

A new strategy for controlling three devastating pests attacking date palm plantations in El Bahariya and Siwa Oases, Egypt,

Salwa, A.M. Abdel-Samad.¹, Alam, H.² and Abbas, M.K.¹

¹Plant Protection Research Institute, Agricultural Research Center, Giza, Egypt.

²The Organic Agriculture Dep., Agricultural Research Center, Giza, Egypt.

Abstract

Egypt is considered the world leader in date production; yet, *Batrachedra amydraula*, *Arenipses sabella* and *Virachola livia* are threatening this distinguished position. The current study aimed to set a new strategy depending on controlling of those pests using a group of parasitoids and predators. Once the pests appeared in El Bahariya and Siwa Oases' palm plantations, *Trichogramma* sp., *Bracon* sp., *Goniozus* sp., *Chrysoperla* sp., *Coccinella* sp. and *Orius* sp. were released. Results related to infestation%, before and after release, pests' emergence and intensification were compared in both Oases. By the end of the season, *A. sabella* and *V. livia* infestation percentage in El Bahariya control farm increased till 82.5 and 70.6%, respectively, while *B. amydraula* showed less infestation, *i.e.* 39%. Infestation declined significantly when natural enemies were released and by the end of the season it reached 2.5, 1.1 and 1.1%, for *A. sabella*, *B. amydraula* and *V. livia*, respectively. In Siwa, infestation in control recorded 40.2, 52.4 and 58.7 %, while in treatments, it dropped to 1.1, 2 and 2.2%, by the end of the season, for the three pests, respectively. *A. sabella* infestation was higher in El Bahariya than Siwa, on the contrary with *B. amydraula*; while *V. livia* was higher in Siwa than El Bahariya till Aug., and the opposite case occurred in Sep. Results proved that using this combination of natural enemies proved effective control method against the three pests under investigation and it is recommended to use this strategy to be integrated in IPM programs in palm plantations in Egypt.

Keywords: Biological control, *Batrachedra amydraula*, *Arenipses sabella* and *Virachola livia*.

Corresponding author: Mohamed.kmam55@yahoo.com

Introduction

Fossil records show that the date palm, *Phoenix dactylifera* L. (Arecales: Arecaceae), has existed for at least 50 million years (Hai, 2016). Old Egyptians learned to pollinate the trees by hand 2500 AC as proved by ancient texts, and they used date as food (Paul and Ian, 2000). Nowadays, Egypt is considered the world leader in date production and cultivation. Each year, it produces, approximately, 1.3 million t. of dates. This represents about 16.6% of global date production and 24.2% of the Arabian output, according to a recent report by the Ministry of Agriculture (Egypt Independent, 2015). Palm trees occupy 86,000 acres of Egypt's lands, with their numbers estimated at 15,582 million trees, as the report mentioned. The date palm tree has great socioeconomic importance and nutritional value in Egypt. Its traditional use as a primary source of food and by-products, and its ecological benefits in oases' agriculture, make it an important fruit tree and the best crop to be cultivated (Bekheet and El-Sharabasy, 2015). Consequently, palm trees plantations are spread all over Egypt, wherever water is available, *i.e.* Nile Delta, the New Valley and in various oases, *i.e.* Siwa, El Bahariya, Farafra, Dakhla, Kharga and Fayoum, as they added.

Palm production faces serious challenges ranging from diseases to damage by insect pests, all of which may reduce productivity by as much as 30 % (Gitau *et al.*, 2009). Climate change and irregular use of chemical pesticides are affecting pests and their natural enemies in the date palm agricultural ecosystems (Al Dosari and Ali, 2007). Although date palm tree is subject to damage by numerous arthropod pests, still, specific insect problems vary according to the geographic area. Pesticides, biological control, pheromone trapping, quarantine, and sanitation practices are used to control insect pests of date palms (Howard *et al.*, 2001). A review set by El Shafie *et al.*, (2017), listed 132 species of mite and insect pests associated with date palm. Although their number seems to be large, only a few species exhibit a high degree of specificity to date palm, among which are the greater and the lesser date moths. They added that the date dust mite and the lesser date moth, *Batrachedra amydraula* Meyrick (Lepidoptera: Cosmopteridae) are by far the most important pests damaging date palm developing fruits. *B. amydraula* eats unripe fruit, feeds on the embryos and cuts the connection between fruits and their stalks, so causing drying and loss of date fruits. Damage caused by this pest has recently increased in date palm plantations. In addition, a report by ICARDA, (2014) stated that pests, particularly the lesser date moth, drastically reduce date palm productivity, quality, and seriously limit farmers' incomes, where it may cause 50-75% losses due to fruit drop.

On the other hand, El Sherif *et al.* (1996) stated that the greater date moth *Arenipses sabella* Hampson (Pyrilidae: Lepidoptera), is one of the pests frequently attack date palm trees in Al-Arish region, Egypt. He added that larvae of *A. sabella* attack spathes and fruits and their damage resemble that caused by *B. amydraula*. In addition, Gameel *et al.*, (2017) proved that *A. sabella* has a great effect on palm trees of different varieties in the New Valley Governorate, and recommended further studies to develop integrated pest management to combat this pest. Another important palm tree pest was noticed by Temerak and Sayed (2001) who stated that pomegranate butterfly, *Virachola livia* Klug, (Lepidoptera: Lycaenidae) is a serious pest that occurs on date palm. Moreover, Gameel *et al.*, (2014) stated that the larvae of *V. livia* infest date fruits when they start coloring.

Date palm pests are initially an ecological problem rather than a chemical problem, so unprincipled use of costly chemical pesticides is a failed strategy (Al Dosari and Ali, 2007) Using predators and parasitoids to control pests is a strategy well-established although it is still limited (Alrubea, 2017). El Shafie *et al.*, (2017) listed 90 predators and parasitoids species, indicating their potential role in date palm pest management. The predators account for more than 20 different species, mainly in the family Coccinellidae, while most of the parasitoids belong to the family Braconidae and Trichogrammatidae. Consequently, the current study was carried out to set a new strategy to control *B. amydraula*, *A. sabella* and *V. livia* in El Bahariya Oasis (370 Km from Cairo) and Siwa Oasis (900 Km from Cairo), both Oases are located in the Western Desert of Egypt. The study aimed also to monitor pests' emergence, augmentation and infestation rates during the whole season, under the conditions of both Oases, to high light the efficiency of the used natural enemies and to compare between the responses of the three pests to those enemies in terms of their infestation percentages in both Oases.

Materials and Methods

Location

The current study was conducted in Egypt, in two Oases *i.e.* Siwa, (Matroh Governorate) and El Bahariya, (Giza Governorate). Three 10-15 years old farms were

selected in each location. Each farm had an area of 5 feddans, with a total area of 30 feddans, in the two locations under study, (1 feddan = 0.42 ha). The estimated palm tree numbers in each feddan ranged from 70-80, and the whole study area in the two locations consisted of mature fruit-bearing trees of the variety Sewi.

Control experiment

A fourth farm separated from the experimental area, with the same size and properties of the treated farms, was used in each Oasis as a control treatment to detect the augmentation and infestation rates of *B. amydraula*, *A. sabella* and *V. livia*. Pests' infestation was monitored, in the absence of their natural enemies, starting from Apr. till Sep., 2017.

Target pests

In April, 2017, investigation of the date palm plantation areas started in order to detect infestation symptoms appearance. The investigation included both; date bunches and date fruits. By April 15th the lesser date moth *B. amydraula* and the greater date moth *A. sabella*, started to emerge. On that date, the release of natural enemies was conducted. Numbers of infested bunches and fruits, for each pest, were recorded before the release. Later, during the month of July, the pomegranate moth, *V. livia*, showed up in the experimental areas and its infestation results were compared to control experiment.

A. sabella

A total number of 30 randomly distributed palm trees were selected in both locations, El Baharyia and Siwa Oases, (5 replicates x 3 farms x 2 locations). A total number of 450 bunches (15/ tree, 225/ location) were visually examined to detect the presence of *A. sabella*. Number of infested bunches was registered on April (before release), May and June.



Fig. (1): *A. sabella* infestation symptoms on a palm tree bunch.

B. amydraula and *V. livia*:

Each farm had a number of five replicates; each replicate was represented by one palm tree. Date fruit samples were investigated on palm trees bunches to detect the infestation by both pests, in Siwa and El Baharyia Oases. Monthly investigation of dates was conducted and a total number of 3000 date fruits each month were examined for the presence of each of *B. amydraula* and *V. livia* (100 date fruits/ replicate/ farm = 1500/ location/ pest = 6000 date fruits for both pests monthly). Insect penetration holes and silky remains close to fruit cap were considered as identifying characteristics or signs of infestation (Ali and Al-Anbaky, 2016), or sometimes date fruits were opened for pest detection. *B. amydraula* data collection started Form April. till July, 2017 while *V. livia* data collection extended from July to Sep. of the same year.

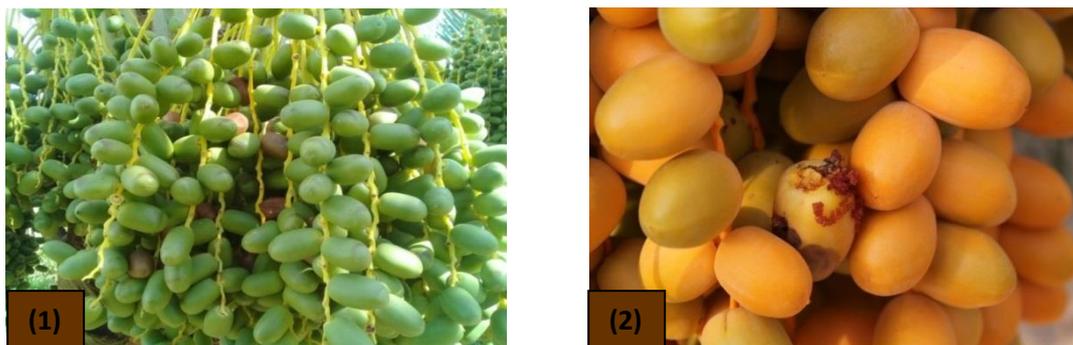


Fig. (2): *B. amydracula*(1) and *V. livia* (2) infestation symptoms on date fruits.

Natural enemies:

Several common produced parasitoids and predators were tested for their efficiency in controlling the three previously mentioned pests. Table (1), shows the natural enemies used in the present study, their parasitism/ predation stage, the number used per feddan and their sources.

Table (1) Name, pest infected stage, usage per feddan and sources of the natural enemies used in the study.

Natural Enemy	Name	Pest infected stage	Usage/ feddan	Source
Parasitoids	1- <i>Trichogramma</i> sp.	Egg	10.000 eggs	Plant Protection Research Institute-ARC
	2- <i>Bracon</i> Sp.	Larva	500 adults	
	3- <i>Goniozus</i> sp.			
Predators	1- <i>Chrysoperlas</i> p.	Eggs and newly hatched larvae		500 adults
	2- <i>Coccinellasp.</i>			
	3- <i>Oriussp.</i>			

Releasing the natural enemies started in April, 15th, just after the appearance of pests of interest; (*A. sabella* and *B. amydruala*). Results were recorded monthly after the release. Tricho cards and capsules containing the parasitoids/ predators are inserted within the fruit bunches.

Data analysis

Results were statistically analyzed using SPSS Statistical Package according to the analysis of variance (ANOVA). LSD was chosen to determine any significant difference among various treatments at $p < 0.05$, in addition to the calculation of infestation percentages.

Results

El Bahriya Oasis - Control results

Monitoring the appearance of *A. Sabella*, *B. amydracula* and *V. livia* in El Bahariya Oasis control farm and the increase in their infestation rates, and consequently their population, from May to Sep.(2017), was carried out. As illustrated in Fig. (3), infestation percentage of *A. sabella*, in May was 41.2 %, and it continued to increase during the next two months where it recorded 63.6% in June, and 82.5% in July. *B. amydracula*, on the other hand, appeared in May, as well, but with less infestation rates than that of *A. sabella*, i.e. 12%; however, its infestation continued to increase where it recorded 22, 31 and 39% during June, July and Aug., respectively. *V. livia* did emerge till the beginning of July, where it started to infest date fruits, till the end of Sep. Infestation percentages increased from 12.3% up to 36% till it reached 70.6%, as shown in Fig. (3).

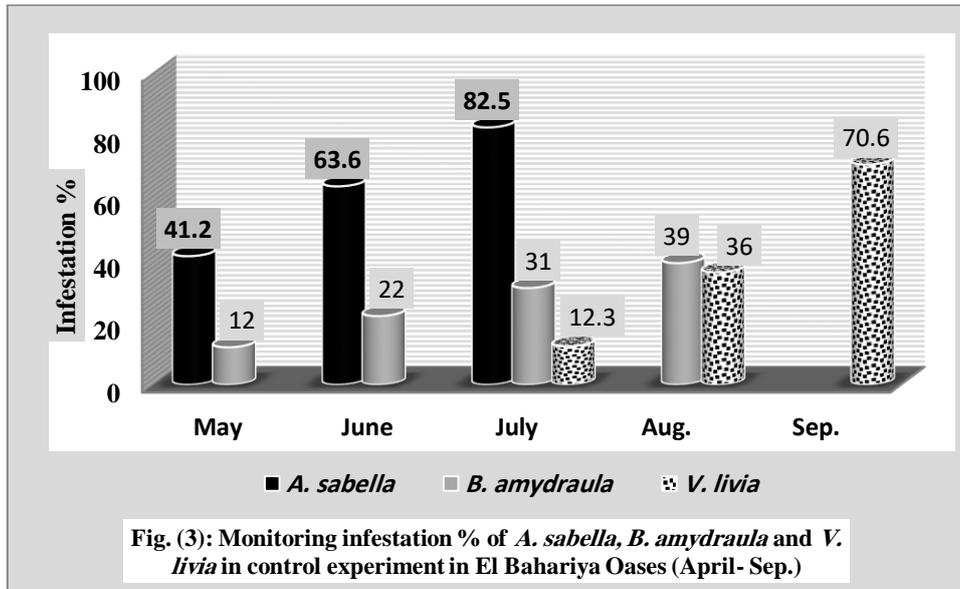


Fig. (3): Monitoring infestation % of *A. sabella*, *B. amydraula* and *V. livia* in control experiment in El Bahariya Oases (April- Sep.)

A. sabella

Total number of 225 bunches were monthly examined by visual, in the three farms to detect the infestation percentage of *A. sabella*, before and after releasing the natural enemies. Number of infested bunches was recorded in April, May and June, as by the end of June the pest was completely controlled. Average infestation percentage before release (B.R.) of natural enemies, in the three treated farms, recorded 28%, as illustrated in Fig. (4) Results showed that releasing the natural enemies caused a great decline in *A. sabella* level of infestation. In May, average infestation percentage dropped to 5%, then to 2.5%, in July.

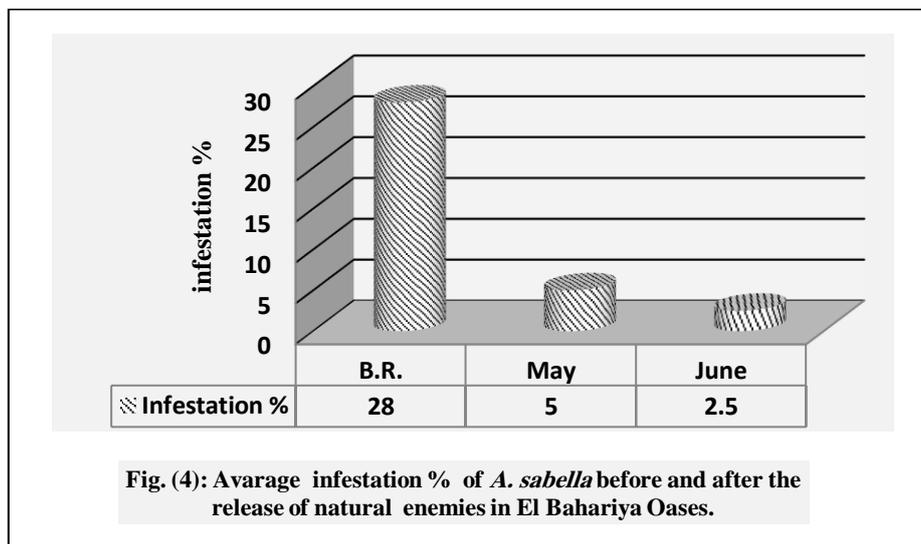


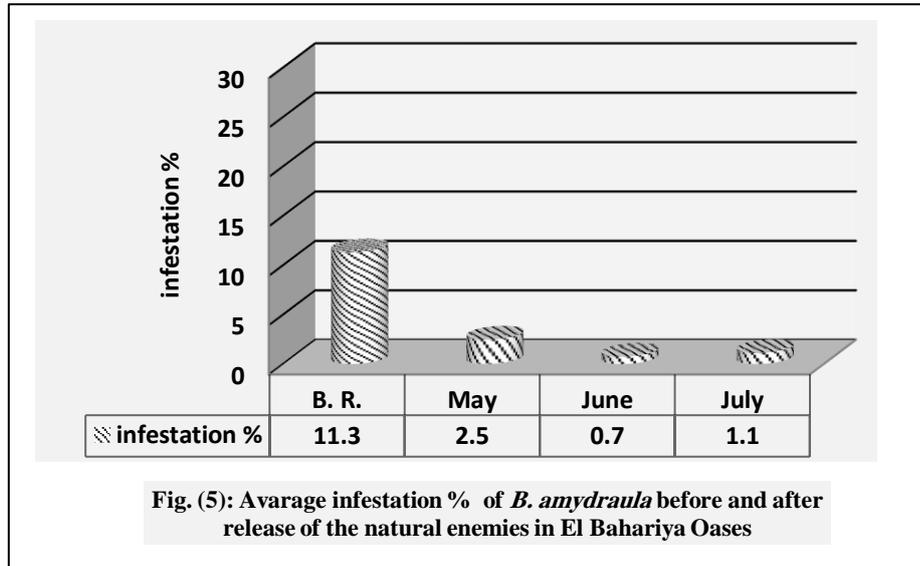
Fig. (4): Average infestation % of *A. sabella* before and after the release of natural enemies in El Bahariya Oases.

B.R. = before release

B. amydraula

Before the release of natural enemies, average infestation percentage of the three farms recorded 11.3%, however, infestation dropped to 2.5% during May; as natural enemies were

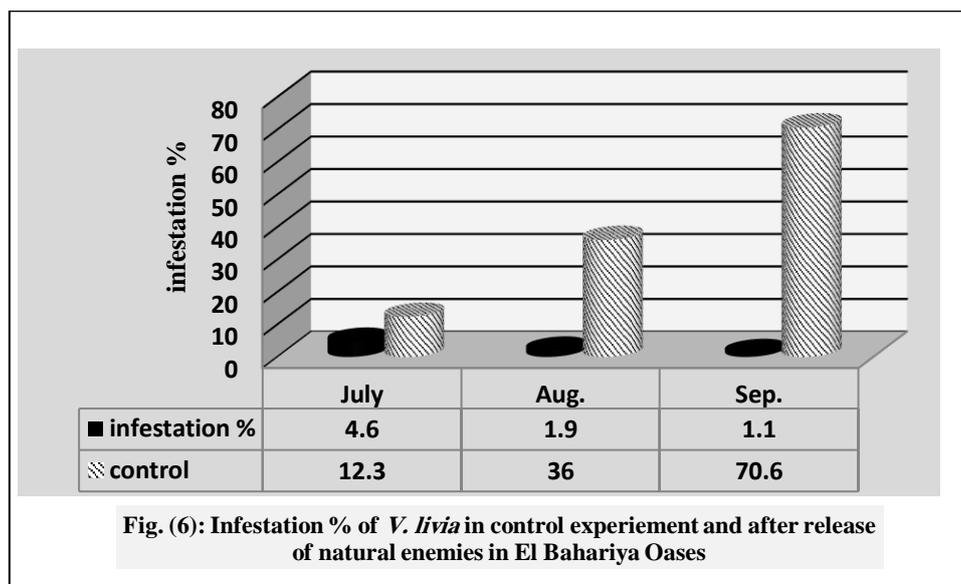
settled since mid-April. Suppression of the lesser date moth infestation continued to increase and then continued to decrease till it reached 1.1%, by July.



B.R. = before release

V. livia

A number of 100 dates per replicate, (5 palm trees replicates were used/ farm), and monthly investigated to detect the infestation of *V. livia* in El Bahariya Oasis experimental farms. Results showed that the pomegranate butterfly started to appear in July, and infestation % in the control farm concerning this pest was 12.3, 36, and 70.6, during the months of July, Aug. and Sep. respectively. Meanwhile, treated farms, where natural enemies are settled, *V. livia* recorded infestation percentages of 4.6, 1.9 and 1.1, respectively, as illustrated in Fig. (6).



Control versus treatment

Considering the following figure, it is obvious that using this special group of natural enemies was highly competence in decreasing the infestation percentages of the three pests under investigation, *i.e.* *A. sabella*, *B. amydruala* and *V. livia*, from 82.5, 39 and 70.6 to 2.5, 1.1 and 1.1, respectively, by the end of their activity season (Fig. 7).

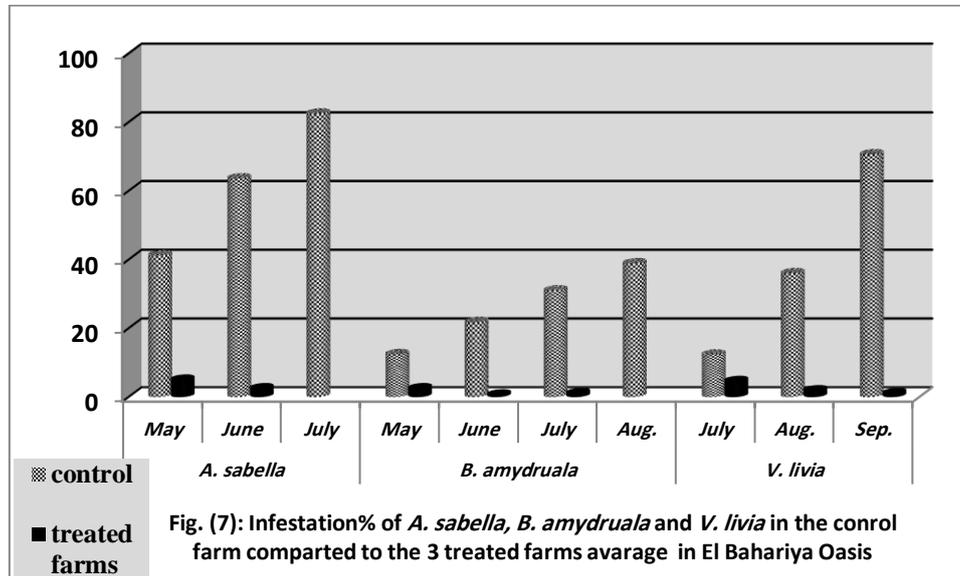
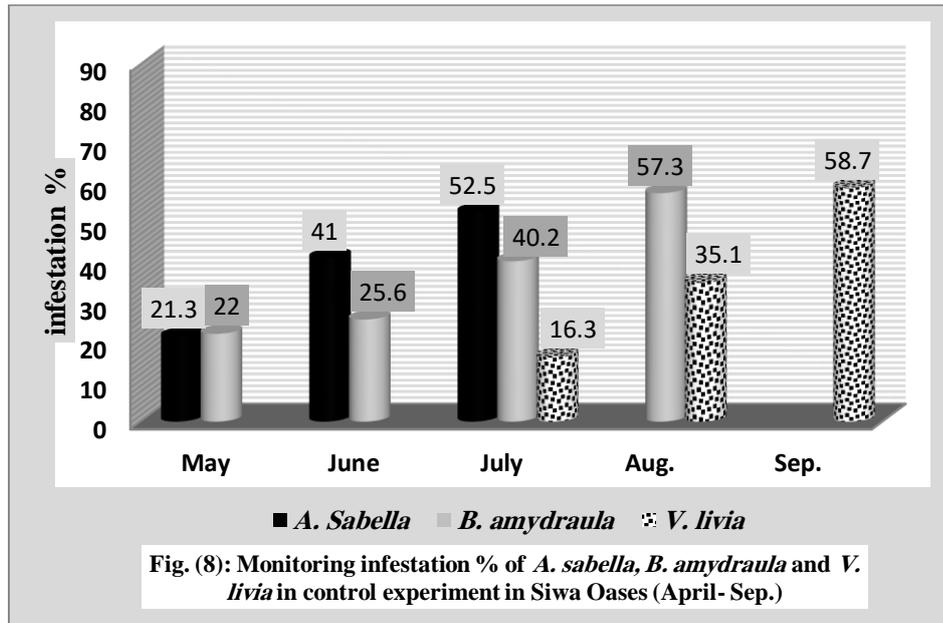


Fig. (7): Infestation% of *A. sabella*, *B. amydruala* and *V. livia* in the control farm compared to the 3 treated farms average in El Bahariya Oasis

Siwa Oasis

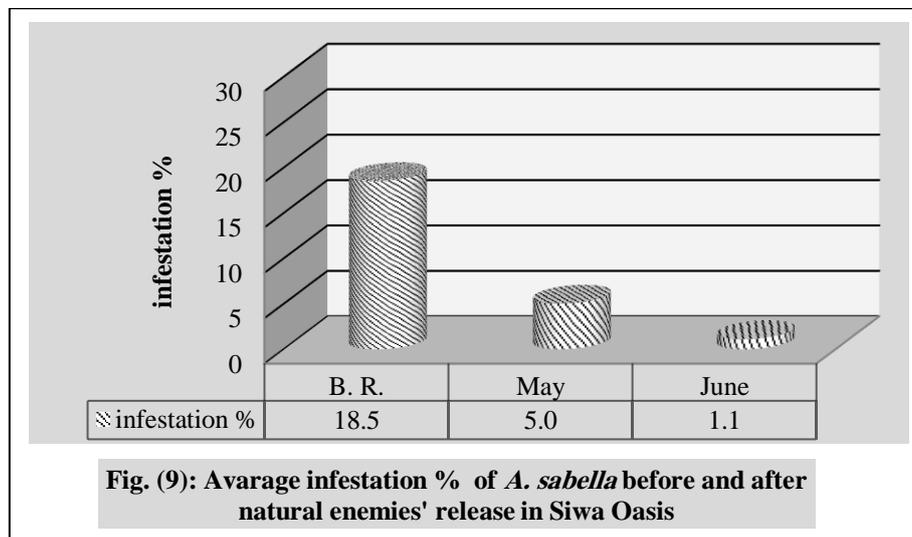
Control results

The control farm in Siwa Oasis showed similar results as compared to El Bahariya Oasis concerning pests' emergence date and infestation increase. As shown in Fig. (8), infestation percentages of *A. sabella* increased from 21.3% up to 41% till it reached 52.4%, during the months of May, June and July, respectively. Meanwhile, *B. amydruala* gave an infestation % of 22% during May, then, increased to 25.6, 40.2 and 57.3%, during June, July and Aug., respectively. On the other hand, *V. livia* started to attack date fruits on the month of July till the end of Sep. (as was in El Bahariya Oasis) and their infestation increased from 16.3 up to 58.7 %, as illustrated in Fig. (8).



A. sabella

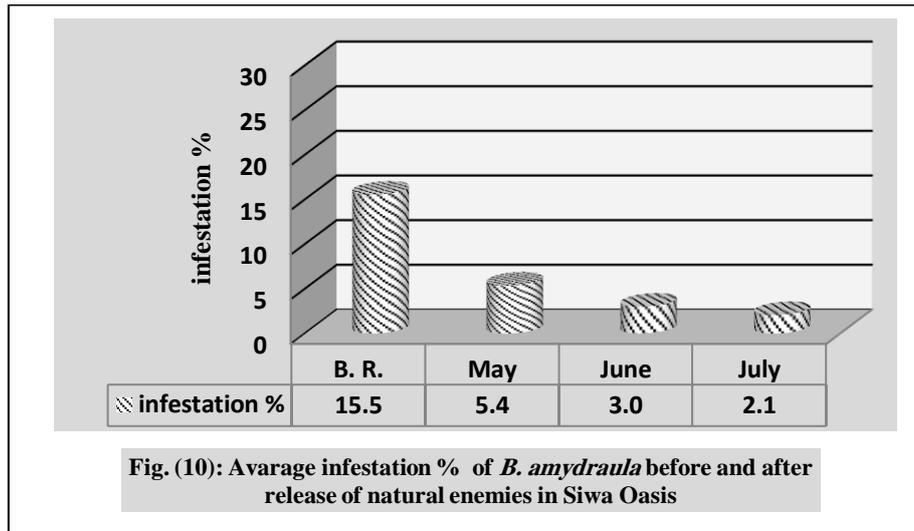
The group of natural enemies released was highly capable of controlling *A. sabella* under Siwa Oasis conditions as in the case in El Bahariya Oasis. Before release, average infestation percentage in the three farms recorded 18.5%, whereas, it decreased to 5 and 1.1%, after using the parasitoids and predators, during May and June, respectively, as shown in Fig. (9).



B.R. = before release

B. amydracula

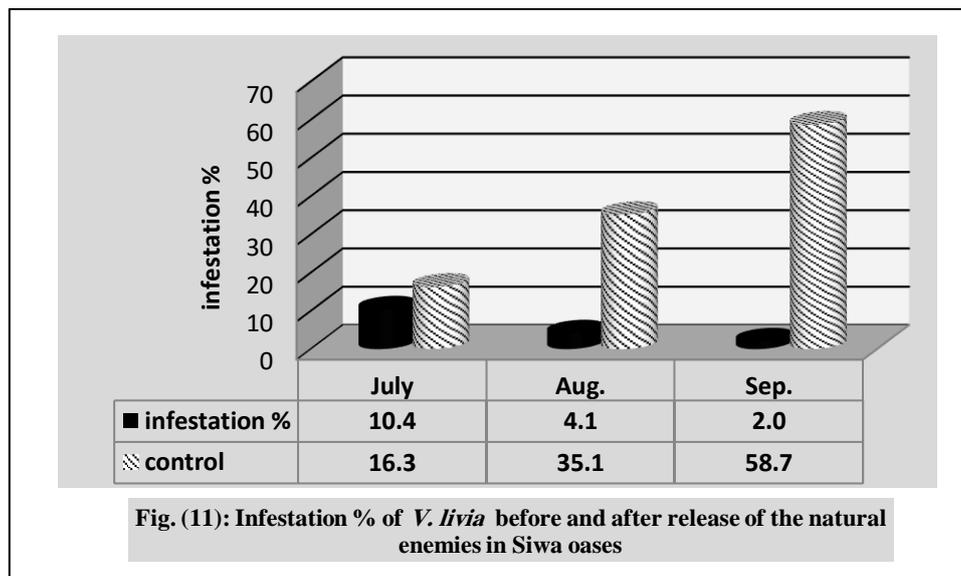
Date samples (500 dates/ 5replicate/ farm) were monthly insoected on palm trees during the months of May, June and July to follow the infestation rates of *B. amydracula* in Siwa Oasis. Results showed that *B. amydracula* recorded an average infestation of 15.5% before the release of natural enemies. During May, average infestation percentage in the treated farms decreased to 5.4%. Fortunately, reduction in infestation continued to occur where it recorded 3, and 2.1 during both June and July, respectively (Fig. 10).



B.R. = before release

V. livia

Comparing the results of control farm, concerning *V. livia*, to the three treated farms, data assured again that the used natural enemies were powerful enough to reduce infestation percentages of this pest till it reached 2 % during Sep., compared to 58.7% in the control farm, as illustrated in Fig. (11).



Control versus treatment

Comparing the results of the control farm during the whole seasons to those of treated farms, results illustrated in Fig. (12) showed that natural enemies under investigation were vigorous enough to suppress pests attack. Infestation% of *A. sabella*, *B. amydruala* and *V. livia* decreased by the end of the seasons to reach 1.1, 2.0 and 2.2%, respectively, whereas, infestation in the control recorded 52.5, 57.3 and 58.7, respectively.

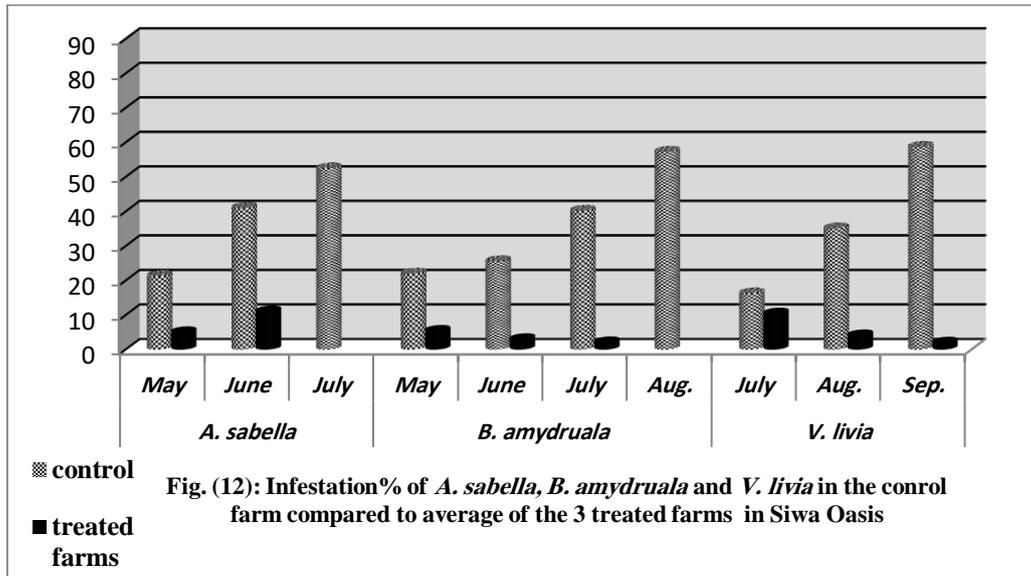


Fig. (12): Infestation% of *A. sabella*, *B. amydruala* and *V. livia* in the control farm compared to average of the 3 treated farms in Siwa Oasis

El Bahariya versus Siwa Oases

Results, concerning the three pests under investigation, were statistically analyzed using ANOVA two ways and the LSD at $p < 0.05$ was, as well, calculated. Data are presented in Table (2) and the analysis showed the following:

1. *A. sabella*

During May, infestation mean numbers did not show any significant difference between El Bahariya and Siwa in the treated farms (4.9 and 5, respectively) meanwhile, control results revealed significant differences in both locations, as presented in Table (2).

During June, infestation mean numbers reflected significant differences, either in the treated farms or in control farm. Generally, infestation with *A. sabella* was higher in El Bahariya than in Siwa.

2. *B. amydruala*:

Infestation mean numbers of *B. amydruala* during the three months of the experiment significantly differed either in control or treated farms in El Bahariya and Siwa Oases. However, Siwa farms recorded higher infestation than El Baharia, as by July, a mean number of 16 was recorded in El Bahariya while Siwa farms recoded 21.1 (LSD was 0.3.), as mentioned in Table (2).

3. *V. livia*

Significant differences were detected between infestation's mean numbers of *V. livia* during the whole season in both locations, either in control or treated farms, where it was higher in Siwa than in El Bahariya during July and Aug., while the opposite occurred during Sep., as presented in Table (2).

Table (2) *A. sabella*, *B. amydruala* and *V. livia* infestation mean numbers in both El Baharia and Siwa Oases in control and treated farms.

Farms	<i>A. sabella</i>				<i>B. amydruala</i>						<i>V. livia</i>					
	May		June		May		June		July		July		August		September	
	B.O.	S.O.	B.O.	S.O.	B.O.	S.O.	B.O.	S.O.	B.O.	S.O.	B.O.	S.O.	B.O.	S.O.	B.O.	S.O.
Treat.	4.9	5	2.5	1.1	2.46	5.3	0.73	3	1.1	2.06	4.6	10.3	1.86	4.1	1.1	1.96
Cont.	41.2	21.3	63.6	41	12.4	22	21.8	25.6	31	40.2	12.3	16.3	36	35.1	71	58.7
Average/ location	23	13	33	21	7.43	13.6	11.3	14.3	16	21.1	8.5	13.3	18.9	19.6	35.8	30.3
LSD	1.01		0.8		0.44		0.27		0.3		0.45		0.23		0.45	

B.O. =El Bahariya Oasis- S.O. =Siwa Oasis

Discussion

Siwa Oasis is one of the world's last remaining pristine Oases, home to spectacular natural landscapes, ancient historical ruins and unique cultural traditions. There are approximately 240,000 palm trees in Siwa, with at least five different varieties (Egypt Independent, 2015). Siwa Oasis became a protectorate in (2002) as per Prime Ministerial decree number 1219 (Baraka, 2010). On the other hand, population of date palm trees in El Bahariya Oasis reaches 1.3-1.5 million palm trees (Abd-Allah, 2016). Fortunately, in 2010, the Egyptian Ministry of Environment has declared El Bahariya Oasis as a protectorate, as per the Prime Ministerial decree number 2656 (Elaref, *et al.*, 2017). Moreover, the status of being protected areas prohibits all activities that damage or deplete the natural environment. Due to those two reasons, *i.e.* their great importance in palm production in Egypt and being protectorates, they were chosen as research sites for this investigation.

Chemical insecticides had been, and still are, used as the main control measure against palm tree pests everywhere in the world, without real consideration to their adverse effects on environment and human health (Baan good, 2008 and El-Juhany, 2010). Using predators and parasitoids in pest control is a well-established strategy, although it is still limited, as mentioned by Alrubea, (2017). Therefore, the present study was implemented as an important attempt to set a new strategy through releasing a special group of parasitoids along with predators, together, to control the lesser date moth, the greater date moth and the pomegranate butterfly.

Trichogramma sp., *Bracon* sp., *Goniozus* sp, *Chrysoperlasp*, *Coccinella* sp and *Orius* sp. are six parasitoids and predators that attack different stages throughout the pest's life cycle; this is considered a distinguished point in this study, *i.e.* trapping eggs and larvae of the pest by the natural enemies and forbid the continuity of their life cycles. The selection of those natural enemies in particular, was attributed to their adaptation to the local environment as some of them were registered associated with Lepidopteran date palm fruit pests in date orchards in Siwa Oasis by Hussain *et al.*, (2016), *i.e.* *Chrysoperlacarnea*, *Orius* spp. and *Braconhebetor* Being local natural enemies raises their efficiency as mentioned by Ali and Mohammed,

(2013). They explained that when egg and larval parasitoids are native, they prove more adaptation as successful bio-control agents.

The high infestation percentage of *A. sabella* in El Bahariya control farm by the end of the season, *i.e.* 82%, lies in the range found by Abdel Rahman *et al.*, (2007), who stated that percent of impressively infested trees with *A. sabella*, in the El Bahariya, ranged between 41% and 100% with a general mean 60%. They added that field observations indicated that this insect became a serious pest in that region causing enormous damages. On the other hand, Siwa Oasis control farm was less infested by *A. sabella*, during the same period but still causing damage that reached 52.5%. Imam, (2012) ensured this finding when he stated that *A. sabella* is one of the most devastating pests that threatens palm trees in Siwa. Similar results were found by Gameel and Sayed (2009) and Gameel *et al.* (2014), who emphasized that in the New Valley, Egypt, the rate of infested bunches by *A. sabella* ranged between 8 and 50%. In Jordan, Al-Antary *et al.* (2015) mentioned that *A. sabella* is considered one of the key pests due to the high infestation rates, that might exceed 55% of bunches during season, they emphasized that biological control studies should be encouraged. In addition, Gameel *et al.*, (2017) noticed that under El-Kharga Oasis conditions, the main date palm cultivar (Saidi) suffered from *A. sabella* attacks. Our results, as well, ensure the importance of this pest and that it should be highly considered.

Furthermore, the current study showed that the infestation percentages of both the greater and the lesser date moths, in the absence of the natural enemies, differed or we might say, converted, according to location. *B. amydruala* achieved higher infestation percentages in the control farm of Siwa than that of El Bahariya Oasis. On the contrary, *A. sabella* showed higher infestation in El Bahariya than Siwa Oases. The difference in infestation rate between the two pests was also noticed by Gameel *et al.*, (2014) who reported that infestation with the lesser date moth was light if compared with the greater date moth in the New Valley region. This conversion could be attributed to the different environmental conditions between Giza and Matroh Governorate and suitability of temperature and humidity in each location for both pests.

In treated farms, natural enemies were able to suppress the population of the greater date moth where infestation decreased in both El Bahariya and Siwa Oases till it reached 2.5 and 11% after 2 months post-release. Results of El-Dakroury *et al.*, (2002) are consonance with our findings; they reported that using *T. evanescens* in Siwa Oasis caused infestation reduction that reached 97.8% for six lepidopterous pests of date fruits, of which are the greater date moth, which mean that 2.2% infestation occurred. The difference in infestation% between the two locations might also due to environmental conditions as explained before. Weather conditions not only affect the infestation rates of the pests, but also, the activity of the natural enemies. Several authors stated that environmental conditions have great influence on the natural enemies' performance, mainly temperature. Mohammad *et al.* (2015) stated that the influence of temperature on the biological performance of *Trichogramma* parasitoid in laboratory and in the surrounding environment should be taken into consideration. Alrubeai, (2017) commented that in stability in climate conditions towards the extreme, especially increasing in temperature and decreasing in relative humidity, is considered a big challenge to biological control programs.

Although Argaman, (1991) reported that no parasitoids or predators being used for management of the lesser date moth comparing to other date palm pests, our results proved that natural enemies were able to decrease the infestation of *B. amydruala* to 1.1 and 2.1%, by July (after 3 months of release), in both El Baharia and Siwa Oases, respectively. It was found in the literature that most of the work done concerning the lesser date moth was mainly related to *T. evanescens*. Mohammad *et al.*, (2015) believed that *T. evanescens* an effective

natural enemy against the lesser date moth in Iraq. Moreover, Ali *et al.*, (2004) remarked that using *T. evanescens* confirmed the efficacy of such good bio-rational agent to reduce the rates of infestations of lesser date moth in date palm orchards in El-Bahriya Oasis. Gameel *et al.*, (2014) recommended the release of the egg parasitoid *T. evanescens* for one time to control *A. sabella* and *B. amydraula* in at the New Valley. They mentioned that promising data were obtained and their study ensures the importance of *Trichogramma* parasitoid as a control agent for date fruits pests.

In addition, few researchers discussed the effectiveness of the other natural enemies used in our study. In a survey carried out by Abbas *et al.*, (2014) *Goniozus* sp., *Bracon* sp. and *Chrysoperla carnea* were mentioned as natural enemies of *B. amydraula*. Abbas *et al.* (2008) mentioned that *Goniozus* sp. was found to be the most common parasitoid of the lesser date moth in Sultanate of Oman, and they added that it seems to be a promising bio-control agent and could be utilized within the IPM program. Moreover, Wakil *et al.* (2015) reported that *Bracon* sp. attacks the lesser date moth.

Concerning the third pest under investigation, *i.e.* *V. livia*, Abd-Ella, (2015) stated that the frequent use of insecticides prompted the development of resistance, although they play a critical role in the management of pomegranate butterfly. To our knowledge, this is the first time for studying *V. livia* is studied in palm plantation in the two Egyptian Oases. Results in this study showed that the maximum infestation of the pomegranate butterfly in the control farms, either in El Bahariya or Siwa Oases, occurred during Sep. In addition, natural enemies used were highly capable of decreasing the infestation of *V. livia* to 1.1 and 2%, respectively, during the same month in both Oases. It seems that research work on *V. livia* infestation in date palm plantation is limited; very few articles were found discussing this issue. Fortunately, parasitoids and predators used in the current study are registered as natural enemies of *V. livia* as stated by Satyagopal *et al.*, (2014), who mentioned that *Trichogramma* sp., *Bracon* sp., *Chrysoperla* sp. and *Coccinella* sp. attack *V. livia* in India. In (2008), Abbas imported and relisted two egg parasitoids, *Trichogramma brassicae* Bezdenko and *T. evanescens* Westw. imported and released in two pomegranate orchards to assess the total action of the indigenous and such imported parasitoids against *V. livia*. The results showed that *Telenomus* sp. had superior role compared to *Trichogramma* spp. Percentages of parasitism on the host's eggs by *Telenomus* sp. ranged from 26.7 to 76.9%, with an average of 58.2% in the first orchard and from 55 to 85% with an average of 70.4% in the second orchard. On the other hand, % parasitism with *T. brassicae* released in the first orchard ranged 0.0-52.7%, with an average of 20.9% while in case of *T. evanescens* released in the 2nd orchard it ranged 0.0-15.4% with an average of 9.9%.

Conclusion

Results of the present study proved that using a group of natural enemies that attack different stages during pest's life cycle, is a competent control strategy. Biological agents are promising alternatives that can be used in integrated pest management programs to control the lesser date moth, the greater date moth and the pomegranate butterfly in Egypt, especially in protected areas where using pesticides may cause problems. Yet, environmental conditions in the implementation site should be taken into consideration.

Acknowledgement

Special thanks are due to the Academy of Scientific Research and Technology, Egypt, for financing this research as a part of the project “strategy of the integrated management of date palm plantations”.

References

- Abbas, M.S.T., R. Al Shidi, S. Jumah, and S.A. Al-Khatry, 2008.** Utilization of *Goniozus* sp. (Hym.: Bethyridae) as a Bio-Control Agent Against the Lesser Date Moth, *Batrachedra amydaraula* (Meyrick) (Lep.: Batrachedridae) in Date Palm Orchards in Sultanate of Oman. *Egyptian J. Biological Pest Control*. 18: 47-50.
- Abbas, M.S.T., S.A. Razvi, R.H. Shidi, and S.A. Al-Khatry, 2008.** Role of Egg Parasitoids for Controlling the Pomegranate Butterfly, *Virachola livia* Klug (Lycanidae: Lepidoptera) in Sultanate of Oman. *Egyptian J. Biological Pest Control*. 18 (1): 43-46.
- Abbas, M.S.T., S.A. Al-Khatry, R.H. Shidi, N.A. Al-Ajmi, 2014.** Natural Enemies of the Lesser Date Moth, *Batrachedra amydraula* Meyrick (Lepidoptera: Batrachedridae) with Special Reference to its Parasitoid *Goniozus* sp. *Egyptian J. of Biological Pest Control*, 24 (2): 293-296.
- Abd-Allah, A.M., 2016.** Evaluation of some Varieties and Seedlings of Date palm Grown at Bahariya Oasis. M.Sc. This in Agric. Sci., Dept. Pomology, Fac. Agric., Cairo Univ., Egypt.
- Abd-Ella, A., 2015.** Efficacy of emam ectin benzoate, pyridalyl and methoxy fenozide on pomegranate butterfly, *Virachola livia* (Klug) (Lepidoptera: Lycanidae) in cultivated and reclaimed lands. *J. Phytopathology and Pest Management*, 2: 32-42.
- Abdel-Rahman, A.G., M.A. Fouda, H.I. Mahmoud, E.A. Agamy, A. Imam, and M. Amany, 2007.** Observations on the greater date moth (*Arenipsessa bella* Hmps) in El-Baharia Oasis– Egypt. The First International Conference of Date Palm “Integrated Crop Management of Date Palm and its Impacts for Producing Clean and Safety Dates Giza, Egypt.
- Ali, A.A. and Mohammed, J.K., 2013.** Potentials of Utilizing Biological Measures for the Management of Lesser Date Moth *Batrachedra amydraula* in Iraq. Proceedings of the Fifth International Date Palm Conference.
- Ali, M.A., M.M. Metwally, and A.E. Hussain, 2004.** Release of *Trichogramma evanescens* (West) in date palm fields as an eco-biological agent for suppression insect’s infestation in date palms and dates at El-Bahria Oases, Giza, Egypt, in: 1st Arab Conference of Applied Biological Pest Control, Cairo, Egypt, Apr. 5-7, pp. 16-17.
- Ali, A.A. and N.N.H. Al-Anbaky, 2016.** Integrated Pest Management for Major Date Palm Pests in Iraq. *Emirates J. Food and Agric*. 28 (1): 24-33.
- Al-Antary, T.M. M.N.M. Al-Khawaldeh, and M.A. Ateyyat, 2015.** Importance and seasonal population dynamics of great date moth *Arenipsessa bella* Hampson (1901) (Lepidoptera: Pyralidae) in Jordan Valley. *Brazilian J. of Biological. Sci.*, 2: 111-119.

- Al Dosari, S. and A.G. Ali, 2007.** Susceptibility of date palm fruit cultivars to the natural infestation by *Oligonychusafra siaticus* (Mcg.) (Acari: Tetranychidae) in relation to their chemical composition. Assiout Univ. Bull. Environ. Res., 10: 1-7.
- Alrubea, H.F., 2017.** Biological control of insect pests in Iraq: 1) an overview of parasitoids and predators research development. Academic Journal of Entomology, 10 (2): 10-18.
- Alrubeai, H.F., B.S. Hamad, A.M. Abdullatif, H.Z. Ali and A. Abed, 2014.** Efficacy of *Tricho gramma evanescens* and *Bacillus thuringiensis* kurstaki to control lesser date moth *Batrachedra amydraula* Merck. J. Agric. Sci. Technol. Bull., 4: 281-284.
- Argaman, Q., 1991.** *Parasierolasw irskiana* n. sp. (Hymenopter: Bethylidae), from the lesser date moth, *Batrachedra amydraula* Meyrick (Lepidopera:Batrachedridae). Israel J. Entomology, 25-26, 195-198
- Baangood, S.A., 2008.** Insects and mites pest on horticultural crops and their integrated control. Adan Co. Printing and Publication. pp. 200–205.
- Baraka, H., 2010.** Protectorates not protected: The Siwa Oasis. Available at: <http://www.egyption dependent.com/protectorates-not-protected-siwa-Oasis/>
- Bekheet, S.A. and S.F. El-Sharabasy, 2015.** Date palm status and perspective in Egypt. In: Al-Khayri J., Jain S., Johnson D. (eds.) Date palm genetic resources and utilization. Springer, Dordrecht.
- Elaref, M.M., M.S. Hamed, A. Salama, and M. Elaref, 2017.** Inventory and assessment of the geomorphosites of Bahariya, Farafra Territory, Western Desert, Egypt. Int. J. Sci.: Basic and Applied Research, 33: 128-143.
- El-Dakroury, M.S.I., M.A. Eweis, and H.A.A. Abul-Fadl, 2002.** Mass production and utilization of *Trichogramma evanescens* west. as a bio-control agent against date fruit pests in Siwa Oasis Egypt. 2nd International Conference, Plant Protection Research Institute, Cairo, Egypt, pp. 263-265.
- EI-Juhany, L.I., 2010.** Degradation of Date Palm Trees and Production in Arab Countries. Causes and Potential Rehabilitation. Australia J. Basic Appl. Sci., 4 (8): 3998– 4010.
- El-Shafie, H., B.M. Abdel-Banat¹, and M.R. Al-Hajhoj, 2017.** Arthropod pests of date palm and their management. CAB Reviews, 12: (49). Available at: https://www.researchgate.net/publication/324081142_Arthropod_pests_of_date_palm_and_their_management
- EI-Sherif, S.I., E.A. Elwan and M.I.E. Abd-El-Razik, 1996.** Insect pests of date palm trees in Northern Sinai, Egypt. Libya Arab J. of Plant Protection, 8: 72–76.
- Egypt Independent, 2015.** Egypt 16.6% of world date production. Available at: <http://www.freshplaza.com/article/142943/Egypt-16.6-percent-of-world-date-production>
- Gameel, S.M.M. and A.A. Sayed, 2009.** Control of the greater date moth, *Arenipses bella* Hampson (Pyralidae: Lepidoptera) at the New Valley- Egypt. Egypt. J. Agric. Res., 87: 1323-1328.
- Gameel, S.M.M., M.A. Ewais, and A.A. Sayed, 2014.** Using of *Trichogramma evanescens* West. (Hymenoptera: Trichogrammatidae) for controlling *Arenipses sabella* Hmpson

- and *Batrachedra amydraula* Meyrick in the date palm fields at the New Valley-Egypt. Egypt. Acad. J. Biolog. Sci., 6: 35-41.
- Gameel, S.M.M., A.A. Abd-Ella, E.F. Tolba, 2017.** Date Palm Host Preference of the Greater Date Moth, *Arenipsessa bella* Hampson (Lepidoptera: Pyralidae) at New Valley Governorate-Egypt. Egypt. Acad. J. Biological Sci., 10 (7): 221–230.
- Gitau, C.W., G.M. Gurr, C.F. Dewhurst, M.J. Fletcher, and A. Mitchell, 2009.** Insect pests and insect-vectored diseases of palms. Australian J. of Entomology, 48 (4): 328–342.
- Hai, H.D., 2016.** Genus *Phoenix*, *Phoenix dactylifera*: Date palm or Date. Available at: <https://www.worldwidefruits.com/phoenix-dactylifera-date-palm.html>
- Haider, M.S., I.A. Khan, M.J. Jaskani, S.A. Naqvi, and M.M. Khan, 2014.** Biochemical Attributes of Dates at Three Maturation Stages. Emirates J. Food Agric., 26 (11): 953-962.
- Hardy, I.C.W. and T.M. Blackburn, 1991.** Brood guarding in a Bethyloid Wasp. Ecological Entomology, 16: 55-62.
- Howard, F.W., D. Moore, R.M. Giblin-Davis, and R.G. Abad, 2001.** Insects on palms. CABI International, Wallingford, Oxon, UK.
- Hussain, A.E., F.M.H. Eid and E.M. El-Saadny, 2016.** Studies on some economic lepidopteran pests of date palm fruits and their associated parasitoid and predatory species in Siwa Oasis, Egypt. Egyptian J. of Bio. Pest Control, 26: 497-501.
- ICARDA, 2014.** Bio-control of date palm pests. Available at: <https://www.icarda.org>
- Imam, A. 2012.** Evaluation of some integrated managements to combat the greater date moth, *Arenipses sabella* Hmps. (Lepidoptera: Pyralidae), on date palm trees under Siwa Oasis. Conditions in Egypt. Available from:
https://www.researchgate.net/publication/283071613_Evaluation_of_Some_Integrated_Managements_to_Combat_the_Greater_Date_Moth_Arenipses_sabella_Hmps_Lepidoptera_Pyralidae_on_Date_Palm_Trees_under_Siwa_Oasis_Conditions_in_Egypt
- Ksentini, I., J.C. Monje, T. Jardak, and N. Zeghal, 2010.** The *Trichogramma* (Hymenoptera: Trichogramma tidae) in a pomegranate orchard in Tunisia. Entomological Sci. Vol. 13: pp. 99–106.
- Latifian, M., 2012.** The effects of cultural management on the lesser date moth (*Batrachedra amydraula* Myer) infestation. Emirates J. Food and Agriculture, Al-Ain, 24 (3): 224-229.
- Mohammad, J.K., R.F. ALJassany, and A.A. Abul-Sattar, 2015.** Influence of temperature on some biological characteristics of *Trichogramma evanescens* (Westwood Hymenoptera: Trichogrammatidae) on the egg of lesser date moth *Batrachedra amydraula* Meyrick. J. Biological Control, 29 (3): 125-130.



Paul, T. N. and Ian, S. 2000. Ancient Egyptian materials and technology. Available at: <https://books.google.com.eg/books?id=Vj7A9jJrZP0C&pg=PA617&lpg=PA617&dq=pollination+of+date+palm+in+ancient+egypt+by+hand&source>

Satyagopal, K., S.N. Sushil, P. Jeyakumar, G Shankar, O.P. Sharma, S.K. Sain, D.R. Boina, R. Ram Asre, S.A. Murali, S. Kumar, D.E. Suresh S. Lingaraju, V.K. Koshta, A.K. Awasthi, R.N. Ganguli, M.P. Thakur, A.S. Kotasthane, K. Rajashekarappa, P. Srivastava, K.P. Singh, S. Khalko, N. Laskar, A. Roy and T.K. Hath. 2014. AESA based IPM package for Pomegranate. 38 pp.

Temerak, S.A. and A.A. Sayed, 2001. Ovi-larvicidal Activity of *Spino sad* in Comparison to *Bacillus thuringiensis* subs *Kurstaki* for the control of *Virachola livia* (Klug.) on date palm trees in the field, New Valley, Egypt. *Assiut J. of Agric. Sci.*, 32: 1–7.

Wakil, W., R.F. Jose, and A.M. Thomas, 2015. Sustainable pest management in date palm: Current status and emerging challenges: Sustainability in plant and crop protection: Book Chapter 6 in: Carob moth, lesser date moth, and raisin moth, Thomas, M.P., El-Shafie, H.A.F. and Wakil, W. (eds), pp.109-167

إستراتيجية جديدة لمكافحة ثلاث آفات مدمرة تهاجم زراعات النخيل في الواحات البحرية وسيوة بمصر بفضيل مجموعة متميزة من الأعداء الطبيعية

سلوى عبد الحميد/ هاله محمد علم /محمد كمال عيسى

1-معهد بحوث وقاية النباتات-مركز البحوث الزراعية-الجيزة-مصر

2-المعمل المركزي للزراعة العضوية-مركز البحوث الزراعية-الجيزة-مصر

الملخص العربي

تعتبر مصر من الدول الرائدة علي مستوى العالم في إنتاج البلح، إلا ان كل من دودة البلح الصغرى والكبرى وابي دقيق الرمان يهددان تلك المكانة المتميزة. وتهدف الدراسة الحالية إلي وضع استراتيجية جديدة تعتمد علي محاصرة الأطوار المختلفة من هذه الآفات. حيث تم إطلاق مجموعة متميزة من الطفيليات والمفترسات في زراعات النخيل بالواحات البحرية وسيوة بمجرد ظهور هذه الآفات. وقد قورنت النتائج المتحصل عليها في الواحتين، وذلك فيما يتعلق بنسبة الإصابة قبل وبعد الإطلاق، وموعد ظهور الآفة ومعدل زيادة اعدادها حيث اشارت النتائج انه في نهاية الموسم ارتفعت نسبة الإصابة بدودة البلح الكبرى وابي دقيق الرمان في تجربة المقارنة بالواحات البحرية حتي وصلت إلي 82.5 و70.6%، علي التوالي، في حين سجلت دودة البلح الصغرى نسبة اصابة اقل وهي 39%. هذا وقد انخفضت نسبة الإصابة بشكل كبير عندما تم اطلاق الأعداء الحيوية، وبحلول نهاية الموسم كانت نسبة الإصابة قد وصلت إلي 2.5 و1.1 و1.1%، لكل من دودة البلح الكبرى والصغرى وابي دقيق الرمان، علي التوالي. وفي واحة سيوة سجلت نتائج الكونترول 40.2 و52.4 و58.7 لكل من الآفات الثلاث علي التوالي، بينما في المزارع التي تم اطلاق الأعداء الحيوية بها انخفضت نسبة الإصابة في نهاية الموسم حيث سجلت 1.1 و2 و2.2% للآفات الثلاث، علي التوالي. وقد لوحظ ان نسبة الإصابة بدودة البلح الكبرى كانت أعلي في الواحات البحرية عنها في سيوة، في حين أظهرت دودة البلح الصغرى عكس ذلك. اما ابي دقيق الرمان فقد ارتفعت نسبة الإصابة به في سيوة عنها في الواحات البحرية حتي شهر اغسطس، ثم حدث العكس تماما في شهر سبتمبر. وقد اثبتت النتائج ان استخدام هذه التركيبة من الأعداء الحيوية حققت فعالية كبيرة في مكافحة الآفات الثلاث محل الدراسة، ولذا فنحن نوصي بإدخال هذه الاستراتيجية ضمن برامج مكافحة المتكاملة للآفات والمطبقة في زراعات نخيل البلح في مصر، وخاصة في المحميات الطبيعية حيث يحرم استخدام مبيدات الآفات.

الكلمات الدالة: دورة البلح الصغرى، دورة البلح الكبرى، ابي دقيق الرمان، نخيل البلح، الواحات البحرية، سيوة