International Journal of Environment
Volume: 11 | Issue: 01| Jan. - March| 2022

EISSN: 2706-7939 ISSN: 2077-4508
DOI: 10.36632/ije/2022.11.1.4
Journal homepage: www.curresweb.com
Pages: 41-50

# Sensitivity infestation by Cucurbita fly: *Dacus ciliatus* Loew (Diptera: Tephritidae) on three different species cucurbits and their control

**Mona. I. Ammar, Samia M. Abozeid and Rahouma A.K.**

Plant Protection Research Institute (PPRI), Agriculture Research Center (ARC), Dokki 12618, Giza, Egypt

**Received:** 20 Feb. 2021 **Accepted:** 15 Mar. 2022 **Published:** 30 Mar. 2022

## ABSTRACT

Experiments were conducted in the experimental Farm of Plant Protection Research Institute, Qaha, Qalubiya governorate under field conditions during two successive seasons (2020 and 2021). The aim of this study Sensitivity infestation by Cucurbita fly: *Dacus ciliatus* Loew (Diptera: Tephritidae) on three different species cucurbits and their control. The results showed that the population fluctuation of the *D. ciliatus* infesting on three different species cucurbitae (cucumber, zucchini, and snake melon) fruits highly significant differences Whereas F value = F value in first season = 10.15 ** and L.S.D. = 21.11 individuals/240 fruits, could be divided three groups in first season but in the second season could be divided two groups whereas F value in second season = 14.66 *** L.S.D. = 29.24 individuals/240 fruits. The data indicated that the most affected by infestation species was zucchini showed that high abundant of population fluctuation in 12nd of May in both seasons. In respect to, Zucchini was susceptible 72.21 (larvae stages) / 240 fruits in the first season but in the second season was highly susceptible with 98.63 (larvae stages) / 240 fruits, respectively. The mean susceptibility degree of the two tested seasons showed highly susceptible with 85.42 (larvae stages) / 240 fruits. Zucchini was showed that, *D. ciliatus* recorded the highest growth rate (4.24), taking time difference 21 days between initial *D. ciliatus* number 21 and maximum count 110(larvae stages) / 40 fruits in the first season. Data of the second season was showed the *D. ciliatus* recorded the highest growth rate 6.76 taking 21 day between the initial pest number No (12 (larvae stages) / 40 fruits and maximum count Nt (154 (larvae stages) / 40 fruits. Data showed when using different treatments Penny 9% (Emamectin benzoate 1.5%+Indoxacarb 7.5%), Sinodor WG70% (Imidacloprid 70%) and Betavant SC14.5% (Indoxacarb 14.5%) have a highly significant effect on decreasing *D. ciliatus* population infesting zucchini growth. The plant extract and nanoparticles treatments have effect on *D. ciliatus* population whereas decreased mean number of pests the most efficiency method compared to control (without treatment).

***Keywords:*** *Dacus ciliatus* Loew, cucumber *Cucumis sativus*, zucchini *Cucurbita pepo* and snake melon *Cucumis melo*, fruits) plant extract, susceptible, modern treatments, environment , safety, growth rate and nanoparticles treatments.

## 1. Introduction

The lesser pumpkin fly *Dacus ciliatus* Loew, this fly is belonging to the Family Tephritidae it is an poligophagous serious pest of Cucurbitae in temperate and tropical regions (El Nahal *et al.*, 1971). This fruit fly was recorded in Africa and Asia in 1914 (Weems, 2002 and 2008) Details on its distribution are available in the EPPO Global Database (EPPO, 2018). Infestations were recorded on zucchini, cucumber, and snake melon fruits at Giza (Fetoh, 2003 and 2006). Few studies on *D. ciliatus* control with particular concerns on histopathology have been investigated. Females oviposit about 210 eggs during the life span and the eggs are laid in groups of 5-15 (El Nahal *et al.*, 1971; Fletcher, 1987 and Srivastava and Butani 2009) After eggs hatching, the young larvae feed on the host plant, causing damage to the ripe fruit. The economic damage caused by this fruit fly is a result of the reduction in

**Corresponding Author:** Mona. I. Ammar, Plant Protection Research Institute (PPRI), Agriculture Research Center (ARC), Dokki 12618, Giza, Egypt.
E-mail: mona.ammar@arc.sci.eg

yield and its control using expensive insecticides (Hassain *et al*., 2002, Matawala *et al*., 2009, Sapkota *et al*., 2010. The pupation usually takes place on ground inside the upper layer of soil (Malihi, 1998). Greater larval exit from the fruit before pupation and adult emergence occur around morning and are controlled by light and temperature (Malan and Giliomee, 1968 and Arai, 1976). Moreover, *Dacus ciliatus* oviposit on shady rather than fruit area exposed to the sun (Syed, 1969). Availability of abundant hosts restricts the movement of mature flies to foraging flights to explore food, water and oviposition sites (Bateman, 1972). *D. ciliatus* flies exhibit a daily pattern of movement between hosts and surrounding vegetation which is more evident in cucurbit infesting species including *D. ciliatus* (Matanmi, 1975). Multiple uses of synthetic chemical pesticides have led to many environmental problems as pest resistance and toxicological effects on non-target organisms. In many cases, synthetic pesticides caused poisoning to farmers (Bag, 2000). It is necessary to search for environmentally safe methods for insect control. The use of plant extracts and their derivatives have evidenced to be effective against many insect pests. (Kim *et al*. 2005, Daoubi *et al*. 2005 and Abd-Elwahab *et al*., (2019)). In order to further development, the utilization of semi chemicals or mixing planting strategies is reinvestigated in pest management in polycultures .Volatile chemical compounds emitted from plant tissues are most likely originated to repel the attacking pests, and also serve as a secondary function as it attracts the parasitoids and predators in search of insect pests (Mauchline *et al*.2005 and Abou-Yousef *et al*. (2010)). In recent years, botanical pesticides and nanoparticles (NPs) which classified on the basis of the kind of material into metallic, semiconductor and polymeric nanoparticles have shown great importance in agricultural fields due to their cheap and low expenses, with no residual effects, environmentally friendly, and highly toxic against major pests such as thrips, aphids, jassids, whitefly, and mites (Stumpf and Nauen 2001; Liu, 2006). There are several advantages to use botanical insecticides rather than synthetic (conventional) insecticides (Rebek and Sadof, 2003). The objective of the present study was Infection rates of *Dacus ciliatus* Loew on some types of cucurbits in the fruit stages and control

## 2. Material and Methods

Two field experiments were conducted in the Experimental Farm of Plant Protection Research Institute, Qaha plant protection research station, Qalubia governorate during the summer plantation seasons (2020 and 2021). The first one conducted to study the relative susceptibility of three Cucurbitae (cucumber, zucchini, and snake melon fruits) to infestation by *Dacus ciliatus* Loew. Seeds of three different Cucurbitae were planted on March 15$^{th}$ An area of about 600 m$^2$ was divided into 12 equal plots comprised the three cucurbitae of plant for 4 replicates each species cucurbitae . The experimental plots were laid out in a randomized complete block design. After 36 days was taken ten fruits / replicates each species were harvested to examined and counted the larvae were inside each fruit during the period from 21$^{st}$ of April to 26$^{th}$ of May. The manual selection experiment was harvested 6 times during the season. For parameters, maximum population size and growth rate for *Dacus ciliatus* were recorded for three different species Cucurbitae and the time taken to reach the maximum count (Nt) were used for comparing between Cucurbitaes. Population growth rate (GR) was calculated by using Odum's equation (Odum, 1971) as follow;

$$GR = (Nt - N\circ)/ \Delta t$$

Where Nt = the number of each pest recorded at the maximum count of the population on a plant.
N∘= the initial number of each pest released on each plant.

Δt= the difference in time between Nt and N∘.

The classification the susceptibility degree of each variety to infestation with the previously mentioned pests was dependent on the general mean number ($\overline{X}$ ) of each pest and the standard deviation (SD) as reported by Chiang and Talekar (1980) The varieties that:-

Highly susceptible (HS): had an average numbers of pest more than $\overline{X}$ +2SD
Susceptible (S): had an average numbers of pest between $\overline{X}$ and $\overline{X}$ +2SD

Low resistant (LR): had an average numbers of pest between $\bar{X}$ and $\bar{X}$ -1SD
Moderately resistant (MR): had an average numbers of pest between $\bar{X}$ -1SD and $\bar{X}$-2SD
Highly resistant (HR): had an average numbers of pest less than $\bar{X}$ -2SD.

In case of the second experimental, used nine treatments and control (without any sprayed with water) were compared with control which sprayed with water against these pest addition control. zucchini was planted on March 15th an area about 1000 $m^2$ was divided into 40 plots (each plots was 25 $m^2$). The experimental plots were laid out in a randomized complete block design and each treatment was represented by four plots. Treatments were applied with rate of Application with water as a foliar spray after 36 days of sowing zucchini in 21st of April Samples of 10 fruits/ replicates were collected at random in the early morning from each treatment. The fruits were sampled directly before spray and 1, 3, 7 and 14days after foliar spray and spray again. And the inspected leaves were transmitted to the laboratory where a binocular microscope was used to count the pest. The reduction percentages were calculated using the equation of Henderson and Tilton (1955) formula: Reduction %= 100 * (1 - (Ta * Cb)/(Tb * Ca), where: Ta= number of mite after spray; Tb= number of mite before spray; Ca = the number of mite in the control after spray; Cb = number of mite in the control before spray.

**Table 1:** Treatments and application rate

| **Treatments** | **Rate of Application** |
|---|---|
| Artemisia cina oil | 10gm./5L |
| *Citrullus colocynthis oil* | 10gm./5L |
| *Mentha microphylla* (Mint) oil | 10gm./5L |
| silica nanoparticles (SiNPs) | 0.06 gm./5L |
| copper (CuO) nanoparticles | 0.06 gm./5L |
| zinc (ZnO) nanoparticles | 0.06 gm./5L |
| Betavant SC14.5% | 2.75$cm^3$/ 5L |
| Penny 9% | 5 $cm^3$/5L |
| Sinodor WG70% | 2$cm^3$/5L |
| Control | Sprayed with tap water |

Final data were analyzed with (SAS, 2002) and appropriate error terms for the F tests of interactions were calculated separately. Comparisons of means were performed using the L.S.D. multiple range test (= 0.0001). The mean of larvae populations from sprayed plots were considered to be an indirect reflection of efficacy of different treatments.

## 3. Results and Discussion

### 3.1. Sensitivity infestation by Cucurbita fly: *Dacus ciliatus* Loew on three different species cucurbits.

In Table. (2), the data indicated that the population fluctuation of the *D. ciliatus* infesting on three different species cucurbitae (cucumber, zucchini, and snake melon) fruits highly significant differences Whereas F value = F value in first season = 10.15 ** and L.S.D. = 21.11 individuals/240 fruits, could be divided three groups in first season but in the second season could be divided two groups whereas F value in second season = 14.66 *** L.S.D. = 29.24 individuals/240 fruits.

#### 3.1.1. Cucumber (*Cucumis sativus*)

Data showed that the population fluctuation of *D. ciliatus* larvae were lower in the second season was 37.19 larvae/240 fruits but in the first season indicted that 60.13 larvae/240 240 fruits, the activity period of during first season was expressed by two peaks, the peaks occur in 12nd and 26th of May were registered 74 and 107 larvae/ 40 fruits, respectively. As the same, in the second season the data revealed that presence one peak in 19th of May 60.39 larvae/ 40 fruits, respectively.

#### 3.1.2. Zucchini (*Cucurbita pepo*)

Data indicated that the population fluctuation of *D. ciliatus* larvae were high in the second season was 98.63 larvae/240 fruits but in the first season indicted that 72.21 larvae/240 fruits, the activity period of during first season was expressed by one peak in 12nd of May was registered 103

larvae/ 40 fruits.as the same in the second season the data showed that presence one peak in 5th of May was 118.67 larvae/ 40 fruits, respectively.

**3.1.3. Snake melon (***Cucumis melo flexuosus***)**

Data revealed that the population dynamics of *D. ciliatus* larvae were high in the first season was 59.97 larvae/240 fruits but in the second season indicted that 50.37 larvae/240 fruits, the activity period of during first season in 12nd of May was registered 83 larvae/ 40 fruits. As the same, in the second season the data revealed that presence in 12nd of May was 71 larvae/ 40 fruits, respectively.

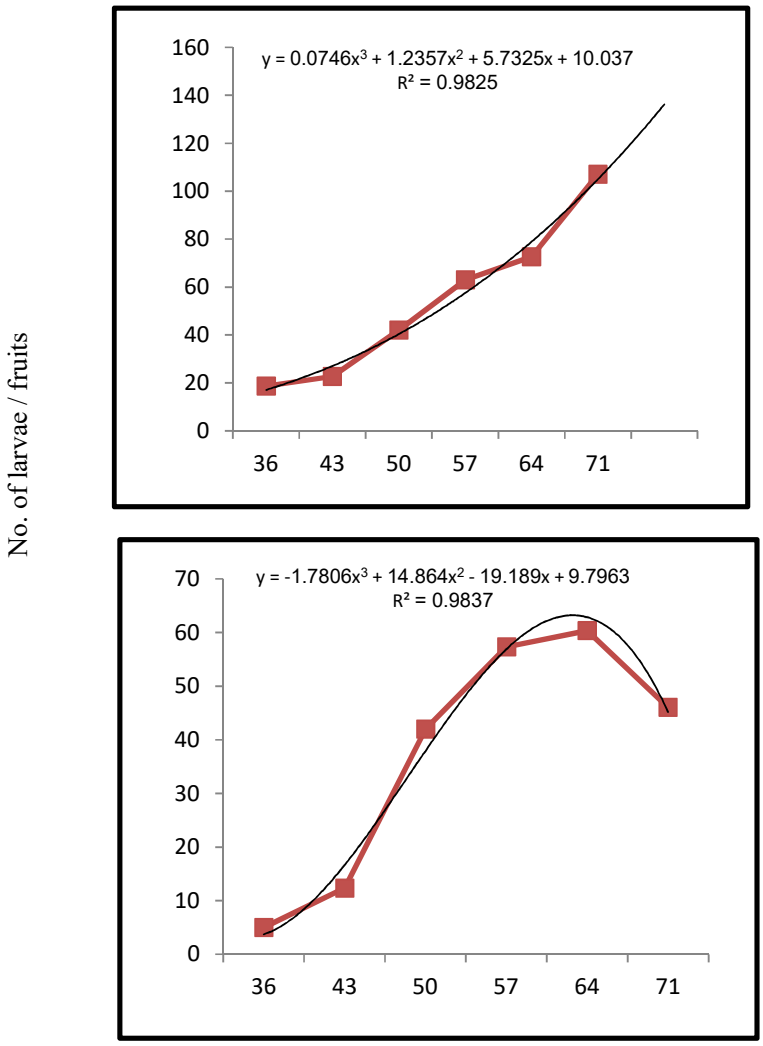


**Fig. 1:** The corrected average change in the age of plant/ unit (y) change in *D. ciliatus* infestation (x) on cucumber fruits in Qaha, Qalubiya Governorate during the two seasons.

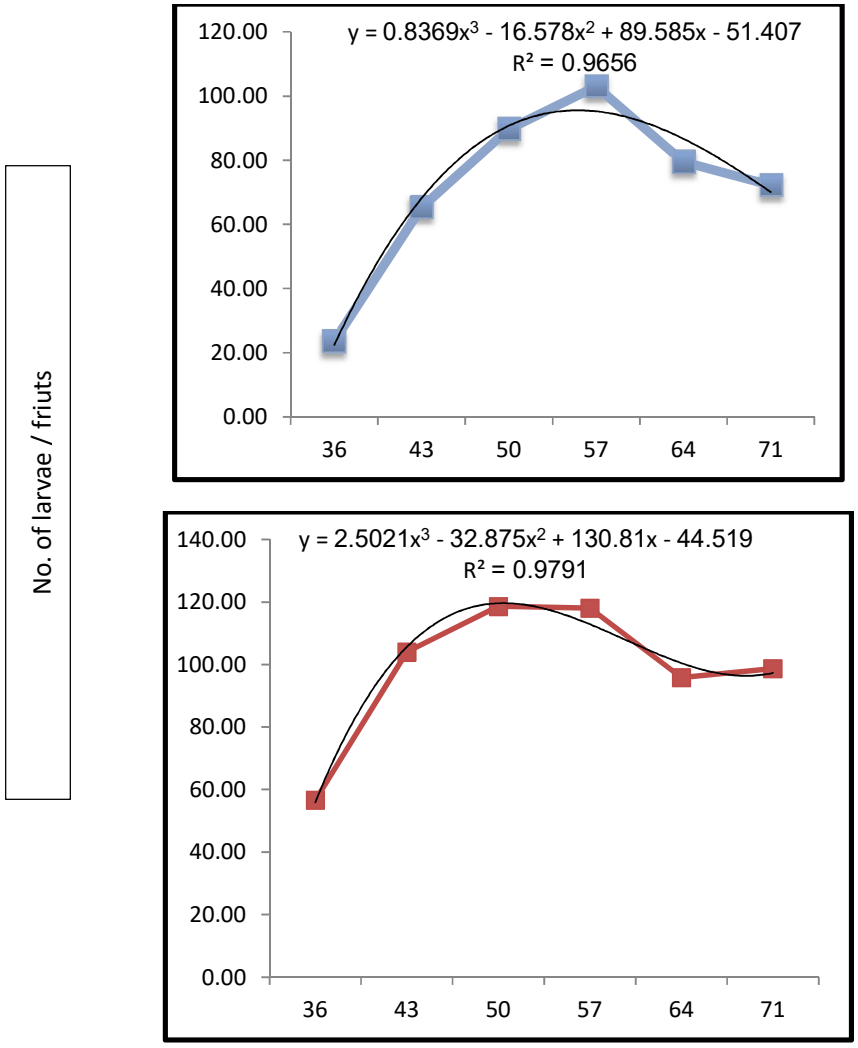


**Fig. 2:** The corrected average change in the age of plant/ unit (y) change in *D. ciliatus* infestation (x) on zucchini fruits in Qaha, Qalubiya Governorate during the two seasons

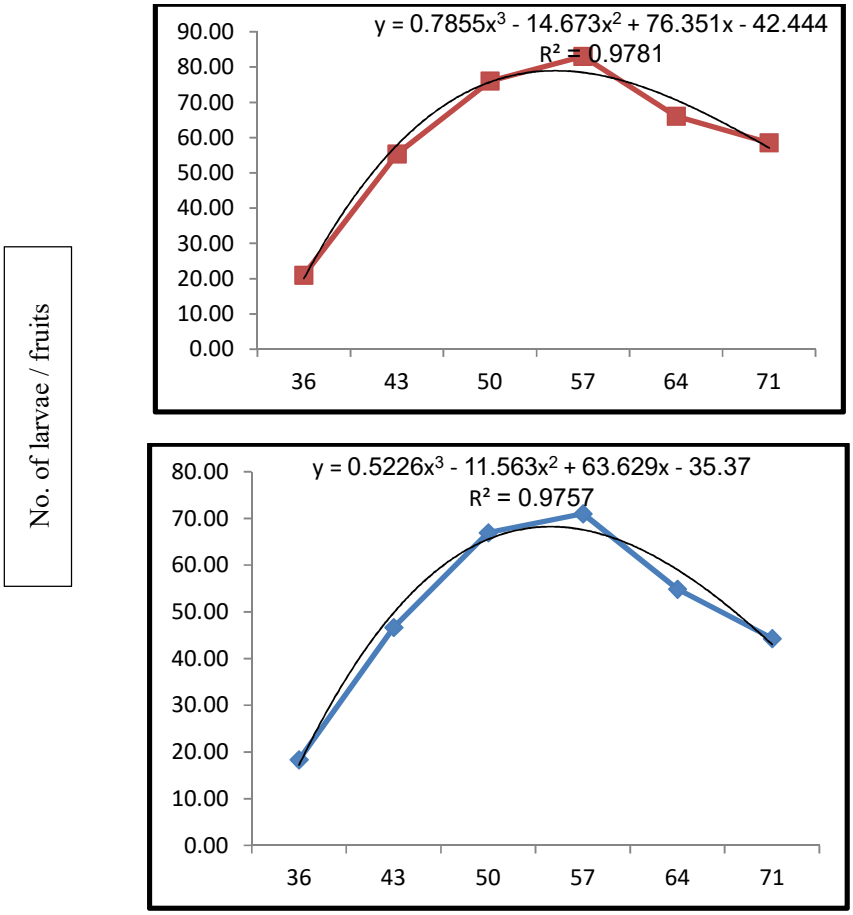


**Fig. 3:** The corrected average change in the age of plant/ unit (y) change in *D. ciliatus* infestation (x) on snake melon fruits in Qaha, Qalubiya Governorate during the two seasons

### 3.2. Evaluation of relative susceptibility degree of three Cucurbitae (cucumber, zucchini, and snake melon fruits) to infestation by *Dacus ciliatus* Loew. during the two seasons (2020-2021) at Qaha, Qalubia governorate :

Table (3) showed that Cucumber *Cucumis sativus* was indicated low resistance 60.13 (larvae stages) / 240 fruits in the first season meanwhile recorded a moderately resistant 37.19 (larvae stages) / 240 fruits in the second season, respectively. The mean susceptibility degree of the two seasons recorded low resistance with 48.66 (larvae stages) / 240 fruits. In respect to, Zucchini *Cucurbita pepo* was susceptible 72.21 (larvae stages) / 240 fruits in the first season but in the second season was highly susceptible with 98.63 (larvae stages) / 240 fruits, respectively. The mean susceptibility degree of the two tested seasons showed highly susceptible with 85.42 (larvae stages) / 240 fruits. Susceptibility degree of Snake melon *Cucumis melo* was low resistance in both seasons with 59.97 and 50.37 (larvae stages) / 240 fruits, respectively. The mean susceptibility degree of the two tested seasons showed low resistance with 55.17 (larvae stages) / 240 fruits.

**Table 3:** Evaluation of relative susceptibility degree of three Cucurbitae (zucchini, cucumber, and snake melon fruits) to infestation by *Dacus ciliatus* Loew. during the two seasons (2020-2021) at Qaha, Qalubia governorate

| Three Cucurbitae | 1st season | S. degree | 2nd season | S. degree | Mean | S. degree |
|---|---|---|---|---|---|---|
| **Cucumber** ***Cucumis sativus*** | 60.13 | LR | 37.19 | MR | 48.66 | **LR** |
| **Zucchini** ***Cucurbita pepo*** | 72.21 | S | 98.63 | HR | 85.42 | **HR** |
| **Snake melon** ***Cucumis melo*** | 59.97 | LR | 50.37 | LR | 55.17 | **LR** |
| **Mean ± SD** | **64.10±15.21** | | **62.06±13.11** | | **63.08±12.73** | |

Susceptible (S) = between $\bar{X}$ and $\bar{X}$ +2SD Low resistant (LR) = between $\bar{X}$ and $\bar{X}$ -1SD Moderately resistant (MR) = between $\bar{X}$ -1SD and $\bar{X}$-2SD

### 3.2.1. Population growth rate:

Data in Table (4) is an attempt to study the population growth rate in length of recording the initial pests numbers ($N_o$) , maximum count of the pests populations ($N_t$) and the time difference them ($\Delta t$) of *Dacus ciliatus* Loew that attacking three Cucurbitae (cucumber, zucchini, and snake melon fruits). Firstly, in respect to Zucchini *Cucurbita pepo* data in Table (4) was showed that, *D. ciliatus* recorded the highest growth rate (4.24), taking time difference 21 days between initial *D. ciliatus* number 21 and maximum count 110 (larvae stages) /40 fruits in the first season. Data of the second season was showed the *D. ciliatus* recorded the highest growth rate 6.76 taking 21 day between the initial pest number $N_o$ (12 (larvae stages) / 40 fruits and maximum count $N_t$ (154 (larvae stages) / 40 fruits. Secondly, in respect to Cucumber *Cucumis sativus*, recorded the growth rate (3.39), taking time difference 28 days between initial *D. ciliatus* number 12 and maximum count 107(larvae stages) / 40 fruits in the first season. Data of the second season was showed the *D. ciliatus* recorded the highest growth rate 6.76 taking 14 day between the initial pest number $N_o$ (15 (larvae stages) / 40 fruits and maximum count $N_t$ (110 (larvae stages) / 80 plant. Finally, in respect to Snake melon *Cucumis melo*, had the lowest growth rate in the first season were (1.68) taking time difference 28 days between initial *D. ciliatus* number 4 and maximum count 51(larvae stages). Data / 40 fruits in the first season where in the second season indicated 2.62 taking 21 day between the initial pest number $N_o$ (11 (larvae stages) / 40 fruits and maximum count $N_t$ (66 (larvae stages) / 40 fruits, respectively.

**Table 4:** Population growth rate three Cucurbitae (zucchini, cucumber, and snake melon fruits) to infestation by *Dacus ciliatus* Loew. during the two seasons (2020-2021) at Qaha, Qalubia governorate

| Three Cucurbitae | First season | | | | Second season | | | |
|---|---|---|---|---|---|---|---|---|
| | Population growth rate parameters | | | GR | Population growth rate parameters | | | GR |
| | No | Nt | Δt | | No | Nt | Δt | |
| **Cucumber** ***Cucumis sativus*** | 12 | 107 | 28 | 3.39 | 15 | 110 | 14 | 6.79 |
| **Zucchini** ***Cucurbita pepo*** | 21 | 110 | 21 | 4.24 | 12 | 154 | 21 | 6.76 |
| **Snake melon** ***Cucumis melo*** | 4 | 51 | 28 | 1.68 | 11 | 66 | 21 | 2.62 |

GR= the population growth rate, Nt = the pest numbers at the maximum count of the population on a plant
No = the initial pest numbers on a plant, Δt = the time difference between No and Nt

### 3.3. Impact of different compounds for reducing the *Dacus ciliatus* Loew on zucchini:

#### 3.3.1. First spray:

The mean reduction percentages of whitefly *D. ciliatus* numbers (nymph) as a result after applications of nine compounds it is clear that the nine control agents can be arranged in descending orders as follows: Penny 9% (Emamectin benzoate 1.5% + Indoxacarb 7.5%), Betavant SC14.5% (Indoxacarb 14.5%), Sinodor WG70%(Imidacloprid 70%), copper (CuO) nanoparticles, zinc (ZnO) nanoparticles, silica nanoparticles (SiNPs), *Mentha microphylla* (Mint) oil and the lowest *Citrullus colocynthis oil* and Artemisia cina oil with mean reduction of 97.33, 94.33, 93.0, 93.0, 90.33, 87.00, 83.00, 78.00and 77.00 for the nine agents, respectively. According to the mean, percentage of reduction in *D. ciliatus* counts after treatment, the compounds significantly divided into seven groups (F value=9.97*** and L.S.D= 6.89%).

#### 3.3.2. Second spray

Data indicated that there are significant differences between the nine compounds where F. value = 8.39*** and L.S.D= 7.17%. These compounds could be divided to four groups can be arranged in descending orders as follows: Penny 9%(Emamectin benzoate 1.5%+Indoxacarb 7.5%), Sinodor WG70%(Imidacloprid 70%), Betavant SC14.5%(Indoxacarb 14.5%), copper (CuO) nanoparticles, zinc (ZnO) nanoparticles, silica nanoparticles (SiNPs), *Mentha microphylla* (Mint) oil and the lowest Artemisia cina oil *oil* and *Citrullus colocynthis* with mean reduction of 96.67, 94.33, 92.67, 93.0, 90.00, 81.00, 79.33, 78.00and 77.00 for the nine agents, respectively. These agree with that obtained by Steffens (1983), Weems (2002), Fetoh (2006), Abou-Yousef *et al.,* (2010).and Ahmad *et al*.,(2011).

**Table 5:** Effect of different treatments on *Dacus ciliatus* Loew infesting zucchini plants under field condition at Qaha, Qalubiya Governorate during 2020 and 2021 seasons.

| | Treatments | No. larvae Per Treatments | Initial Kill | Reduction % after application | | | Residual toxicity | Mean% |
|---|---|---|---|---|---|---|---|---|
| | | | After 24 hours | 3 Days | 7 Days | 14 Days | | |
| First spray | **Artemisia cina oil** | 91 | 31 | 72 | 89 | 71 | 81 | 77.33 E |
| | ***Citrullus colocynthis oil*** | 112 | 35 | 71 | 92 | 71 | 82 | 78.00 E |
| | ***Mentha microphylla* (Mint) oil** | 107 | 39 | 75 | 98 | 76 | 82 | 83.00 DE |
| | **Silica nanoparticles (SiNPs)** | 102 | 49 | 80 | 100 | 81 | 88 | 87.00 CD |
| | **Copper (CuO)nanoparticles** | 99 | 67 | 87 | 100 | 92 | 92 | 93.00 ABC |
| | **Zinc (ZnO) nanoparticles** | 89 | 51 | 82 | 100 | 89 | 90 | 90.33 BC |
| | **Betavant SC 14.5%** | 102 | 61 | 89 | 100 | 94 | 98 | 94.33 AB |
| | **Penny 9%** | 103 | 66 | 92 | 100 | 100 | 97 | 97.33 A |
| | **Sinodor WG 70%** | 110 | 62 | 87 | 100 | 92 | 98 | 93.00 ABC |
| | **Control** | 103 | -- | -- | -- | -- | | -- |
| | **F value= 9.97*** and L.S.D= 6.89** | | | | | | | |
| Second spray | **Artemisia cina oil** | 78 | 34 | 73 | 91 | 74 | 84 | 79.33 C |
| | ***Citrullus colocynthis oil*** | 69 | 34 | 66 | 95 | 74 | 81 | 78.33 C |
| | ***Mentha microphylla* (Mint) oil** | 71 | 37 | 69 | 97 | 77 | 79 | 81.00 C |
| | **Silica nanoparticles (SiNPs)** | 66 | 43 | 83 | 100 | 85 | 90 | 89.33 B |
| | **Copper (CuO) nanoparticles** | 73 | 63 | 85 | 100 | 93 | 90 | 92.67 AB |
| | **Zinc (ZnO) nanoparticles** | 82 | 59 | 83 | 100 | 87 | 89 | 90.00 AB |
| | **Betavant SC14.5%** | 79 | 63 | 87 | 100 | 92 | 97 | 93.00 AB |
| | **Penny 9%** | 69 | 70 | 91 | 100 | 99 | 95 | 96.67 A |
| | **Sinodor WG70%** | 73 | 64 | 88 | 100 | 95 | 98 | 94.33 AB |
| | **Control** | 77 | | | | | | |
| | **F value= 8.39*** and L.S.D= 7.17** | | | | | | | |

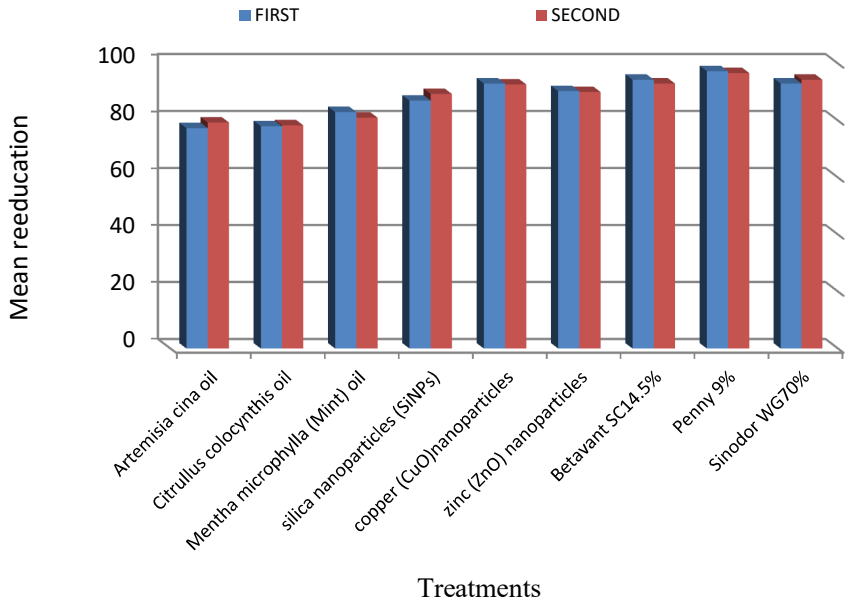


**Fig. 4.** Effect of different treatments on *Dacus ciliatus* Loew infesting squash plants under field condition at Qaha, Qalubiya Governorate during 2020 and 2021 seasons.

## References

Abou-Yousef, H.M., F.S. Farghaly, and H.M. Torkey, 2010. Insecticidal activity of some plant extracts against some sap- sucking insects under laboratory conditions. World Journal of Agricultural Sciences, 6(4): 434-439.

Ali, H., S. Ahmad, G. Hassan, A. Amin, Z. Hussain, and M. Naeem, 2011. Bioefficacy of different plant extracts against melon fruit fly in bitter gourd. Pakistan Journal of Weed Science Research, 17(2): 143-149.

Arai, T., 1976. Effects of temperature and light – dark cycles on the diel rhythm of emergence in the oriental fruit fly, *Dacus dorsalis* Hendel (Diptera: Trypetidae). Jpn. J. Appl. Entomol. Zool. 20, 69-76. (In Japanese with English summary).

Azab, A.K. and M.T. Kira, 1954. Cucurbit fruit fly, *Dacus ciliatus* (Loew) in Egyptian Society Fouad 1st d, Entomology Bulletin, 30: 379-382.

Azab, A.K., A.K.M. El-Nahal, and S.M. Wailem, 1970. The immature stages of the

Bag, D., 2000. Pesticides and health risks. Economic and Political Weekly, 35: 3381–3383.

Bateman, M.A., 1972. The ecology of fruit flies. Annual Review of Entomology. 17: 493

El Nahal, A.K.M, A.K. Azab, and S.M. Swailem, 1971. Studies on the biology of the melon fruit fly, *Dacus ciliatus* Loew (Diptera: Trypanaeidae). Bulletin de la Societe Entomologique d'Egypte, 54: 231-241

El-Nahal, A.K.M.; A.K. Azanb, and S.M. Swailem, 1970. Studies on the biology of the melon fruit fly, *Dacus ciliatus* Loew. Bull. Soc. Entomol. Egypt, 54: 243–247.

European and Mediterranean Plant Protect ion Organization, 2018. Data Sheets on Quarantine Pests. CABI and EPPO for EU under Contract-90/399003.

Fetoh, B.E.A., 2003. Recent record of parasitoid species of cucurbit fruit fly, *Dacus ciliates* (Loew) (Diptera: Tephritidae) in Egypt. Egyptian Journal of Biological Pest Control, 13 (1& 2), 127.

Fetoh, B.E.A., 2006. Occurrence, distribution and biology of the pumpkin fruit fly, *Dacus ciliatus* Loew (Diptera: Tephritidae) as reappearing pest in Egypt. Egyptian Journal of Agricultural Research, 84(1):11-16.

Fletcher, B.S., 1987. The biology of Dacine fruit flies. Annual Review of Entomology, 32: 115-144.

Hassain, M.S., K.M. Obaidullah, U.M. Nazim, S. Akhtar, and A.K.M. Quamruzzaman, 2002. Evaluation of integrated management practices against fruit fly on cucumber. Pakistan Journal of Biological Science, 5(9): 919 – 922.

Henderson, C.F. and E.W. Telton, 1955. Tests with acaricides against the brown wheat mite. J. Econ. Entomol., 48: 157-161.

Hussein, K.T., 2002. Toxicity and disrupting activity of *Thevetia peruvine* compound stigmasts En-3-ol in *Culex pipiens* larvae (Diptera: Culicidae). Journal of Egypt German Society of Zoology, 39: 33-42.

Malan, E.M. and J.H. Giliomee, 1968. Aspekte van die bionomie van *Dacus ciliates* Loew (Diptera: Tephritidae). J. Entomol. Soc. South Africa, 31: 373-389.

Malihi, Y., 1998. Aspects of the biology of *Dacus (Didacus) ciliatus* Loew (Diptera: Tephritidae). M.S. thesis. Tel Aviv University Tel Aviv, Israel. (in Hebrew with an English abstract).

Matanmi, B.A., 1975. The biology of tephritid fruit flies (Diptera: Tephritidae) attacking cucurbits at Ile-Ite, Nigeria. Niger. J. Entomol., 1: 153-159.

Mwatawala, M.W., M. De Meyer, R.H. Makundi, and A.P. Maerere, 2009. Host range and distribution of fruit–infesting pestiferous fruit flies (Diptera, Tephritidae) in selected areas of Central Tanzania. Bulletin of Entomological Research, 99: 629 – 641.

Odum, E.P., 1971. Fundamentals of ecology. Third edition. W.B. Saunders company: Philadelphia, 574.

Samalo, A.P., R.C. Beshra, and C.R. Satpathy, 1991. Studies on comparative biology of the melon fruit fly, *Dacus cucurbitae* Coquillett. Orissa Journal of Agricultural Research, 4:1–2.

Sapkota, R., K.C. Dahal, and R.B. Thapa, 2010. Damage assessment and management of cucurbit fruit flies in spring–summer squash. Journal of Entomology and Nematology, 2(1): 7 – 12.

SAS Institute, 2002. "SAS/STAT user's guide", version 9.1.3 Service Pack 4. SAS Institute Inc., Cary, NC, USA.

Srivastava, K.P. and D.K. Butani, 2009. *Pest Management in Vegetables*. Stadium Press, India. 380.

Steffens, R.J., 1983. Ecology and approach for integrated control of *Dacus frontalis* in the Cape Verde islands. Journal of Insect Science, 43: 625 –638.

Syed, R.A., 1969. Studies on the ecology of some important species of fruit flies and their natural enemies in West Pakistan. CIBC, Commonwealth Agriculture Bureau, Farnham Royal, Slough, UK. 12.

Weems, H.V., 2002. Lesser pumpkin fly, cucurbit fruit fly, *Daucus ciliatus* (Loew). Florida Univ., USA, EENY, (1) 250.

Weems, Jr. H.V., 2008. Lesser pumpkin fly, Ethiopian fruit fly, cucurbit fly, *Dacus ciliatus* (Loew) (Insecta: Diptera: Tephritidae). University of Florida, EENY 258, IFAS Extension.