott (1925).

6. Morphogenetic Action of The Tested Plant Extracts Against Pupae of B. zonata

The morphological deformities resulted from treatment assessed as morphological deformities pupal-adult intermediates. The obtained malformations were evaluated as graded scoring system. The degree of morphological action (score) was evaluated by multiplying the number of pupae or adults by their numerical activity ratings and dividing the sum by the total number of treated pupae. An unaffected stage should receive a zero score; maximum observed response and not the maximum theoretical response should set the highest number. The total score were computed using the formula of Redfern et al (1970).

\[
\text{The treated individuals x degree of score} \div \text{The total number of individuals}
\]

7. Statistical analysis

Regression toxicity lines were established for the tested plant extracts and the slope, LC50, and LC90 values were estimated using Probit analyses (Finney, 1971). For biochemical investigations, calculated lethal concentrations of 50% of M. oleifera oil, lemon peel oil and M. oleifera leaf extract were used for pupal treatments. The data recorded under laboratory condition was subjected to statistical analysis to find out the significance of the results obtained. SPSS 14 for windows software package was used for statistical analysis of biological aspects using least significant difference (LSD).

RESULTS AND DISCUSSION

In the present study, evaluation of some plant products as biopesticides were carried out in the laboratory against peach fly pupae. The results so obtained are presented hereunder:

1. Toxicity bioassays

This experiment was conducted to study the effect of M. oleifera oil, lemon peel oil and M. oleifera leaf extract for their toxicity against pupal stage when mixed with three types of treated soil under laboratory conditions.
The results presented in Table (2) indicated that *M. oleifera* oil was the most potent plant extract to the pupal stage since the calculated values of LC$_{50}$ and LC$_{90}$ were 2.370, 2.569 & 2.773 and 18.314, 85.459 & 92.171 ml/L in clay, yellow and sandy soils respectively. Whereas lemon peel oil come in the second position in order of toxicity recording the values of 3.754, 5.609 & 5.758 and 17.142, 66.017 & 48.429 ml/L as LC$_{50}$ and LC$_{90}$ in clay, sandy and yellow soils respectively. *M. oleifera* leaf extract was the least toxic compound where the LC$_{50}$ and LC$_{90}$ values were 3.915, 5.549 & 7.429 and 77.142, 62.239 & 52.509 ml/L in clay, sandy and yellow soils respectively. The toxicity index of three compounds at both levels of LC$_{50}$ was calculated which could be arranged descendingly as follow: *M. oleifera* oil, lemon peel oil and *M. oleifera* leaf extract. These results are in agreement with those of Mosallam (1993) who evaluated some pesticides as soil treatment (sand, silt and clay) against pupae of the *Ceratitis capitata*. Pyriproxyfen was the most potent against the pupal stage of treatment.

Table 2. Toxicity of *Moringa oleifera* oil, lemon peel oil and *M. oleifera* leaf extract on pupae of *B. zonata* when mixed with treated soil

| Treatment                  | N *  | Lethal concentrations** | Slope ± SE | Toxicity index at LC$_{50}$ |
|----------------------------|------|-------------------------|------------|-----------------------------|
| **Moringa oleifera oil**   |      |                         |            |                             |
| Yellow soil                | 30   | 2.569                   | 85.459     | 4.654                       |
| sandy soil                 | 30   | 2.773                   | 92.171     | 4.627                       |
| Clay soil                  | 30   | 2.370                   | 18.314     | 4.459                       |
| **Lemon peel oil**         |      |                         |            |                             |
| yellow soil                | 30   | 5.758                   | 48.429     | 3.946                       |
| sandy soil                 | 30   | 5.609                   | 66.017     | 4.104                       |
| clay soil                  | 30   | 3.754                   | 17.141     | 3.883                       |
| **Moringa oleifera Leaf extract** | |                         |            |                             |
| yellow soil                | 30   | 7.429                   | 52.509     | 3.685                       |
| sandy soil                 | 30   | 5.549                   | 62.239     | 4.687                       |
| clay soil                  | 30   | 3.915                   | 77.142     | 4.413                       |

2. Effect of The Tested Plant Extracts on Some Biochemical Effects of *Bactrocera zonata* Pupae

2.1. Total proteins

Data in Table (3) show that in all treatments of the 1-day old pupae of *B. zonata* with tested plant extracts caused a reduction in the level of total proteins where 12.11 mg/g. b. wt in the highest concentration that obtained with *M. oleifera* oil compared with 17.28 and 17.49 mg/g. b. wt in the same concentration in lemon peel oil and *M. oleifera* leaf extract respectively while in case of control was 24.13 mg/g. b. wt. Regard to the respecting pupae total proteins show highly significant difference between control and the tested plant extracts. These results are in agreement with those of Halawa et al (2013) who showed that the level of total proteins were decrease in the activity in *B. zonata* pupae resulted from Beticol, Biosad, Elsan, Lufax, Mani, Match and Radiant during all tested periods as compared to control. Recently (Farag et al 2017) reported that both Biomectin and Tracer showed toxic effects to *B. zonata* flies, the amount of protein level decreased in treated flies compared to control.

2.2. Total carbohydrates

For total carbohydrate concentrations in *B. zonata* pupae, the tested plant extracts were highly significant reduced the total carbohydrates concentrations (0.72, 1.47 and 2.01 mg/g. b. wt) at the highest concentrations of *M. oleifera* oil, *M. oleifera* leaf extract and lemon peel oil, respectively comparing with untreated pupae (3.10 mg/g. b. wt) Table 3. These results are in agreement with those of Sharma et al (2011) cleared that the Carbohydrate (glucose) levels were increased to 27.87% and 46.8%, respectively in anopheline larval tissues after treatment with petroleum ether extract of *Artemisia annua* and methanolic extract of *Azadirachta indica*. In culicine larvae, glucose levels were reduced to 58.96% and 24.65%, respectively.
2.3. AchE enzyme activity

Data tabulated in Table (3) show that the activity of AchE enzyme in pupae of B. zonata was highly significant decreased in the tested plant extracts compared to control. It was 53.39, 60.86 and 60.96μg Ach Br/min/g.b. wt at the highest concentration of lemon peel oil, M. oleifera leaf extract and M. oleifera oil than that obtained with control 75.96μg Ach Br/min/g.b. wt, respectively. Ach E is a key enzyme which terminates never impulses by catalyzing the hydrolysis of neurotransmitter acetylcholine, in the nervous system of different organisms. Additionally, it's known that, the altered Ach E activity, is one of the main resistance mechanisms in many insects (Wang et al 2004 and Nathan, 2013). The obtained results are in agreement with those of Halawa et al (2013) who showed that the activity of AchE enzyme in the 2-day pupae of peach fruit fly, B. zonata was generally decreased in treatment with Biosad, Elsan, Lufox, Mani, and Match compared to untreated. Similarly Farag et al (2017) illustrated that activity of acetylcholine esterase decrease in treated individuals with Biomectin and Tracer compared to untreated ones.

3. Laboratory evaluation of Moringa oleifera oil, lemon peel oil and M. oleifera leaf extract as singly tested against pupal stage of peach fly, B. zonata

The tested plant extracts namely M. oleifera oil, lemon peel oil and M. oleifera leaf extract were evaluated in the laboratory against peach fly pupae, B. zonata, by mixing the three types of soils at the required concentration and the results of these experiments are as below:

3.1 Effect of Moringa oleifera oil, lemon peel oil and M. oleifera leaf extract on some biological measurements

3.1.1 Effect of pupal mortality

Effect of M. oleifera oil, lemon peel oil and M. oleifera leaf extract on percentage of pupal mortality at different concentrations 1.5, 3 and 6ml/L are shown in Tables (4, 5 & 6). Generally, data indicated that percentage of pupal mortality were increased gradually with increase concentration and the percent mortality showed noticeable higher values were 6, 5 & 4.66 in treated yellow soil and values were 6.33, 5 & 5 in treated sandy whereas, in clay soils the values were 7, 6.33 & 6 at concentration of 6ml/L respectively.

Table 3. The effect of certain plant extracts on biochemical constituents of B. zonata pupae after dipping for 10 seconds

| Treatment                              | Concentration ml/L | Total proteins (mg/g.b.wt) | Total carbohydrates (mg/g.b.wt) | AchE enzyme (μg Ach Br/min/g.b. wt) |
|----------------------------------------|--------------------|-----------------------------|--------------------------------|-------------------------------------|
| Moringa oleifera oil                   | 1.5                | 18.28                       | 2.63                           | 64.15                               |
|                                        | 3.0                | 16.68                       | 1.38                           | 64.01                               |
|                                        | 6.0                | 12.11                       | 0.72                           | 60.96                               |
| lemon peel oil                         | 1.5                | 19.48                       | 2.81                           | 69.87                               |
|                                        | 3.0                | 18.60                       | 2.31                           | 63.20                               |
|                                        | 6.0                | 17.28                       | 2.01                           | 53.39                               |
| Moringa oleifera leaf extract          | 1.5                | 22.22                       | 1.98                           | 66.13                               |
|                                        | 3.0                | 20.79                       | 1.60                           | 66.43                               |
|                                        | 6.0                | 17.49                       | 1.47                           | 60.86                               |
| Control                                | -                  | 24.13                       | 3.10                           | 75.96                               |
| F. test                                |                    |                             |                                |                                     |
| L.S.D                                  |                    | 0.428                       | 1.149                          | 2.931                               |
Table 4. Effect of lemon peel oil, *Moringa oleifera* oil and *M. oleifera* leaf extract on *B. zonata* pupae* when mixed with yellow soil

| Treatment                  | Concentration ml/L | Pupal mortality | Pupal duration /day | % Adult emergence | % Emerged deformed adult | Malformation score |
|----------------------------|--------------------|-----------------|---------------------|-------------------|------------------------|-------------------|
| Lemon peel oil             | 1.50               | 2.00            | 7.00                | 80.00             | 20.83                  | 1.33              |
|                            | 3.00               | 3.66            | 10.00               | 63.33             | 37.27                  | 2.33              |
|                            | 6.00               | 5.00            | 12.00               | 50.00             | 41.10                  | 2.17              |
| *Moringa oleifera* oil     | 1.50               | 4.00            | 8.00                | 60.00             | 21.70                  | 1.63              |
|                            | 3.00               | 5.66            | 9.33                | 43.33             | 23.33                  | 2.33              |
|                            | 6.00               | 6.00            | 14.66               | 40.00             | 26.10                  | 2.30              |
| *Moringa oleifera* leaf extract | 1.50            | 1.66            | 6.00                | 83.33             | 15.73                  | 0.33              |
|                            | 3.00               | 2.33            | 8.00                | 76.66             | 25.57                  | 1.00              |
|                            | 6.00               | 4.66            | 9.66                | 53.33             | 35.93                  | 1.47              |
| Control                    | -                  | 0.66            | 7.00                | 93.33             | 0.00                   | 0.23              |

F. test | ** | ** | ** | ** | ** | **
L.S.D    | 1.002 | 0.695 | 10.020 | 3.258 | 0.222 |

* (3 replicates each 10 pupae)

Table 5. Effect of lemon peel oil, *Moringa oleifera* oil and *M. oleifera* leaf extract on *B. zonata* pupae when mixed with sandy soil

| Treatment                  | Concentration | Pupal mortality | Pupal duration /day | % Adult emergence | % Emerged deformed adult | Malformation score |
|----------------------------|---------------|-----------------|---------------------|-------------------|------------------------|-------------------|
| Lemon peel oil             | 1.50          | 2.33            | 8.33                | 76.66             | 13.10                  | 0.70              |
|                            | 3.00          | 4.00            | 12.66               | 60.00             | 21.70                  | 1.67              |
|                            | 6.00          | 5.00            | 14.66               | 50.00             | 26.10                  | 2.13              |
| *Moringa oleifera* oil     | 1.50          | 4.33            | 7.00                | 56.66             | 18.10                  | 1.03              |
|                            | 3.00          | 4.66            | 11.00               | 53.33             | 18.87                  | 1.67              |
|                            | 6.00          | 6.33            | 12.66               | 36.66             | 27.77                  | 2.90              |
| *Moringa oleifera* leaf extract | 1.50        | 4.00            | 6.66                | 60.00             | 22.20                  | 0.33              |
|                            | 3.00          | 4.66            | 10.00               | 53.33             | 24.50                  | 0.67              |
|                            | 6.00          | 5.00            | 11.66               | 50.00             | 53.33                  | 1.27              |
| Control                    | -             | 1.00            | 7.66                | 90.00             | 0.73                   | 0.50              |

F. test | ** | ** | ** | ** | ** | **
L.S.D    | 0.775 | 1.413 | 7.752 | 6.208 | 0.418 |

Statistical analysis assures that there were highly significant differences between the three tested plant extracts and control in three tested types of soils. These results are in agreement with those of Negm (2014) who cleared that the tested concentrations of Novaluron significantly reduced pupal mortality of *B. zonata*.

3.1.2 Effect of pupal duration

Results obtained in Tables (4, 5 & 6) revealed that percentages of pupation were increased gradually which showed higher value recording 12.00, 14.66 & 9.66 day in treated yellow soil and 14.66, 12.66 & 11.66 day in treated sandy soil and 15.00, 16.33 & 14.00 day in treated clay soil at the highest concentration when treated with lemon peel oil, *M. oleifera* oil and *M. oleifera* leaf extract respectively. In general, lemon peel oil, *M. oleifera* oil and *M. oleifera* leaf extract caused elongated the pupal duration when the concentrations were increased. Statistical analysis of the data revealed that this increase in pupal duration was significant for the three tested plant extracts compared with untreated in treated sandy soil while was highly significant differences in treated yellow and clay soils.
3.1.3 Effect of % adult emergence

In case of treated soils with M. oleifera oil, lemon peel oil and M. oleifera leaf extract it was found in Tables (4, 5 & 6) that adult emergence was concentration-related. It decreases with increase of concentrations until reach to very low emergence (40.00%, 50.00% & 53.33%) in treated yellow soil respectively at the highest concentration (6ml/L) compared with untreated counterparts (control) which was 93.33%. While in treated sandy soil adult emergence decrease in treatment with M. oleifera oil which reach to very low emergence (36.66%) compared with lemon peel oil (50.00%) and M. oleifera leaf extract (50.00%) at the highest concentrations and control was 90.00%. In case of treated clay soil, adult emergence was very low decreased compared with treated yellow and sandy soils which reached to 30.00%, 36.66% and 40.00% at the highest concentrations when treated with M. oleifera oil, lemon peel oil and M. oleifera leaf extract respectively. This decrease was highly significant concerning the three tested plant extracts and control in three tested types of soils. The obtained results are in agreement with those of Abo El-ma-hasen et al (2010) who found that a reduction in adult emergence of house fly which was completely inhibited at 1000 and 2000 ppm of Pyriproxyfen (insect growth regulators). Negm (2014) who showed that the tested concentrations of Novaluron significantly reduced adult emergence of B. zonata.

3.1.4. Effect of %Emerged deformed adult

According to the concentrations of lemon peel oil, M. oleifera oil and M. oleifera leaf extract which mixed the yellow, sandy and clay soils, the percentage of emerged deformed adult was concentration dependent where it reached the maximum values as 41.10%, 26.10% and 35.93% respectively in yellow soil while in treated sandy soil as 26.10%, 27.77% & 33.33% and in treated clay soil were 44.43%, 55.50 & 55.50 % respectively at a concentration of 6ml/L. Pupae and emerged adult flies showed different scores of deformities in all parts of the body; plates(a, 1-2-3-4 -5) cleared pupal-adult intermediate individuals. It is likely that all these deformities could attributed to the interference of the three plant extracts with the hormonal system of pupae and adults. Statistical analysis of the data revealed that there were highly significant differences between the three tested plant extracts and control in three tested types of soils (Tables 4, 5 & 6). The results are also in agreement with those reported by Kelany et al. (1991) who found that different grades (scores) of deformities in emerged flies of M. domestica when treated with aqueous neem seed kernel extract. Hussein (1995) mentioned that the vetia oil and clove oil caused 28.0% and 20.5% malformation in pupae of Parasarcophaga aegyptiaca respectively. These results are in harmony with those obtained by Selim (2005) who found that treatment of 3rd larval instar of M. domestica with NeemAzal-T and galangal extract caused abnormalities in larvae, pupae and adults. Khalil et al (2010) who stated that Pyriproxyfen induced high malformations percentage in the adult fly of M. domestica.

3.1.5. Malformation score

Results in Tables (4, 5 & 6) showed that mean of malformation score of deformed adults produced after treatment with M. oleifera oil were increased gradually which showed higher value recording 2.90, 2.73 & 2.30 at the highest concentration in sandy, clay and yellow soils respectively. The same trend, in treatments with lemon peel oil and M. oleifera leaf extract which cleared at the highest concentration, the highest values were 3.07, 2.17 & 2.13 and 1.93, 1.47 &1.27 in clay, yellow and sandy soils, respectively. Statistical analysis showed that there were highly significant differences between the three tested plant extracts and untreated in three tested types of soils. The present results are in conformity with those reported by Fahmy et al (2013) who recorded the morphogenetic activity as larval-adult and pupal-adult intermediates of B. zonata resulting from IGRs treatment where the EC50 values for 1-day pupae were 2.80, 1450 and 5000 ppm, for Pyriproxyfen, Methoxyfenozide and Novaluron, respectively.
Table 6. Effect of lemon peel oil, *Moringa oleifera* oil and *M. oleifera* leaf extract on *B. zonata* pupae when mixed with clay soil

| Treatment               | Concentration | Pupal mortality | Pupal duration /day | % Adult emergence | %Emerged deformed adult | Malformation score |
|------------------------|---------------|-----------------|---------------------|------------------|-------------------------|-------------------|
| Lemon peel oil         | 1.50          | 2.00            | 10.00               | 80.00            | 28.93                   | 1.63              |
|                        | 3.00          | 4.66            | 13.66               | 53.33            | 37.60                   | 2.60              |
|                        | 6.00          | 6.33            | 15.00               | 36.66            | 44.43                   | 3.07              |
| *Moringa oleifera* oil| 1.50          | 3.66            | 9.00                | 63.33            | 31.70                   | 2.43              |
|                        | 3.00          | 6.00            | 12.33               | 40.00            | 41.67                   | 2.40              |
|                        | 6.00          | 7.00            | 16.33               | 30.00            | 55.50                   | 2.73              |
| *Moringa oleifera* leaf extract | 1.50 | 3.66 | 8.66 | 63.33 | 31.70 | 1.20 |
|                        | 3.00          | 4.00            | 12.66               | 60.00            | 44.27                   | 1.67              |
|                        | 6.00          | 6.00            | 14.00               | 40.00            | 55.50                   | 1.93              |
| Control                | -             | 1.33            | 8.66                | 86.66            | 1.46                    | 0.27              |
| F. test                | **            | **              | **                  | **               | **                      | **                |
| L.S.D                  | 1.069         | 1.016           | 10.685              | 10.144           | 0.399                   |                   |

Deformed pupae and adults produced after treatment of the three types of soils with *M. oleifera* oil, lemon peel oil and *M. oleifera* leaf extract and then offered to pupae of *B. zonata* could be explained as follow:

A- Pupal-adult intermediate (Pupal- adult intermediate (incomplete adult exclusion))

This type of deformed individual posses the external character of pupae (covered with pupal exoskeleton), but has a distinct adult head or distinct adult head and thorax. This intermediate individuals may be elongated, pigmented twisted or twisted as shown in plates (a. 1-2-3-4-5). These deformations of resulted Pupal-adult intermediate appeared in the following cases:

a- Head only emerged from the pupalexuviae, plate (a. 1)
b- Deformed head and part of thorax emerged, plate (a. 2-3)
c- Partially eclosed adult with deformed thorax and poorly developed wings. The abdomen failed to exuviate, plate (a. 4).

Adult completely free from pupal exuvia except one of wing, plate (a. 5).

a.1- part of head enclosed from the puparium.

a.2- Deformed head and part of thorax enclosed.
Impact certain plant extracts on toxicity, biochemical effects and some biological measurements of peach fly, *Bactrocera zonata* (Saunders)

A.3 - Deformed head and longer part of thorax enclosed.

A.5 - Adult completely free from pupal exuvia except one of wing.

B. Deformed adults

Morphological abnormalities in adult stage were revealed after treated pupae of *B. zonata* with *M. oleifera* oil, lemon peel oil and *M. oleifera* leaf extract. These deformations of resulted adult flies appeared in the following cases:

Adults succeed to get loose from the pupal exuvia. These adults possessing different forms of deformation indicating abnormal eclosion as shown in the following cases:

1. Abnormal adult fly with severely curled wings, plate (b.1).
2. Deformed adult fly with obvious enlarged thorax and crumpled wing, one wing had broken, plate (b.2).

A (Normal adult)
b.1- Deformed adult with severely curled wings.
b.2- Deformed fly with obvious enlarged thorax and crumpled wing, one wing had broken.

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The focus of the work was to study the effects of different concentrations of moringa oil, lemon peel and moringa leaf extract on the biochemical (total protein, total carbohydrates and AChE) and some biological measurements (vomiting, pupation duration, complete emergence, complete malformed and deformity degree) of the fruit fly. The results showed that moringa oil was the most toxic plant extract to the adult flies, where the concentration that resulted in 50% adult mortality was 2.0.2 and 2.2.5 ml/l, while the concentration that resulted in 25% adult mortality was 90.002 and 22.1.1 ml/l when mixed with the three types of soil (yellow, sandy and clay), compared to the control sample. These results indicate the possibility of using these plant extracts tested and marketed as natural products to control the fruit fly.