ABSTRACT: Field studies were conducted on cotton mealybug, *Phenacoccus solenopsis* Tinsley (Hemiptera: Sternorrhyncha: Coccoidea: Pseudococcidae) which infested green bean plants at Attfih district, Giza Governorate, Egypt during two successive summer and nili seasons of 2016 and 2017. The population density, activity periods and the effects of some weather factors on *P. solenopsis* and its associated natural enemies were considered. The obtained results revealed that in summer season the total numbers of alive stages had one peak of activity in the 3rd of July during the first and second seasons (2016 and 2017), respectively. While, in nili season the total number of alive stages had one peak of activity in the 3rd and the 17th December, during the first and second seasons (2016 and 2017), respectively. The total effects of some weather factors such as maximum and minimum air temperature (°C) and relative humidity percentage (RH%) showed significantly positive relationship with the cotton mealybug population. During this study, three hymenopterous solitary endparasitoids and four predacious species were recorded. The parasitoids were *Aenasius arizonensis* (Girault), *Anagyrus pseudococci* (Girault) and *Acerophagus gutierreziae* Timberlake (Encyrtidae). The predacious ones were *Scymnus syriacus* Mars., *Coccinella undecimpunctata* (L.) (Coleoptera: Coccinellidae), *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae) and *Orius laevigatus* (Fiber.) (Hemiptera: Anthocoridae). In an attempt to control this insect pest specie, eight insecticides namely, mineral oil, lufenuron, chlorpyrifos, malathion, deltamethrin, buprofezin, thiamethoxam and imidacloprid were tested on *P. solenopsis* and its natural enemies on green bean under field conditions. The obtained results indicated that imidacloprid was the highest efficacy against *P. solenopsis* recording 90.71–89.17% reduction of the insect population after 21 days of application. Also imidacloprid was the highest efficacy against parasitoids and predators of the cotton mealybug. IGRs toxicants (buprofezin and lufenuron) found to be safer to the predacious insects than other tested insecticides.

Key words: Insecticides, green bean, weather factors, control, *Phenacoccus solenopsis*, natural enemies.

INTRODUCTION

Green bean, *Phaseolus vulgaris* L., is one of the most important leguminase crops which used as human food in Egypt and playing a vital role in the global food system, which infested by meany pests throughout the growing season such as the cotton mealybug. The cotton mealybug, *Phenacoccus solenopsis* Tinsley attacking 159 host plant species (agricultural and horticultural crops) belonging to 21 different families. It causes large damages of the quantity of yield either directly by sucking plant juice, weakening and death of some parts of plants or indirectly by excreted honeydew, which causes growth of sooty mould and inhibit photosynthesis process in plant. Also, it may transmit the pathogens to plants (Hodgson *et
The P. solenopsis had found on a wide range of vegetable crops including species of economically important families such as Malvaceae, Solanaceae and Cucurbitaceae which reported by many authors such as Abd-Rabou et al. (2010), Wang et al. (2010), Zhu et al. (2011), Ibrahim et al. (2015), Nabil et al. (2015) and Nabil (2017). It is also recorded associated with 28 species of natural enemies including 12 predators and 16 parasitoids (Shah et al., 2015). The effect of abiotic factors (temperature and relative humidity) on the biology, ecology and population dynamics of any organism was studied. Temperature is a major factor that affect on the abundance of mealybugs. Also, Fecundity of an insect pest is affected by RH% and temperature as well as life span and development of the mealybug (Kumar et al., 2013; Nabil and Hegab, 2019). Parasitoids and predators are considered the most important biotic factors that affected on the population of P. solenopsis. For example the parasitoid, Aneasius bambawalei Hayat (Hymenoptera : Encyrtidae) caused 20-70% parasitism of P. solenopsis (Tanwar et al., 2008; Ram et al. 2009; Hanchinal et al., 2010), respectively. The effect of the coccinellid predators on P. solenopsis population were recorded by Kedar et al. (2011). Assessment of the potential effects that pesticides have on the natural enemies is therefore an important part of IPM programs. As such, more nonselective pesticides are not favoured and a reduced application rate of broad-spectrum pesticides may decrease the impact on natural enemies, but still remain efficacious against pests. Therefore, the current study aimed to determine some ecological parameters of the different stages of this insect and its associated natural enemies on green bean in summer and nili seasons to evaluate the effects of some weather factors on the different stages of the pest. And also aimed to screen some insecticides used to control the pest and its side effects on associated natural enemies (parasitoids and predators). Such study may help for designing a comprehensive pest management program and prediction models for the cotton mealybug.

MATERIALS AND METHODS

Study Location

The seasonal population of the cotton mealybug, Phenacoccus solenopsis Tinsley and its associated natural enemies were monitored during summer and nili seasons of 2016 and 2017 on green bean, Phaseolus vulgaris L., plantations at Attifh district, Giza Governorate, Egypt. The experiments were conducted in an area of about half faddan (2100 m²) of green bean (Giza 3 cv.) which cultivated on the first week of March in the summer seasons and on the first week of August at nili season. Each area was divided into four equal replicates. The green bean plantations received normal agricultural practices and were not subjected to any chemical control application.

Samples Collection

One hundred leaves, twenty five ones of each replicate were taken weekly at random throughout the seasons of the study. The collected samples were packed up in paper bags, transferred to the laboratory and examined by the aid of a needle using a stereoscopic microscope at the laboratory of the Scale Insects and Mealybugs Department, Plant Protection Research Institute, Agriculture Research Center. Alive stages (nymphs and adults) of the insect pest and natural enemies were categorized and their counts were recorded. Specimens were enclosed in glass jars (15 cm diameter and 20 cm height). The jars were covered with muslin held in position by a rubber band and checked daily. The predators and parasitoids were separated from the collecting leaves parts during the initial examinations. The predacious and parasitic species were identified with helping of Prof. Dr. S. Abd-Rabou, Chief Researcher emeritus, Scale Insects and Mealybugs Department, Plant Protection Research Institute, Agricultural Research Center, Egypt. Population fluctuations of the mealybug and its natural enemies (predators and parasitoids) were estimated during the period of investigation.

Effect of some Weather Factors on the Insect Population and Natural Enemies

The main weather factors, maximum temperature (Max. Temp.), minimum temperature (Min. Temp.) and relative humidity (RH%)
corresponding to the sampling periods were obtained from the Meteorological Central Laboratory, Agricultural Research Center, Ministry of Agriculture, to indicate the effect of each factor of the tested climatic factors on the population of tested insect and its associated natural enemies.

Insecticides

The current study was carried out to evaluate the field performance of eight insecticides in their respective commercial formulations available on the market. The insecticide generic and chemical information is given in Table 1. The concentrations used were based on the recommendations of the Egyptian Ministry of Agriculture for each insecticide to control the pest insects under field conditions.

A field trial was conducted on plants grown on a farm located in Atfih distact, Giza Governorate, Egypt during two consecutive summer green bean seasons of 2016 and 2017. The infested green bean plants with cotton mealybug were identified, selected and labeled before the application of insecticides according to Monga et al. (2009). This area did not receive any insecticidal treatments before the start of the experiment. The trial of nine treatments (eight insecticides + control) was laid out in a randomized complete block design with three replicates. A spray was applied with a CP3 knapsack sprayer (Cooper Pegler Co. Ltd., Northumberland, England). The insecticides were used in commercial formulation and the concentrations were prepared using water as a diluent. Insecticides were sprayed in the early morning when the insects were active and the environmental conditions minimize the potential risk of spray drift and evaporation. Control plots were sprayed with water only. Thrity plants of 50-80 cm height with heavy infestation of mealybug and associated the natural enemies (parasitoids and predators) were randomly selected in the field. Plant to plant distance was 30 cm. Each plant was acted as a replicate. The spray application was done on 20\textsuperscript{th} and 30\textsuperscript{th} June during 2016 and 2017, respectively. Data were recorded on the selected plants before spraying as well as 7, 14 and 21 days after application. The mean numbers of cotton mealybugs per green bean plants and associated natural enemies were recorded.

The percent reduction of the mealybug population and associated natural enemies in all treatments compared to the control were calculated according to Henderson and Tilton (1955).

\begin{equation}
\text{Population reduction (\%)} = \frac{N \text{ in control before treatment} \times N \text{ in Treatment after treatment}}{N \text{ in control after treatment} \times N \text{ in Treatment before treatment} \times 100}
\end{equation}

N= number of individuals

Statistical Analysis

Simple correlation values (r), partial regression (b), coefficient of determination percentage (CD%), The analysis of variance (ANOVA) and the least significant difference (LSD) values were calculated using CoStat, Computer Program version 6.311, 2005 (Costat Statistical Sotware, 2005).

| Common name          | Trade name | Formulation | Application rate |
|----------------------|------------|-------------|------------------|
| Mineral oil          | Tiger      | 97% EC      | 1L/100L          |
| Lufenuron            | Match      | 5% EC       | 160 ml/fad.      |
| Malathion            | Ictathion  | 57% EC      | 150 ml/100L      |
| Deltamethrin         | Decis      | 2.5% EC     | 500 ml/100L      |
| Chlorpyrifos         | Dursban H  | 48%EC       | 1L./fad.         |
| Imidacloprid         | Ecomida    | 30.5% SC    | 60 ml/100L       |
| Thiamethoxam         | Actara     | 25% WG      | 25 g/100L        |
| Buprofezin           | Applaud    | 25% SC      | 600 ml/fad.      |
RESULTS AND DISCUSSION

Population Density of Phenacoccus solenopsis Tensely in Summer Seasons

Results given in Figs. 1 and 2 show that during the first and second summer seasons (2016 and 2017) nymphs showed one peak of activity on the 3rd of July. Also, adult females during the first and second seasons (2016 and 2017) had one peak of activity on the 5th and the 12th of June, respectively. The total number of alive stages had one peak of activity on the 3rd of July during the first and second seasons (2016 and 2017), successively.

Effects of some Weather Factors on P. solenopsis

Results presented in Table 2 indicate that in the first season, maximum temperature had positive highly significant on the total alive stages of the cotton mealybug where \( r = 0.664^{**} \). While, in the second season each of maximum and minimum temperature had positive highly significant and positive significant on the total alive stages of the cotton mealybug where \( r = 0.712^{**} \) and 0.537*, consecutively. Coefficient of determination (CD%) obviously cleared that the three considered weather factors affected the total number of alive stages population by 72.30 and 64.57%, in the first and second seasons, successively.

These results are in agreement with those obtained by Hameed et al. (2014), Tehniyat et al. (2015), Nabil (2017) and Nabil and Hegab (2019) who mentioned that cotton mealybug population showed positive significant relationship with maximum temperature, minimum temperature and RH%.

Natural Enemies

During this study three parasitoids and four predators species were recorded. The parasitoids were Aenasis arizoningensis (Girault), Anagyrus pseudococci (Girault) and Acerophagus gutierreziae Timberlake (Hymenoptera: Encyrtidae). All previously mentioned species are solitary endoparasitoids. The predacious species were Scymnus syriacus Mars., Coccinella undecimpunctata L. (Coleoptera: Coccinellidae), Chrysoperla carnea (Stephens) (Neuroptera: Chrysopidae) and Orius laevigatus (Fiber.) (Hemiptera: Anthocoridae).

As shown in Tables 3 and 4 during the first and second seasons 2016 and 2017, A. arizoningensis recorded the highest number on the 3rd of July (32 individuals/sample) and the 19th of June (14 individuals/sample), successively. While, A. Pesudococci reached the highest number on the 12th of June (7 individuals / sample) and the 5th of June (4 individuals / sample), respectively. A. gutierreziae appeared in rare individuals in all samples during the study course.

Chrysoperla carnea was the most abundant predator during the study period followed by C. undecimpunctata. But S. syriacus and O. laevigatus appeared in a few numbers all over the study period. During the first and second seasons 2016 and 2017 C. carnea recorded the highest number on the 3rd of July (21 individuals / sample) and on the 19th of June (14 individuals / sample), successively. While, C. undecimpunctata reached the highest number on the 26th of June (14 individuals/ sample) and on the 19th of June (9 individuals/sample), respectively. These results were in agreement with those obtained by Khan et al. (2012) who stated that C. carnea and Cryptolaemus montrouzieri predators showed strong predatory potential against P. solenopsis, and being the most ravenous feeder. Moreover, prey stages also had a considerable effect on consumption rate, development and fecundity. Attia and Awadallah (2016) surveyed the predators, parasitoids and hyperparasitoids associated with nymphaal and adult stages of P. solenopsis infesting five ornamental host plants and six weeds. They recorded six predacious species, two endoparasitoids and four hyperparasitoids.

The predacious species were Hyperaspidis vinciguerrae Capra, S. syriacus, Nephus (Sides) hieki Fursch (Coccinellidae), Dicrodiplosis manihoti Harris (Cecidomyiidae), C. carnea, Sympherobius amicus Navas (Hemerobiidae) and Orius albidipennis (Reuter). The primary parasitoids were A. gutierreziae and Chartocerus dactyllopii (Ashmead). Also, Bharathi and Muthukrishnan (2017) stated that the solitary endoparasitoid, A. bambawalei, was found as one of the key regulating factor for the mealybug, despite harboring 11 different hyperparasitoids. Nabil and Hegab (2019) recorded A. arizoningensis as a primary parasitoid of P. solenopsis infesting okra plants. Substantially, good deal of natural enemies, both the predators and parasitoids were
Fig. 1. Seasonal abundance of *Phenacoccus solenopsis* Tensily infesting green bean plants in Atfih (Giza) during summer season 2016.
Fig. 2. Seasonal abundance of *Phenacoccus solenopsis* Tensily infesting green bean plants in Atfih (Giza) during summer season 2017
Table 2. Correlation coefficient and multiple regression indicating the effects of some weather factors on *Phenacoccus solenopsis* Tinsley on green bean plantations at Atfih (Giza) during summer and nili seasons 2016 and 2017

| Location     | Season       | Considered weather factor | r      | b      | CD (%) |
|--------------|--------------|---------------------------|--------|--------|--------|
| Atfih (Giza) | Summer 2016  | Max. Temp. ºC             | 0.664**| 0.003  | 72.30  |
|              |              | Min. Temp. ºC             | 0.412  | 0.089  |        |
|              |              | RH (%)                    | -0.095 | 0.706  |        |
|              |              | Max. Temp. ºC             | 0.712**| 0.009  |        |
|              | Summer 2017  | Min. Temp. ºC             | 0.537* | 0.022  | 64.57  |
|              |              | RH (%)                    | -0.296 | 0.022  |        |
|              | Nili 2016    | Max. Temp. ºC             | 0.277  | 0.266  |        |
|              |              | Min. Temp. ºC             | 0.398  | 0.102  | 20.04  |
|              |              | RH (%)                    | 0.413  | 0.088  |        |
|              | Nili 2017    | Max. Temp. ºC             | 0.191  |        |        |
|              |              | Min. Temp. ºC             | 0.456  | 0.057  | 39.48  |

Table 3. Seasonal abundance of natural enemies associated with *Phenacoccus solenopsis* Tinsley infesting green beans plants in Atfih (Giza) during summer season 2016

| Sampling date | No. of parasitoids | No. of predators |
|---------------|--------------------|------------------|
|               | Total number of *P. solenopsis* | 4. *arizonensis* | 4. *pseudococc* | 4. *gutierreziae* | 4. *syriacus* | 4. *carnea* | 4. *undecimpunctata* | 4. *laevigatus* |
| Apr., 3       | 46                 | 0                | 0                | 0                | 0                | 0                | 0                | 0                |
| 10            | 85                 | 0                | 0                | 0                | 0                | 0                | 0                | 0                |
| 17            | 113                | 0                | 0                | 0                | 0                | 0                | 0                | 0                |
| 24            | 155                | 1                | 0                | 0                | 0                | 0                | 0                | 0                |
| May, 1        | 190                | 4                | 0                | 0                | 0                | 0                | 0                | 0                |
| 8             | 202                | 9                | 2                | 0                | 0                | 5                | 0                | 0                |
| 15            | 323                | 11               | 2                | 0                | 0                | 6                | 0                | 0                |
| 22            | 399                | 13               | 3                | 0                | 0                | 9                | 4                | 0                |
| 29            | 443                | 15               | 4                | 0                | 1                | 11               | 5                | 0                |
| Jun., 5       | 513                | 16               | 5                | 0                | 1                | 13               | 9                | 0                |
| 12            | 533                | 22               | 7                | 0                | 0                | 15               | 11               | 0                |
| 19            | 588                | 24               | 3                | 0                | 0                | 17               | 12               | 2                |
| 26            | 628                | 25               | 1                | 0                | 0                | 18               | 14               | 4                |
| Jul., 3       | 717                | 32               | 1                | 1                | 1                | 21               | 2                | 3                |
| 10            | 266                | 9                | 0                | 1                | 4                | 8                | 1                | 1                |
| 17            | 171                | 5                | 0                | 0                | 0                | 3                | 0                | 1                |
| 24            | 78                 | 2                | 0                | 0                | 0                | 1                | 0                | 0                |
| 31            | 29                 | 2                | 0                | 0                | 0                | 0                | 0                | 0                |
| Total         | 5479               | 190              | 28               | 2                | 7                | 127              | 58               | 11               |
| Mean          | 304.39             | 10.56            | 1.56             | 0.11             | 0.39             | 7.06             | 3.22             | 0.61             |
Table 4. Seasonal abundance of natural enemies associated with *Phenacoccus solenopsis* Tinsley infesting green beans plants in Atfih (Giza) during summer season 2017

| Sampling date | No. of parasitoids | No. of predators |
|---------------|--------------------|-----------------|
|               | Total number of *P. solenopsis* | *A. arizonensis* | *A. pseudococci* | *A. gutierreziae* | *S. syriacus* | *C. carnea* | *C. decempunctatula* | *O. laevis* |
| Apr., 3       | 31                 | 0               | 0               | 0               | 0               | 0               | 0               | 0               |
| 10            | 39                 | 0               | 0               | 0               | 0               | 0               | 0               | 0               |
| 17            | 55                 | 0               | 0               | 0               | 0               | 0               | 0               | 0               |
| 24            | 68                 | 0               | 0               | 0               | 0               | 0               | 0               | 0               |
| May, 1        | 90                 | 0               | 0               | 0               | 0               | 0               | 0               | 0               |
| 8             | 112                | 0               | 0               | 0               | 0               | 0               | 0               | 0               |
| 15            | 131                | 0               | 0               | 0               | 0               | 0               | 0               | 0               |
| 22            | 185                | 1               | 0               | 0               | 0               | 0               | 0               | 0               |
| 29            | 214                | 6               | 3               | 0               | 0               | 1               | 3               | 0               |
| Jun., 5       | 263                | 8               | 4               | 0               | 0               | 6               | 5               | 0               |
| 12            | 320                | 12              | 1               | 0               | 0               | 9               | 7               | 0               |
| 19            | 377                | 14              | 1               | 0               | 0               | 14              | 9               | 0               |
| 26            | 406                | 13              | 0               | 0               | 0               | 13              | 5               | 2               |
| Jul., 3       | 448                | 10              | 0               | 0               | 2               | 9               | 0               | 2               |
| 10            | 185                | 2               | 0               | 0               | 6               | 5               | 0               | 1               |
| 17            | 122                | 1               | 0               | 0               | 0               | 0               | 0               | 0               |
| 24            | 41                 | 0               | 0               | 0               | 0               | 0               | 0               | 0               |
| 31            | 16                 | 0               | 0               | 0               | 0               | 0               | 0               | 0               |
| Total         | 3103               | 67              | 9               | 0               | 8               | 57              | 31              | 5               |
| Mean          | 172.39             | 3.72            | 0.50            | 0.00            | 0.44            | 3.17            | 1.72            | 0.28            |

found associated with the field population of *P. solenopsis*, indicating great potential for environmental friendly natural biological control.

**Population Density of *Phenacoccus solenopsis* Tinsley in Nili Seasons**

Results illustrated in Figs. 3 and 4 show that during the first and second seasons (2016 and 2017) nymphs recorded one peak of activity on the 17th of December, consecutively. Also, adult females during the first and second seasons (2016 and 2017) had one peak of activity on the 19th of November, respectively. The total number of alive stages had one peak of activity on the 3rd and the 17th December, during the first and second seasons (2016 and 2017), successively.

**Effects of some Weather Factors on *P. solenopsis***

Results presented in Table 2 indicate that in the first and second seasons (2016-2017) maximum temperature, minimum temperature and RH (%) affected the total number of alive stages population by 20.04 and 39.48%, successively. Climatic conditions have a great impact on the population dynamics of cotton mealybug and its distribution over a wide host range (Prasad et al., 2012). Therefore, continuous monitoring of the population and dynamics of cotton mealybug is required to avoid severe crop losses with the ongoing changes in climatic conditions (Rezk et al., 2019).
Fig. 3. Seasonal abundance of *Phenacoccus solenopsis* Tensily infesting green bean plants in Atfih (Giza) during nili season 2016
Fig. 4. Seasonal abundance of *Phenacoccus solenopsis* Tensily infesting green bean plants in Atfih (Giza) during nili season 2017
Natural Enemies

During this study three parasitoids and four predators species were recorded. The parasitoids were *A. arizonensis*, *A. pseudococci* and *A. gutierreziae*. All previously mentioned species are solitary endoparasitoids. The predacious species were *S. syriacus*, *C. undecimpunctata*, *C. carnea* and *O. laevigatus*.

As shown in Tables 5 and 6 during the first and second seasons 2016 and 2017 *A. arizonensis* recorded the highest number on the 12th of November (22 individuals/ sample) and the 5th of November (9 individuals/ sample), successively. While, *A. Pseudococci* reached the highest number in the 26th of November (5 and 9 individuals/sample) during the first and second seasons 2016 and 2017, respectively. *A. gutierreziae* appeared in rare individuals in all samples during the study course.

*C. undecimpunctata* was the most abundant predator during the study period followed by *C. syriacus* and *O. laevigatus*. But *S. syriacus* appeared in a few numbers all over the study period. During the first and second seasons 2016 and 2017 *C. carnea* recorded the highest number on the 10th of December (16 and 13 individuals / sample) during the first and second seasons 2016 and 2017, successively. While, *C. undecimpunctata* reached the highest number on the 26th of November (9 individuals / sample) and on the 3rd of December (6 individuals / sample), respectively. *O. laevigatus* occurred at the highest number on the 3rd of December (6 individuals / sample) during the first season 2016. While, during the second one *O. laevigatus* reached the highest number on the 19th of November (4 individuals / sample) and on the 3rd of December (4 individuals / sample).

These results were in agreement with those obtained by Khan *et al.* (2012) who stated that *C. carnea* and *Cryptolaemus montuosi* predators showed strong predatory potential against *P. solenopsis*, being the most ravenous feeder.

Efficacy of Some Insecticides Against the Cotton Mealybug and its Natural Enemies on the Cotton Mealybug, *Phenacoccus solenopsis*

Eight insecticides from different chemical groups as foliar treatment applications were evaluated against the cotton mealybug *P. solenopsis* and its natural enemies under field conditions of summer seasons during 2016 and 2017 on green bean plantation at Atfih district Giza Governorate. Results presented in Tables 7 and 8 summarize the effects of the evaluated insecticides. It is obvious that during the first and second seasons (2016 and 2017) malathion, imidacloprid and thiamethoxam induced a fast, initial effect after 7 days of application against the cotton mealybug population. The reduction in the population was 91.10 and 84.77, 85.51 and 83.99 and 82.23 and 81.25%, respectively. Followed by mineral oil, chlorpyrifos and buprofezin with values of 81.14, 80.05 and 71.62, consecutively during the first season, while during the second one chlorpyrifos, mineral oil and buprofezin showed varied percentage of initial reduction with values of 80.77, 75.91 and 66.89%, consecutively. Finally lufenuron and deltamethrin showed the lowest initial effect percentage of reduction after 7 days of application during the first and second seasons where the reduction were 65.70 and 65.57 as well as 62.08 and 61.71%, successively. The residual effect extended up to 21 days after initial application against the cotton mealybug population the reduction in the population during the first seasons (2016) was recorded with imidacloprid followed by thiamethoxam, chlorpyrifos, malathion, mineral oil, buprofezin, deltamethrin and lufenuron with values of 94.11, 93.89, 91.15, 90.36, 84.76, 84.45, 82.30 and 77.43%, respectively. While, during the second season (2017) the highest reduction in the population was recorded with imidacloprid followed by thiamethoxam, malathion, chlorpyrifos, mineral oil, buprofezin, lufenuron and deltamethrin with values of 92.22, 88.11, 87.99, 84.26, 81.10, 74.20, 73.69 and 69.27, consecutively. The mean population reductions of the cotton mealybugs after different insecticide treatments on green bean plants during two growing summer seasons (2016 and 2017) showed that imidacloprid was the most effective insecticide causing 90.71 and 88.14%, consecutively, followed by malathion, thiamethoxam, chlorpyrifos, mineral oil, buprofezin, lufenuron and deltamethrin with values of 88.90, 86.24; 88.69, 85.82 ; 85.49, 83.09 ; 82.35, 79.37; 78.45, 71.76 ; 72.24, 70.98 and 71.94, 60.75%, successively.

These results were in agreement with those obtained by Mamoon-ur-Rashid *et al.* (2011),
Table 5. Seasonal abundance of natural enemies associated with *Phenacoccus solenopsis* Tinsley infesting green beans plants in Atfih (Giza) during nili season 2016

| Sampling date | No. of parasitoids | No. of predators |
|---------------|--------------------|------------------|
|               | Total number of *P. solenopsis* | *A. arizonensis* | *A. pseudococci* | *A. gutierreziae* | *S. syriacus* | *C. carnea* | *C. undecimpunctata* | *O. laevigatus* |
| Sep., 17, 2016| 68                 | 0                | 0                | 0                | 0            | 0            | 0            | 0            |
| 24            | 71                 | 0                | 0                | 0                | 0            | 0            | 0            | 0            |
| Oct., 1       | 94                 | 1                | 0                | 0                | 0            | 0            | 0            | 0            |
| 8             | 182                | 3                | 0                | 0                | 0            | 0            | 0            | 0            |
| 15            | 219                | 9                | 0                | 0                | 0            | 0            | 0            | 0            |
| 22            | 247                | 10               | 1                | 0                | 0            | 5            | 0            | 0            |
| 29            | 264                | 16               | 1                | 0                | 0            | 6            | 0            | 0            |
| Nov., 5       | 331                | 19               | 2                | 0                | 0            | 7            | 3            | 0            |
| 12            | 531                | 22               | 2                | 0                | 1            | 10           | 4            | 0            |
| 19            | 567                | 18               | 4                | 0                | 1            | 12           | 7            | 1            |
| 26            | 600                | 15               | 5                | 0                | 0            | 13           | 9            | 1            |
| Dec., 3       | 647                | 13               | 3                | 0                | 0            | 15           | 8            | 6            |
| 10            | 644                | 11               | 1                | 0                | 0            | 16           | 1            | 5            |
| 17            | 614                | 8                | 1                | 1                | 1            | 10           | 1            | 2            |
| 24            | 383                | 4                | 0                | 1                | 3            | 7            | 1            | 1            |
| 31            | 188                | 1                | 0                | 0                | 0            | 2            | 0            | 1            |
| Jan., 7, 2017 | 72                 | 1                | 0                | 0                | 0            | 1            | 0            | 0            |
| 14            | 45                 | 1                | 0                | 0                | 0            | 0            | 0            | 0            |
| Total         | 5767               | 152              | 20               | 2                | 6            | 104          | 34           | 17           |
| Mean          | 320.39             | 8.44             | 1.11             | 0.11             | 0.33         | 5.78         | 1.89         | 0.94         |
Table 6. Seasonal abundance of natural enemies associated with *Phenacoccus solenopsis* Tinsley infesting green beans plants in Atfih (Giza) during Nili season 2017

| Sampling date | Total number of *P. solenopsis* | No. of parasitoids | No. of predators |
|---------------|---------------------------------|-------------------|-----------------|
|               |                                 | *A. arizonensis*   | *A. pseudococcii* | *A. gutierreziae* | *S. syriacus* | *C. carena* | *C. undecimpunctata* | *O. laevigatus* |
| Sep., 17, 2017| 69                              | 0                 | 0               | 0               | 0            | 0           | 0               | 0              |
| 24            | 72                              | 0                 | 0               | 0               | 0            | 0           | 0               | 0              |
| Oct., 1       | 95                              | 0                 | 0               | 0               | 0            | 0           | 0               | 0              |
| 8             | 133                             | 2                 | 0               | 0               | 0            | 0           | 0               | 0              |
| 15            | 203                             | 2                 | 0               | 0               | 0            | 0           | 0               | 0              |
| 22            | 213                             | 3                 | 0               | 0               | 3            | 0           | 0               | 0              |
| 29            | 250                             | 7                 | 0               | 0               | 5            | 0           | 0               | 0              |
| Nov., 5       | 266                             | 9                 | 1               | 0               | 2            | 1           | 0               | 0              |
| 12            | 316                             | 6                 | 3               | 0               | 2            | 7           | 2               | 1              |
| 19            | 479                             | 5                 | 6               | 0               | 4            | 9           | 3               | 4              |
| 26            | 514                             | 3                 | 9               | 0               | 1            | 10          | 5               | 3              |
| Dec., 3       | 570                             | 3                 | 4               | 1               | 1            | 11          | 6               | 4              |
| 10            | 588                             | 1                 | 2               | 1               | 0            | 13          | 1               | 2              |
| 17            | 676                             | 0                 | 1               | 2               | 0            | 8           | 1               | 1              |
| 24            | 349                             | 0                 | 1               | 1               | 0            | 6           | 0               | 1              |
| 31            | 184                             | 0                 | 0               | 1               | 0            | 1           | 0               | 1              |
| Jan., 7, 2018 | 104                             | 0                 | 0               | 0               | 0            | 1           | 0               | 0              |
| 14            | 58                              | 0                 | 0               | 0               | 0            | 0           | 0               | 0              |
| Total         | 5139                            | 41                | 27              | 6               | 8            | 76          | 19              | 17             |
| Mean          | 285.50                          | 2.28              | 1.50            | 0.33            | 0.44         | 4.22        | 1.06            | 0.94           |
Table 7. Impact of different insecticides against the cotton mealybug, *P. solenopsis* and its associated natural enemies on green bean plants in Atfih (Giza) during summer season 2016

| Treatment    | Days after post treatment and reduction percentages |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|--------------|---------------------------------------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|              |                                                   | 7| 14| 21| Mean| 7| 14| 21| Mean| 7| 14| 21| Mean| 7| 14| 21| Mean|
| Mineral oil  |                                                   | 81.14| 81.14| 84.76| 82.35c| 76.69| 78.45| 76.79| 77.31d| 73.82| 71.96| 74.11| 73.30e|
| Iufenuron    |                                                   | 65.7| 73.60| 77.43| 72.24e| 75.71| 78.95| 73.12| 75.92ed| 74.64| 74.64| 70.74| 73.34e|
| Chlorpyrifos |                                                   | 80.05| 85.26| 91.15| 85.49b| 82.91| 83.54| 81.09| 82.51c| 75.69| 79.17| 80.77| 78.54d|
| Malathion    |                                                   | 91.10| 89.24| 90.36| 88.90a| 88.17| 89.74| 90.18| 89.36a| 88.33| 88.33| 89.23| 88.63b|
| Deltamethrin |                                                   | 62.08| 71.43| 82.30| 71.94e| 78.02| 71.43| 72.92| 72.77f| 75.69| 81.77| 83.17| 80.21d|
| Buprofezin   |                                                   | 71.62| 79.28| 84.45| 78.45d| 69.70| 75.76| 72.92| 72.77f| 67.59| 72.99| 70.09| 70.22f|
| Thiamethoxam |                                                   | 82.23| 89.94| 93.89| 88.69a| 85.11| 85.66| 89.02| 86.59b| 81.48| 86.11| 80.77| 82.79c|
| Imidacloprid |                                                   | 85.51| 92.50| 94.11| 90.71a| 90.10| 90.54| 92.49| 90.71a| 88.78| 94.39| 89.64| 90.94a|
| Control      |                                                   | 0.00| 0.00| 0.00| 0.00| 0.00| 0.00| 0.00| 0.00| 0.00| 0.00| 0.00| 0.00|
| LSD          |                                                   | 3.02| 2.25| 2.21| 2.21| 50.61| 62.08| 72.77| 72.77|

Table 8. Impact of different insecticides against the cotton mealybug, *P. solenopsis* and its associated natural enemies on green bean plants in Atfih (Giza) during summer season 2017

| Treatment    | Days after post treatment and reduction percentages |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|--------------|---------------------------------------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|              |                                                   | 7| 14| 21| Mean| 7| 14| 21| Mean| 7| 14| 21| Mean| 7| 14| 21| Mean|
| Mineral oil  |                                                   | 75.91| 81.1| 84.76| 74.37c| 77.22| 82.92| 88.12| 82.75d| 80.39| 84.13| 85.51| 83.34c|
| Iufenuron    |                                                   | 65.57| 73.69| 73.69| 70.98d| 68.94| 70.88| 79.74| 73.19f| 67.65| 76.19| 72.83| 72.22d|
| Chlorpyrifos |                                                   | 80.77| 84.26| 84.26| 83.09b| 82.02| 86.51| 90.62| 86.38b| 83.46| 88.15| 87.80b|
| Malathion    |                                                   | 84.01| 87.99| 87.99| 86.24a| 89.95| 92.46| 94.76| 92.39a| 90.71| 92.48| 89.7| 90.96a|
| Deltamethrin |                                                   | 61.71| 69.27| 69.27| 60.75f| 69.85| 71.53| 80.19| 73.85c| 64.71| 64.29| 80.43| 69.81c|
| Buprofezin   |                                                   | 66.89| 74.2| 74.2| 71.76d| 79.9| 70.59| 74.2| 74.89d| 70.59| 76.19| 72.83| 73.20d|
| Thiamethoxam |                                                   | 81.25| 88.11| 88.11| 85.82a| 91.01| 93.26| 90.62| 91.63a| 88.97| 92.86| 91.85| 91.23a|
| Imidacloprid |                                                   | 83.99| 90.22| 90.22| 88.14f| 85.14| 94.43| 96.12| 91.89g| 90.2| 94.44| 92.75| 92.46a|
| Control      |                                                   | 0.00| 0.00| 0.00| 0.00| 0.00| 0.00| 0.00| 0.00| 0.00| 0.00| 0.00| 0.00|
| LSD          |                                                   | 1.92| 2.63| 3.05| 3.05| 50.61| 62.08| 72.77| 72.77|

LSD f 50.61 62.08 72.77

f 144.31 63.93 63.93
Ashiq et al. (2015) and Rezk et al. (2019) who stated that imidacloprid, thiamethoxam and malathion proved to be the best products after 5 and 7 days of application against mealybug.

Impact on the Natural Enemies

Results presented in Tables 7 and 8 indicate that there are significant differences among all treatments in parasitoids reduced percentages after insecticides application. During the first season (2016) imidacloprid was the most toxic insecticide against parasitoids where the percentage of reduction was 90.71% followed by malathion, thiamethoxam, chlorpyrifos, mineral oil, lufenuron, deltamethrin and buprofezin with values of 89.36, 86.59, 82.51, 77.31, 75.92, 74.03 and 72.79%, successively. While, during the second season (2017) Malathion was the most toxic insecticide against parasitoids where the percentage of reduction was 92.39% followed by imidacloprid, thiamethoxam, chlorpyrifos, deltamethrin, buprofezin, lufenuron and mineral oil, these products that are registered for use in green bean and other vegetables against several pests. These results were in agreement with those obtained by Mamoon-ur-Rashid et al. (2011) and Karmakar and Shera (2017) who disclosed that, the use of synthetic insecticides is extremely toxic to predators such as C. carnea, Hippodemia convergens, Coccinella septempunctata L., Brumus natralus and C. montrouzieri of mealybugs. Imidacloprid was found comparatively the most toxic to the activities of predator, C. carnea up to 10 days after application of insecticides. Also, mentioned that buprofezin insecticide may be preferred as first spray to other recommended insecticides for the control of mealybug to conserve the natural enemies in cotton ecosystem.

REFERENCES

Abbas, G., M.J. Arif, M. Ashfaq, M. Aslam and S. Saeed (2010). Host plants, distribution and over wintering of cotton mealybug (Phenacoccus solenopsis; Hemiptera: Pseudococcidae). Int. J. Agric. and Biol., 12: 421-425.

AbdfRabou, S., J.F. Germain and T. Malausa (2010). Phenacoccus parvus Morrison et P. solenopsis Tinsley, deux Cochenilles nouvelles pour l’Egypte (Hemiptera: Pseudococcidae). Bulletin de la Société Entomologique de France, 115 (4): 509-510.

Aheer, G.M., Z. Shah and M. Saeed (2009). Seasonal history and biology of cotton

The cotton mealybug, P. solenopsis (Tinsley) (Hemiptera: Pseudococcidae), has become a widespread pest causing serious losses in several economically important crops, particularly cotton (Rezk et al., 2019). The use of agrochemicals particularly pesticides, can hamper the effectiveness of natural enemies, causing disruption in the ecosystem service of biological control. Malathion, imidacloprid, thiamethoxam, chlorpyrifos, deltamethrin, buprofezin, lufenuron and mineral oil, these products that are registered for use in green bean and other vegetables against several pests. These results were in agreement with those obtained by Mamoon-ur-Rashid et al. (2011) and Karmakar and Shera (2017) who disclosed that, the use of synthetic insecticides is extremely toxic to predators such as C. carnea, Hippodemia convergens, Coccinella septempunctata L., Brumus natralus and C. montrouzieri of mealybugs. Imidacloprid was found comparatively the most toxic to the activities of predator, C. carnea up to 10 days after application of insecticides. Also, mentioned that buprofezin insecticide may be preferred as first spray to other recommended insecticides for the control of mealybug to conserve the natural enemies in cotton ecosystem.
mealybug, *Phenacoccus solenopsis* Tinsley. J. Agric. Res., 47: 423-431.

Arif, M.I., M. Rafiq and A. Ghaffar (2009). Host plants of cotton mealybug (*Phenacoccus solenopsis*): a new menace to cotton agroecosystem of Punjab, Pakistan. Int. J. Agric. and Biol., 11: 163-167.

Ashiq, H.S., Q.W. Masood, A. Muhammad and L. Khalid (2015). Efficacy of different insecticides against cotton mealybug *Phenacoccus solenopsis* Tinsley (Sternorrhyncha: Coccoidea: Pseudococcidae) in ecological zone of Rahim Yar Khan. Int. J. Adv. Res. Biol. Sci., 2 (2): 61–67.

Attia, A.R. and K.T. Awadallah (2016). Predators, parasitoids and hyperparasitoids associated with the cotton mealybug, *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae) infesting different host plants at Giza region. Egypt. Acad. J. Biol. Sci. (A. Entomol.), 9 (4): 97–103.

Bharathi, K. and N. Muthukrishnan (2017). Survey and records of mealybugs species on cotton and alternate host of key mealybug *Phenacoccus solenopsis* Tinsley and its natural enemies complex in major cotton growing areas of South Tamil Nadu, India. Int. J. Current Microbiol. and Appl. Sci., 6 (12): 1047-1054.

CoStat Statistical Software (2005). Microsoft computer program for the design and analysis of agronomic research experiments. Version 6.311. CoHort Software, Monterey, California, USA.

Hameed, A., M.S. Shahzad, A. Mehmoon, S. Ahmad and N. Islam (2014). Forecasting and modeling of sucking insect complex of cotton under agro-ecosystem of Multan-Punjab, Pakistan. Pak. J. Agric. Sci., 51 (4): 997-1003.

Hanchinal, S.G., B.V. Patil, M. Bheemanna and A.C. Hosamani (2010). Population dynamics of mealybug, *Phenacoccus solenopsis* Tinsley and its natural enemies on Bt cotton. Karnataka J. Agric. Sci., 23 (1): 137-139.

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

Hodgson, C.J., G. Abbas, M.J. Arif, S. Saeed and H. Karar (2008). *Phenacoccus solenopsis* Tinsley (Sternorrhyncha: Coccoidea: Pseudococcidae), a new invasive species attacking cotton in Pakistan and India, with a discussion on seasonal morphological variation. Zootaxa, 1913: 1-35.

Ibrahim, S.S., F.A. Moharum and N.M. Abd El-Ghany (2015). The cotton mealybug *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae) as a new insect pest on tomato plants in Egypt. J. Plant Prot. Res., 55 (1): 48-51.

Karmakar, P. and P.S. Shera (2017). Toxicity of insecticides to *Aenasius arizonensis* (Girault) (=*Aenasius bambawalei* Hayat), a solitary endoparasitoid of *Phenacoccus solenopsis* Tinsley on Bt cotton under semifield conditions. J. Biol. Control, 31(1): 5-9.

Khan, H.A., A.H. Sayyed, W. Akram, S. Raza and M. Ali (2012). Predatory potential of *Chrysoperla carnea* and *Cryptolaemus montrouzieri* larval on different stages of the mealybug, *Phenacoccus solenopsis*: a threat to cotton in south Asia. J. Insect. Sci., 12: 1-12.

Kedar, S.C., R.K. Saini and P. Ram (2011). Relative abundance of coccinellid predators associated with *Phenacoccus solenopsis* on cotton. Ann. Plant Prot. Sci., 19 (2): 475-476.

Kumar, S., J.K. Sidhu, J.C. Hamm, J.S. Kular and M.S. Mahal (2013). Effect of temperature and relative humidity on the life table of *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae) on cotton. Florida Entomol., 96 (1): 19-28.

Mamoon-ur-Rashid, M., M.K. Khattak, K. Abdullah and S. Hussain (2011). Toxic and residual activities of selected insecticides and neem oil against cotton mealybug, *Phenacoccus solenopsis* Tinsley (Sternorrhyncha: Pseudococcidae) under laboratory and field conditions. Pak. Entomol., 33(2): 151-155.

Monga, D., K.C. Kumhar and R. Kumar (2009). Integrated management of mealybug, *Phenacoccus solenopsis* Tinsley on cotton. Proc. Int. Conf. Emerging Trends in Prod., Proc. and Utilization of Natural Fibres, April 16-19, Mumbai, India, 132-137.
Nabil, H.A. (2017). Ecological studies on cotton mealybug, *Phenacoccus solenopsis* Tinsley (Hemiptera: Sternorrhyncha: Coccoidea: Pseudococcidae) on eggplant at Sharkia Governorate, Egypt. Egypt. Acad. J. Biol. Sci. Entomol., 10 (7): 195–206.

Nabil, H.A., A.S. Hassan and S.A.A. Ismail (2015). Registration of the cotton mealybug, *Phenacoccus solenopsis* Tinsley (Hemiptera: Sternorrhyncha: Coccoidea: Pseudococcidae) for the first time on four economical crops in Egypt. Zagazig J. Agric. Res., 42 (6): 1555-1560.

Nabil, H.A. and M.A.M. Hegab (2019). Impact of some weather factors on the population density of *Phenacoccus solenopsis* Tinsley and its natural enemies. Egypt. Acad. J. Biol. Sci., 12 (2): 99-108.

Prasad, Y., M. Prabhakar, G. Sreedevi, R. Ramachandra and B. Venkateswarlu (2012). Effect of temperature on development, survival and reproduction of the mealybug, *Phenacoccus solenopsis* Tinsley (Hemiptera: Coccoidea: Pseudococcidae) on cotton. Crop Prot., 39: 81–88. DOI: https://doi.org/10.1016/j.cropro.2012.03.027

Ram, P., R.K. Saini and Vijaya (2009). Preliminary studies on field parasitization and biology of *Phenacoccus solenopsis* mealybug parasitoid, *Aenasius bambawalei* Hayat (Encyrtidae: Hymenoptera). J. Cotton Res. Dev., 23 (2): 313-315.

Rezk, M., A.T. Hassan, M.F. El-Deeb, N. Shaarawy and Y. Dewer (2019). The impact of insecticides on the cotton mealybug, *Phenacoccus solenopsis* (Tinsley): Efficacy on potato, a new record of host plant in Egypt. J. Plant Prot. Res., 59 (1): ISSN 1427-4345. DOI: 10.24425/jprr.2019.126042.

Shah, T.N., A.M. Ahmed and N. Memon (2015). Population dynamics of cotton mealybug, *Phenacoccus solenopsis* Tinsley in three talukas of district Sanghar (Sindh). J. Entomol. and Zool. Studies, 3 (5): 162-167.

Saini, R.K., S.S.P. Sharma and H.R. Rohilla (2009). Mealybug *Phenacoccus solenopsis* Tinsley and its survival in cotton ecosystem in Haryana. In: Proceedings of National Symposium on Bt cotton: opportunities and prospectus, Central Inst. Cotton Results, Nagpur, Indie, 17–19 November 2009.

Tanwar, R.K., V.K. Bhamare, V.V. Ramamurthy, M. Hayat, P. Jeyakumar and O.M. Bambawale (2008). Record of new parasitoids on mealybug, *Phenacoccus solenopsis*. Indian J. Entomol., 70 (4): 404-405.

Tehniyat, N.S., A.M. Ahmed and N. Memon (2015). Population dynamics of cotton mealybug, *Phenacoccus solenopsis* Tinsley in three talukas of district Sanghar (Sindh). J. Entomol. and Zool. Studies, 3(5): 162-167.

Vennila, S., Y.G. Prasad, M. Prabhakar, R.K.V. Nagare, M. Amutha, A.M. Dharajyothi, G. Sreedevi, B. Venkateswarlu, K.R. Kranthi and O.M. Bambawale (2011). Spatiotemporal distribution of host plants of cotton mealybug, *Phenacoccus solenopsis* Tinsley in India. NCIPM, Tech. Bull., 26: 1-50.

Wang, Y.P., G.W. Watson and R.Z. Zhang (2010). The potential distribution of an invasive mealybug *Phenacoccus solenopsis* and its threat to cotton in Asia. Agric. and Forest Entomol., 12: 403-416.

Zhu, Y.Y., H. Fang and Yao-Bin (2011). Bionomics of mealybug *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae) on cotton. Acta Entomologica Sinica, 54 (2): 246-252.
رصد وإدارة حشرة بق القطن الدقيقية Phenacoccus solenopsis Tinsley المرتبطة بها على نباتات الفاصوليا الخضراء

أكيرا محمد صبى يوسف حسن البحراوي، ـ شبان عدنبي ـ كامل نجيب حماد، ـ أحمد السيد أحمد محمد المبكي

1- معهد بحوث وقاية النباتات - مركز البحوث الزراعية - الجبزة - مصر
2- قسم وقاية النباتات - كلية الزراعة - جامعة الزقاق - مصر

Phenacoccus solenopsis Tinsley Hemiptera: Sternorrhyncha: Coccoidea: Pseudococcidae

أجريت دراسات حقلية على حشرة بق القطن الدقيقية (Sternorrhyncha: Coccoidea: Pseudococcidae) بمحافظة الجيزة خلال موسمين متتاليين خلال العروتين الصيفي والخليبي موسمي 2012 و2017، تم دراسة تأثيرات P. solenopsis وأعدادها الطبيعية المرتبطة بها، أسجلت النتائج المحصول عليها أن P. solenopsis في الموسم الصيفي، سجل لها فئة موسمية واحدة في 3 يوليو خلال الموسم الأول والثاني (2012 و2017)، على التوالي، بينما في المواسم النيتية، سجلت الحشرة فئة موسمية واحدة في 3 و17 ديسمبر، خلال الموسمين الأول والثاني (2012 و2017)، على التوالي. أظهرت عوامل المناخ المتماثلة في درجة حرارة الهواء القصوى والدنيا ونسبة الرطوبة النسبية علاقة معنوية موجبة مع حشرة بق القطن الدقيقية. خلال هذه الدراسة تم تسجيل ثلاثة طفيليات وأربعة أنواع مفترسة، الطفيليات التي سجلت منها المفترسات التي، Acrophagus gutierreziae Timberlake (Encyrtidae), p pseudococcii (Girault), Scymnus syriacus Mars., Cocinella undecimpunctata (L.) (Coleoptera:Coccinellidae), سجلت Chrysoperla carnea (Stephens) (Neuroptera: Chrysopidae) و Orius laevigatus (Fiber.) في محاولة للسيطرة على هذه الأفلاة الحشرية. تم تقسيم ثمانية مبيدات حشرية (Hemiptera: Anthocoridae), و thiamethoxam، buprofezin، deltamethrin، malathion، chlorpyrifos، lufenuron، mineral oil وأعدادها الطبيعية تحت التطور البيولوجي P. solenopsis imidacloprid، بوضوح النتائج التي تم الحصول عليها أن إيميداكلوريد كان أعلى فعالية ضد P. solenopsis سجل أعلى تأثير ضد الفئات والملامات المرتبطة ببشرة بق القطن الدقيقية، أسجلت النتائج أيضاً أن مبيد منظمات النمو الحشرية (lufenuron و buprofezin) أكثر أماناً للأعداء الطبيعية من المبيدات المختبرة الأخرى.

المحكمون:
1- أ.د. عبد البديع عبد الحليم غانم
2- أ.د. عبد العزيز محمود محمد محسن

أستاذ الحشرات الاقتصادية – كلية الزراعة – جامعة المنصورة
أستاذ الحشرات الاقتصادية – كلية الزراعة – جامعة الزقاق