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# Study the Effect of Two Mineral Compounds for Controlling the Peach Fruit Fly, *Bactrocera zonata,* Saunders on Mango Groves in Egypt

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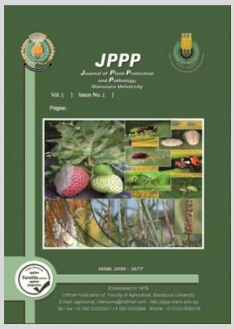


## ABSTRACT

Experiments executed at two experiential farms in Al-Adliya, Belbeis, Sharkia and Giza Governorate, during seasons 2019-2020, on Mango orchards by using two mineral products instead of using insecticides that may cause resurgence of pest strains resistant, emergence secondary pests by disposal of natural enemies, and raise growing public interests over issues relevant to public health, environmental quality and food safety. Therefore, there is an immediate need to incubate an alternative and environmentally suitable method for *B. zonata* management. This experiment evaluated treatments efficacy, kaolin and calcium carbonate compared with traditional insecticide Malathion 57%, Data explained in seasons, male numbers of *B. zonata* captivated every week by sticky-traps were low on the trees sprayed by kaolin and calcium carbonate than Malathion. In Al-Adliya farm lowest infestation for both of fallen and stable fruits recorded per tree sprayed with calcium carbonate average, 25.12 and 17.01% for fallen fruits and 2.22 and 2.10% for stable fruits respectively for seasons 2019-2020. Data reported, the tested formulations in area situation showed significantly depression rate, 54.94 to 81.78 for fallen and stable fruits. Modest infestation percent in Giza farm for both of fallen and stable fruits were restricted/tree in kaolin with average 20.02; 12.14 and 3.42; 4.02 for fallen and stable fruits in 2019-2020 seasons, respectively. Tested compounds kaolin and calcium carbonate able to limit *B. zonata*, infestation.

***Keywords:*** *B. zonata*; infestation; fallen fruits; stable fruits; kaolin; calcium carbonate and malathion.

## INTRODUCTION

Mango orchards areas in Egypt are approximately 150433 fed. Mean production about was 5.0 Tons / Feddan annually (Anonymous, 2014). Scores of insects' are critical and attack Mango trees and effect on quality and production and the most economic and dangerous insect pests are in stage of ripening fruits and in some cases, the evaluation damages of yield record more than 50% depending on rules of management and the season, Abdullahi, *et al*. 2011.

Fruit-flies are an important insect and dangerous against fruits and vegetables around the world, cause the economic damages. Bactrocera species considered as a wide-host, Clarke, *et al*., 2005. *Bactrocera zonata*, Saunders, Diptera: Tephritidae, considered as a more danger against fruits tropical and subtropical, Fletcher 1987. The Peach-fruit flies registered attack more than 50 species from wild and cultivated plants; especially the fleshy-fruits and some fruits e.g. guavas; mangoes; peach; citrus and apricots, White and Elson-Harris 1992.

Synthetic chemical products became unsafe way in controlling pests as they are one of the main reasons in the environmental pollution and reason a chronic diseases for humans and hurtful for most of the living organisms. Insecticides used to control this pest but the insecticides caused many problems to environmental especially, humans, plants, animals, air, water and soil, Nadeem *et al.*2014 reported that a lot of insecticides were observed susceptible to high resistance level such as trichlorfon and malathion, while lambda-cyhalothrin and spinosad were showed susceptible to low resistance from the fruit flies. So that beginning search on the alternative to chemical insecticides such mineral products, plant oils , plant extracts, natural products, and finally beginning the search on other alternatives, Soliman.1998 , 2004 and Soliman *et al.*2015. Latterly, while the some searches used of lower toxic control as a new technique such as, using of plant-extracts and mineral compounds, because they have a lower toxicity and harmless to the environments. Yazici and Kaynak, 2009, they mentioned that, the current materials, the kaolin; white clay marked by aluminum silicate layer allowed with leaving a thin-layer on fruit surface and allow in light reflecting. Little searches were tested, on the defense effects against insect-pests and influence combination with fruit irrigation operations; such as Glenn, *et al*., 2010, Ou, *et al*. 2010, Shellie and Glenn 2008, Song, *et al*. 2012 and Tubajika, *et al*. 2007. Kaolin clay, mineral compound contained on a fine-powder composed of kaolinite and spray on infested trees as a water suspension for insect control; after the kaolin form drying; a white and thin< 3µm particle film remains on fruit surfaces; this film reduce water-stress but doesn't photosynthesis reduce or growthing of fruits, Glenn, *et al.* 1999&2002 and Kerns & Wright 2000. Recently; in fields and laboratory trials, using of kaolin-clay was effected on major of insect-pests and two spotted spider mite, Glenn, *et al*. 1999, Knight, *et al*. 2000, Lapointe 2000, Unruh, *et al.* 2000, Puterka, *et al*. 2000, Saour and Makee 2004, Wyss and Daniel 2004, Caleca and Rizzo 2007 and Braham, *et al*. 2007. The kaolin decreased the ovipostion by many ways; it prevents fruit coloring caused making long

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distances and the host-recognition very difficult, Saour and Makee, 2004. White colors are the least attractive for female's ovipostion for *C. capitata*, Katsoyannos 1989. Kaolin-clay layers caused the surface of fruits less-suitable and harder for eggs laying, Glenn *et al*. 1999 and Saour & Makee 2004.

Physical characteristics of Calcium-carbonate may be similarity the kaolin-clay, Puterka, *et al.* 2000. Calcium-carbonate listed as particulate substance used to plants protection against arthropods; on the other hand, some searches used limestone-liquid for the same purposes, Yee 2010 and Prager, *et al*. 2013.

The techniques has been studied and data resulted that, color change "whitening" for fruits, caused by calcium-carbonate leave a micro-powder on fruit surface makes, insect- pests became unable to position on fruit surface, Tsuchiya *et al*., 1995; and the calcium-carbonate infect adult female antennae making ovipostion is impossible, Nagasawa and Arakawa 1952. Recently, the lime solution was improved under the commercial name "White Coat" in the field applying; data obtained that, the spraying of apple fruit by "White Coat" caused decreases in eggs numbers significantly, of *C. sasakii*, Ishiguri and Yoshinaga, 2015. This agent reported to ensure effective on "mandarin orange fruits" against "yellow tea thrips", *Scirtothrips dorsalis* Hood, Kaneko 2012. The volatile-chemicals cue on fruit surface from a distance and receiving physical contact stimuli working on choosing site for eggs-laying, Ishiguri and Yoshinaga, 2015. The spraying of fruit surfaces by "calcium-carbonate" no caused inverse-effects on mechanical-function for pubescence and there is no index that, the "calcium-carbonate" prevent female ovipostion activity.

This study aimed to evaluate the role of some mineral compounds in reducing injury and resulting damage caused by *B. zonata* on Mango groves.

## MATERIALS AND METHODS

Studies were carried out throughout the two consecutive years (2019-2020) from early Joly to mid-September for each season, to estimate the effect of two mineral compounds on the reduction of peach fly *Bactrocera zonata* infestation in Mango orchards Mangifera indicia

**Field experiment site:**

The first one was of farm Al-Adliya Association, Belbeis, Sharkia Governorate. The number of Mango trees was 100 trees/feddan, and the trees are about 15 years old. The experimental area was divided into three compounds tested as insecticides and control and the compounds were replicated twice a month in between on 0.5 fed. for each compound.

The second farm was in Giza Governorate, the mango trees density was 120 trees per fed., and the trees are about 15 years old also. Experimental areas were divided into four treatments in two farms 6 fed., as a three treatments with insecticides and control. Tested compounds were replicated "three times" in 0.5 fed., for each.

**Used compounds:**

The first compound was Kaolin, (formulated product - Surround WP; concentration 95%; with applied rate: 5 kg /100 l) diluted with water + (2 ml Tencotic as emulsifier was added).

The second compound was Calcium carbonate spraying with range applied 5kg f.p./100L., diluted with water + (2 ml Tencotic as emulsifier was added).

The third compound with tested pesticide "Malathion57%" which known for peach-fly control "in Egypt" with conc., 500ml tested pesticides+500ml buminal+19L, of water. Tested chemicals were applied and sprayed when tested fruits were in half size. This sprayings were utilized with using by Hand Held Knapsack sprayer CP-3. The solution was used for spraying trunks of trees at branching area using about 150 – 200 cm3 / tree. Each 20 liters solution sprayed downwind at sun set. Spraying operations were at all rows of mango trees used by target spraying technique. Caught adult male's numbers of *B. zonata*, in tested farms were evaluated every week. Both compounds and Malathion were sprayed "four times" during two weeks.

**Monitoring:**

The adult population regulate of *B. zonata*, conducted by yellow-sticky-traps during experimental period, "Jackson traps" were used and treated with aqueous-solution of sex-pheromone-methyl-eugenol to catching adults of peach fruit-fly *B. zonata.* These traps were hanged in treatments and control groves. Sexual traps numbers were (12 traps), 1 trap for each compound replicate was putted on head height of tested mango plant within tree canopy. "Jackson traps" was used and installed at 1 week before 1st spray to count of population density before treatments. Tested traps were investigated for one week at least during experimental period, 15 weeks.

**Fruit damage:**

Range infections of *B. zonata*, were evaluated on remaining fruit; 5 trees/compound were randomly chosen; inspection were conducted visually to calculated of penetrated fruits for 50 fruits samples weekly, and throughout end fruiting-period, the all falling fruits were investigated. Also, the punctured and falling fruits numbers were calculated/tree, during maturity for invested fruits at experimental period end.

**Statistical analysis:**

Data obtained were analyzed statistically by "ANOVA", SAS Institute 2002, and means were detailed using test of "Tukey's HSD" at level 0.05, when the F-test was significant.

## RESULTS AND DISCUSSION

Through the two seasons, caught males of *B. zonata* were decreased during the 1st six weeks of investigation. Thereafter, males of population densities mounted progressive and registered a maximum-peaks periods during the successive weeks (13, 14 and 15). Male's numbers of *B. zonata*, showed that, the weekly-caught in sticky traps were low in sprayed trees by calcium-carbonate and kaolin than insecticide malathion and untreated trees.

**Fruit damage**

Result obtained in Table 1, cleared that the fallen infestations and stable-fruits/tree with tested compounds during seasons 2019-2020, at Sharqia Gov., grove. At end

of experiments, average numbers of fallen-fruits/tree showed low significant with tested compounds when compared with control during season 2019; F=36.372 and P=0.0000, while during season 2020 mean number/tree of fallen-fruits decreased, recorded significantly difference; F=3.788 and P=0.0000. On the other hand, the obtained data showed that, lowest mean numbers of fallen-fruits/tree in two seasons 2019-2020, were 6.21 and 7.24 respectively, with "kaolin" treatment. Data of fallen and stable-fruits/tree gave low infestation percentage in kaolin plots treatments recorded (25.12 and 17.01%) and (2.22 and 2.10%) for fallen and stable-fruits throughout two seasons 2019-2020 respectively. Infested% for fallen-fruits showed high significant, when compare treatments with control throughout two seasons 2019-2020, recorded (F=80.016 and P=0.000) and (F=34.861 and P=0.000) for two seasons respectively. Furthermore, the infestation% between treatments and control of stable-fruits were significantly difference, resulted (F=54.296 and P=0.000) for season 2019 and (F=78.852 and P=0.000) for season 2020. Infested fallen-fruit at season 2019 resulted F=93.24 & P=0.000 and at 2020 were F=77.17 & P=0.0000, while in infested stable-fruit resulted F=44.13 and P=0.0000 of year 2019, for year 2020 data recorded F=34.91 and P= 0.0000.

In table (2) data reported that the efficiency of various compounds on the infestation percentage decrease with *B. zonata* in the both years of 2019 & 2020 at the orchard of Sharqia Gov. the obtained data cleared that, all tested formulations under field condition showed significantly decreases in infestation range (54.94 to 81.78), for fallen-fruits and stable-fruits respectively. Subsequently, in stable-fruits/tree, data cleared that, significantly difference among compounds in decreasing percentage recorded (F=7.324, P=0.0085) and (F=5.075, P=0.025) in the two experimental seasons 2019-2020 respectively, while there is no-significant difference were registered of decreasing percentage of fallen-fruits infestation/tree two tested seasons.

**Table 1. Infestations of fallen and stable fruits in tested compounds during 2019-2020 years, in Adlya farm.**

| Compound | 2019 | | | 2020 | | |
|---|---|---|---|---|---|---|
| | Means numbers of fallen-fruits | Infestation% of fallen-fruits | Infestation% of stable-fruits | Means numbers of fallen-fruits | Infestation% of fallen-fruits | Infestation% of stable-fruits |
| untreated | 13.41a | 76.31a | 10.41a | 9.83a | 67.44a | 11.21a |
| Malathion | 8.22b | 36.63b | 3.81b | 8.22ab | 26.24b | 4.22b |
| Calcium carbonate | 6.84b | 26.44bc | 3.02b | 7.63ab | 21.41b | 3.10bc |
| Kaolin | 6.21b | 25.12c | 2.22b | 7.24b | 17.01b | 2.10c |
| F. | 36.372 | 80.016 | 54.296 | 3.788 | 34.861 | 78.852 |
| P. | 0.000 | 0.000 | 0.000 | 0.316 | 0.000 | 0.000 |
| Sign. | *** | *** | *** | * | *** | *** |

**Table 2. The effectiveness of tested compounds on reduction% in infestations by *B. zonata*, in treated mango during 2019-2020 in Adlya farm.**

| Compound | 2019 | | 2020 | |
|---|---|---|---|---|
| | fallen fruits | stable fruits | fallen fruits | stable fruits |
| Malathion | 54.94 | 63.54b | 61.03 | 67.13b |
| Calcium carbonate | 65.60 | 70.84ab | 68.44 | 73.53ab |
| Kaolin | 67.00 | 79.52a | 74.62 | 81.78a |
| F. | 2.522 | 7.334 | 1.099 | 5.075 |
| P. | 1.223 | 0.0085 | 0.365 | 0.025 |
| Sign. | Ns. | ** | Ns. | * |

Data results in Table (3), cleared that the fallen-fruits and stable-fruits infestation in tested compounds during two years 2019-2020 in 2nd farm at Giza Gov., data showed that, the calcium-carbonate compound gave low mean numbers of fallen-fruits in two experimental years were (5.01 and 12.14) in tested years 2019 and 2020 respectively. Also, data showed significantly differences among treatments and control recorded (F=21.054, P=0.0000) in season 2019 and (F=22.533, P=0.0000) in season 2020. The reduction% of fallen and stable-fruits infestations per tree were recorded with calcium carbonate compound, with an average of 20.02, 12.14 for fallen fruits and 3.42 & 4.02 for stable fruits for 2019 & 2020 years, respectively.

Data in tables (3 & 4) revered that % infestation of fallen-fruits and stable-fruits recorded significantly difference between treatments in successive seasons of experiment recorded (F=93.24, P=0.0000) with infested fallen-fruit/tree at year 2019 and (F=77.17, P=0.0000) at year 2020). However, in infested stable-fruits data recorded (F=44.13, P=0.0000) for year 2019 and (F=34.91, P= 0.0000) for year 2020.

Results assured that the efficacy of various compounds on the infestation percentage decrease with *B. zonata*, in two tested years in the second orchard from Giza Gov. Data reported that, significantly reducing in rates of experimental years (F=22.155; P=0.0003) and (F=6.424; P=0.0019) respectively. Data resulted that, insignificantly in fallen and stable-fruits during 1st year of experiment (F=3.122, P=1.114) and (F= 5.764, P= 1.987) for two seasons respectively. This research estimated the effectiveness of calcium carbonate compounds in comparison with kaolin treated on mango-trees as spot spray to combination with Malathion as known insecticide against peach flie *B. zonata*. Data was presented by the sexual traps; indicate that the kaolin and calcium carbonate compounds were more impressive than "malathion" in decreasing of population's *B. zonata*, males in first of four weeks followed by first-spray and extend its influence to some extend until eight weeks at end of study. For last four weeks of experiments there was a reduction in the efficacy of the sprays as defined by trap caught and fruits infestation ranges. Using of mineral component as calcium-carbonate and "kaolin" to controlling of some species of fruit-flies were studied by some authors. Mineral compounds cause damages to cuticle surfaces of insect and may be caused some behavior and biologic changes, e.g. feeding reductions; moving and ovipostion, (Glenn and

Puterka, 2005). The insects can produced varieties of cuticle-lipids to form a watertight and can escape from death (Barik *et al*. 2008). *Chuan Wang et al. 2015*, mentioned that, there are significantly difference in fertilizer effect of calcium against Oriental fruit-flies and red-scale insect when treated by Nano-particles. On the other hand, Nano-calcium carbonate-particles can protect fruits from ovipostion by oriental fruit-flies. The 2nd advantages of calcium particles are the low possibility resistance. Oriental fruit-flies, e.g. Tephritidae flies appear resistance against some recent used pesticides including, organophosphrus; pyrethroids and spinosad (Hsu and Feng, 2006; Hsu *et al*. 2004 and Vontas *et al* 2011), the foliar spray were showed, the population density reducing and levels of fruit infestations by oriental fruit-fly *B. dorsalis*, in Papaya orchards in Hawaii. Also the "Kaolin" resulted highly effect in control of another Tephritidae flies; the olive fruit-fly *B. oleae*, in olive orchards in Syria, (Saour and Makee 2003); the fruits damages were caused by "kaolin" treated and then spray on olive-trees gave low significant than control. Mazor and Erez 2004, in Israel, tests in lab., and fields with kaolin "Surround WP" resulted approximately completely protection on nectarine; persimmon and apple against *C. capitata*. Katsoyannos 1989, examined attraction of 7 colors on *C. capitata*, in Citrus groves, data showed that, the yellow colors were more attractive to fertilized females while white and blue were less colors attraction. Treated leaves and fruits by "kaolin" coated with a white particles films could be influenced on females landing (Saour and Makee, 2003). Moreover, they reported that, shining white color of "kaolin" spray on olive-trees may be dislocated the orient olive fruit-fly *B. oleae*, in olive orchards. Puterka *et al*. 2000, studied the used successful of "kaolin" against pear psylla, *C. pyricola* and he suggested 6 mechanisms or action; repellence; ovipositional deterrence; decreased feeding efficacy; grasping disrupted or appearance false of host; host camouflage and direct mortality. Mazor and Erez 2004, reported that, the treatment compound "kaolin" are the best suitable to dry-regions because it washed by major rainfall. The recent pest-management requires the pesticides which don't persist for a long time (Mangan *et al*., 2006). This results agreement with (Baraham *et al*., 2007) who indicated that, kaolin seems to be a successful way for the controlling of medfly populations in *Citrus* orchards. Calcium-carbonate caused significantly of decreased oviposition and less visible residues. According to the crops and its processing "kaolin-lime" and "rock-dusts" offer an interesting opportunity to decreasing fruits damage by *D. suzukii*. The compound "kaolin" was reduced ovipostion as effectively as "Spinosad" killing the flies and prevented oviposition (Daniel *et al.,* 2015). However, to improving the effectiveness, furthermore studies on the numbers; the concentrations and best timing of applications early in season before egg laying are needed.

**Table 3. Infestation of fallen and stable fruits in the different compounds during years of 2019 & 2020 in Giza farm.**

| Compound | 2019 | | | 2020 | | |
|---|---|---|---|---|---|---|
| | Means numbers of fallen-fruits | Infestation% of fallen-fruits | Infestation% of stable-fruits | Means numbers of fallen-fruits | Infestation% of fallen-fruits | Infestation% of stable-fruits |
| untreated | 23.75a | 84.22a | 17.03a | 28.01a | 78.52a | 19.22a |
| Malathion | 18.01ab | 27.71b | 5.01b | 9.75b | 30.73b | 6.61b |
| Calcium carbonate | 5.02c | 20.02b | 3.42b | 8.25b | 12.14c | 4.02b |
| Kaolin | 11.53bc | 26.09b | 4.43b | 9.75b | 21.52bc | 6.24b |
| F. | 21.054 | 93.24 | 44.13 | 22.533 | 77.17 | 34.91 |
| P. | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Sign. | *** | *** | *** | *** | *** | *** |

**Table 4. The effectiveness of tested compounds on reduction% in infestations by *B. zonata*, in treated mango during 2019-2020 in Giza farm.**

| Compound | 2019 | | 2020 | |
|---|---|---|---|---|
| | fallen fruits | stable fruits | fallen fruits | stable fruits |
| Malathion | 67.13 | 70.60 | 60.90c | 65.63b |
| Calcium carbonate | 76.25 | 80.00 | 84.58a | 79.19a |
| Kaolin | 69.04 | 74.14 | 72.62b | 67.73b |
| F. | 3.122 | 5.764 | 22.155 | 6.424 |
| P. | 1.114 | 1.987 | 0.0003 | 0.0019 |
| Sign. | Ns. | Ns. | ** | ** |

These experiments aimed were conducted to evaluate mineral-organic compounds such as "kaolin" and calcium carbonate to controlling of peach flies. And find out how to use an alternative to traditional chemical pesticides with live aircraft and environment in mango groves. Also, kaolin was more effective following calcium carbonate compared to malathion as the common insecticide. Constructed kaolin, forming a particle film on fruits surface as a barrier to protect them from putting eggs with *B zonata* female,. Like this agents of pest controlling, calcium-carbonate compound appear safety and It is harmless to humans and the environment compared to insecticide chemicals.

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## دراسة تأثير اثنين من المركبات المعدنية علي مكافحة ذبابة الخوخ في بساتين المانجو في مصر

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اجريت الدراسة علي بساتين المانجو في مزرعتين الاولي في جمعية العادلية مركز بلبيس محافظة الشرقية, والثانية في محافظة الجيزة خلال موسمي 2019- 2020. أجريت التجارب باستخدام اثنين من المركبات المعدنية كبديل لاستخدام مبيدات حشرية قد تسبب ظهور سلالات مقاومة من ذبابة الخوخ وظهور الافات الثانوية عن طريق القضاء علي اعدائها الطبيعيين, وزيادة المخاوف العامة المتزايدة بشأن القضايا المتعلقة بالصحة العامة , نظافة البيئة وسلامة الغذاء. لذلك هناك حاجة ملحة لتطوير وايجاد طريقة بديلة ومتوافقة بيئيا لمكافحة ذبابة الخوخ في هذة الدراسة تم تقييم فاعلية المركبات المعدنية الكاولين و كربونات الكالسيوم مقارنة بالملاثيون 57% كمبيد حشري تقليدي. اظهرت البيانات في كلا الموسمين ان عدد ذكور ذباب الخوخ التى تم إصطيادها اسبوعيا من المصائد الفرمونية كان اقل في الاشجار المعاملة بالكاولين وكربونات الكالسيوم مقارنة بالملاثيون والكنترول. في مزرعة العادلية حيث سجلت اقل نسبة اصابة لكل من الثمار المتساقطة والباقية علي الاشجار المعاملة بكربونات الكالسيوم بمتوسط 25.14 و 17.022% في الثمار المتساقطة و 2.2 و 2.0% للثمار الثابتة علي الاشجار وذلك لموسم 2019 وموسم 2020 علي التوالي. اشارت البيانات الي ان جميع المركبات المختبرة تحت ظروف الحقل تسببت في انخفاض معنوي في معدل الاصابة من 54.92 الي 81.79 لكل من الثمار الساقطة والثمار الثابتة. وقد سجلت اقل نسب اصابة في مزرعة الجيزة لكل من الثمار المتساقطة والثابتة المعاملة بمركب الكاولين بمتوسط 20.0 و 12.12 للثمار المتساقطة و3.4 و 4.0 للثمار الثابتة لكلا الموسمين علي التوالي. وقد بينت الدراسة ان كلا من المركبات المعدنية التي تحتوي علي الكاولين وكربونات الكالسيوم قادرة علي الحد من الاصابة بهذة الافة الخطيرة والمحافظة علي بساتين المانجوخالية من المبيدات .