A NEW STRATEGY FOR CONTROLLING THREE DEVASTATING PESTS ATTACKING DATE PALM PLANTATIONS IN EL BAHARIYA AND SIWA OASES, EGYPT THROUGH USING A SPECIAL GROUP OF NATURAL ENEMIES

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Abstract

Egypt is considered the world leader in date production; yet, *Batrachedra amydraula* Meyrick, *Arenipses sabella* Hampson *and Virachola livia Klug* are threatening this position. This study aimed to set a new strategy by using six parasitoids and predators, *i.e. Trichogramma* sp., *Bracon* sp., *Goniozus* sp., *Chrysoperla* sp., *Coccinella* sp. and *Orius* sp. to trap the different pests' stages in El-Bahariya and Siwa Oases' palm plantations. By the end of the season of each pest, *A. sabella* and *V. livia* infestation% in El-Bahariya control farm recorded 92.1 and 51%, respectively, while *B. amydraula* recorded 40.2%. Infestation declined when natural enemies were released, *i.e.* 0, 1.1 and 1.1%, for the three pests, respectively. In Siwa, infestation in control recorded 52, 40.2 and 43%, while dropped in treatments to 0, 2 and 2 %, for the three pests, respectively. Using this combination of natural enemies was effective and it is recommended to integrate this strategy in palm plantations IPM programs in Egypt, mainly, in protectorates, where using pesticides is prohibited.

Key words: Natural enemies**,** *Batrachedra amydraula*, *Arenipses sabella*, *Virachola livia*, biological control

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 and for making wine (Paul and Ian 2000). Nowadays, Egypt is considered the world leader in date production and cultivation. Each year, it produces, approximately, 1.3 million tons of dates. Palm trees occupy 86,000 acres of Egypt's lands, with their numbers estimated at 15,582 million trees, as mentioned in a report produced by the Egyptian Ministry of Agriculture (Egypt Independent 2015). 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.

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). 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 fruits, feeds on the embryos and cuts the connection between fruits and their stalks causing drying and loss of date fruits. 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 (Pyralidae: Lepidoptera), is one of the pests frequently attack date palm trees in Al-Arish region, Egypt. He mentioned 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.

El-Shafie et al. (2017) stated that traditional chemical insecticides are not only expensive; but also have negative impacts on environment and human health, and some pests develop resistance towards them, such as the case of *B. amydraula*. Therefore, chemical pesticides should not be relied upon as short-term solutions against date palm pests to avoid the risk of residues in fruits and to maintain the balance of the ecosystem. Unprincipled use of costly chemical pesticides is considered a failed strategy (Al Dosari and Ali 2007). To significantly reduce or even completely eliminate pesticide usage in date palm plantation ecosystems, an integrated pest management (IPM) application is necessary (Latifian 2012). Using predators and

parasitoids to control pests is a control 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. *Trichogramma* sp. is considered an important biological control agent in suppressing the population of *B. amydraula*. In addition, *Goniozus* sp. is a cosmopolitan genus with the potential of being a biological control agent for various Lepidoptera pests (Hardy and Blackburn 1991). Due consideration should be given to the beneficial natural enemies, nominated as good candidates, when launching control operations against date palm pests. 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 and Siwa Oasis. The study aimed also to compare and monitor pests' emergence date, augmentation and infestation rates during the whole season, in the absence and presence of the used group of natural enemies, under the conditions of both oases.

MATERIALS AND METHODS

Location:

The current study was conducted in Egypt, in two oases *i.e.* Siwa, (Governorate of Matroh, it lays between the Qattara Depression and the Great Sand Sea in the Western Desert, nearly 50 km east of the Libyan border, and 900 km from Cairo, latitude is 29.203171° North and the longitude is 25.519545° East) and El Bahariya, (Governorate of Giza, it is a depression and oasis in the Western Desert of Egypt, approximately 370 km away from Cairo, latitude & longitude is 28° 21' 5" North , 28° 51' 44" East.). Three old farms -10-15 years- 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 trees numbers in each feddan ranged from 70-80, and the whole study area in the two locations consisted of mature fruit-bearing palm 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 control to detect the augmentation and infestation rates of *A. sabella, B. amydraula and V. livia*.

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. The release of natural enemies was

conducted on this date. Later, during the month of July, the pomegranate moth, *V. livia,* appeared in the experimental areas.

a- *A. sabella:*

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

b- *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 caused by both pests, in Siwa and El Bahariya 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 May till Aug., 2017 while *V. livia* data collection extended from July to Sep., of the same year.

Natural enemies:

Several commercially 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. Releasing the natural enemies started in April, 15th, just after the appearance of *A. sabella and B. amydruala*. Tricho cards and capsules containing the parasitoids/ predators were inserted within the fruit bunches. Results were recorded monthly after the release starting from May till the end of the season.

Data analysis:

Results were statistically analyzed using SPSS Statistical Package (IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp). A one way ANOVA was performed to compare between the infestation caused by the three pests under investigation in treated and control farms. The significant difference among various treatments was set at $p< 05$.

RESULTS

Control results in both oases:

Monitoring the appearance of *A. Sabella, B. amydraula* and *V. livia* in El Bahariya and Siwa Oases control farms and the increase in their population and consequently their infestation rates, from May to Sep. (2017) was carried out. As presented in Table 2, infested bunches mean numbers of *A. sabella* in El Bahariya Oasis, in May, recorded 4.8 ± 0.49. A continuous increase in infestation rates was noticed during the next two months, where in June and July mean numbers of infested bunched reached 7.2± 0.66 and 9.4±0.5, respectively (= infestation percentages of 70.6 and 92.1%). There was a statistically significant difference between mean numbers of infested bunches in the three months as determined by one-way ANOVA (F (2, 12) = 16.89, p < .001). In Siwa Oasis, infestation mean numbers of *A. sabella* rose from 2.6± 0.67 to 5± 1.64 and reached 6.4± 1.77, during the months of May, June and July, respectively (= infestation percentages of 21, 40.3 and 52%). No statistically significant difference were found between mean numbers of infested bunches in the three investigated months (F (2, 12) = 1.75, p = .215).

In El Bahariya Oasis, *B. amydraula* caused infestation mean numbers higher than that of *A. sabella, i.e.* 13.8±0.91, 20± 2, 27± 3.3 and 34.6± 3.8 during May, June, July and Aug., respectively. Results proved that there was a significant difference between infestation mean numbers of the four months (F (3, 16) = 10.81, p < .001). Under Siwa conditions, *B. amydraula* infestation mean numbers were also higher than that caused by *A. Sabella* in Siwa, *i.e.* 17.8± 2.1, 21± 2.5, 33± 5.4 and 41.4± 6.7 during May, June, July and Aug., respectively (Table 2). There was a statistically significant difference between infestation mean numbers in the four months (F (3, 16) = 5.6, p = .008).

V. livia did not emerge in both oases till the beginning of July, where it started to attack the date fruits till the end of Sep. infestation mean numbers in El Bahariya Oasis increased from 13±1 to 29± 0.8 then to 44.4± 1, during June, July and Sep., respectively, whereas in Siwa it recorded 13.6±0.92, 25.8± 1.2 and 37± 2.3 in the three months, respectively (Table 2). Results showed a statistically significant difference between mean numbers in the three months in both Oases, *i.e.* El Bahariya (F (2, 12) = 258, p < .001), Siwa (F (2, 12) = 684, p < .001).

El Bahariya Oasis

A. sabella:

A total number of 225 bunches were monthly visually examined, in the three farms to detect the infestation percentage of *A. sabella,* in the presence of natural enemies. Results showed great decline in *A. sabella* infestation levels compared to the

control farm. . In May, average infestation % dropped from 47± 0.3 in control to 5± 1.3 in the treated farms. Suppression caused by natural enemies continued to occur during June and July, as shown in Fig. (1a), where infestation % reached an average of 2.5± 1.8 and zero, respectively, whereas control recorded 70.6%± 0.2 and 92.1%± 0.11, respectively. Results proved that there was a statistically significant difference between control and treated fames ($p < .001$).

B. amydraula

Infestation caused by *B. amydraula* during May dropped from 16% ± 0.3 in control to 2.5%± 0.67 in treated farms. Infestation% continued to decrease till it reached 1.1± 0.4% by July, compared to 31%± 0.1 in control farm (Fig. 1b). A significant difference was noticed between the treated and control farms ($p < .001$).

V. livia

Pomegranate butterfly started to appear in July, and infestation% in the control farm recorded 15± 0.2, 33± 0.3, and 51± 0.4, during July, Aug. and Sep, respectively. In treated farms, *V. livia* recorded average infestation% of 4.6±0.29, 1.9± 0.49 and 1.1± 0.78, respectively, as illustrated in Fig. (1c). Results differed significantly between control and treatment ($p < .001$).

Siwa Oasis

A. sabella

Average infestation% in the three farms recorded 5± 2, 1.1± 0.56 and zero, during May, June and July, respectively. Control results differed significantly from treated farms ($p< .001$), where it recoded infestation% of 21± 0.2, 40.3± 0.4 and 52± 0.1, respectively, as illustrated in Fig. (2a).

B. amydraula

Results showed that *B. amydraula* recorded an average infestation% of 5.4± 0.77, 3±0.57, and 2.1± 0.57, during May, June and July, respectively (Fig. 2b). Control, on the other hand, recorded infestation% of 22± 0.3, 25.6±0.1 and 40.2± 0.1; these results differed significantly from the treated farms ($p< .001$).

V. livia

Comparing the results of control to the average of the three treated farms, concerning *V. livia,* data assured that the used natural enemies were powerful enough to reduce infestation percentages of this pest till it reached 2%± 0.7 during Sep., compared to 43%± 0.1 in the control farm. In Siwa, it recorded an infestation% of 10.3± 1 and 4.1% ± 0.2 in July and Aug., respectively, compared to control farm where it recorded 16%± 0.1 and 30%± 0.11 (Fig. 2c). ANOVA one proved there was significant differences between both control and treatment ($p < .001$).

El Bahariya versus Siwa Oases:

Data were subjected to the analysis of variance (one way ANOVA) to show the differences between the two oases concerning the infestation rates of the three pests in both control and treated farms. Results showed that the mean number of *A. sabella* infestation in El Bahariya Oasis control was higher than that in Siwa where it recorded 7.13± 0.58 and 4.67± 2.78, respectively. Results proved there was statistically significant difference between the two locations (F (1, 28) = 5.436, p = .027), while treated farms average infestation% showed no significant differences between El Bahariya and Siwa during May and June (F (1, 4) = .002, p = .969 and F (1, 4) = 0.5, p = .510), respectively. July infestation recorded 0% in both oases. On the other hand, *B. amydruala* infestation mean numbers in control farms in the two locations showed no significant differences as proved by one way ANOVA. In El Bahariya Oasis infestation mean number recorded 24± 2.19 whereas Siwa recorded 28.3± 3.0 (F (1, 38) = 1.32, p = .257). In treated farms, results differed significantly between El Bahariya and Siwa during May, June and July, where Siwa results were higher than that of El Bahariya as explained previously (F (1, 4) = 7.89, p = .04, F (1, 4) = 13.7, p = .021 and F (1, 4) = 1.87, p = .0243, respectively). *V. livia* infestation in control farms did not show any significant differences between the two sites (F (1, 28) = 0.57, p = .454) where infestation mean numbers were 28.8±3.46 and 25.47±2.6, in both El Bahariya and Siwa Oases, respectively. On the contrary, treated farms results proved there were significant differences between El Bahariya and Siwa during July and Aug. (F (1, 4) = 29.37, p = .006 and F (1, 4) = 17.7, p = .014) whereas Sep. results showed no significant difference as proved by ANOVA one (F (1, 4) = 0.6, p = .477).

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. Siwa Oasis became a protectorate in (2002) as per Prime Ministerial decree number 1219 (Baraka 2010). In addition, 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)**.** The status of being protected areas prohibits all activities that damage or deplete the natural environment. Due to 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 (Baangood 2008; 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, to control the lesser date moth, the greater date moth and the pomegranate butterfly. *T. evanescens*, *Bracon* sp., *Goniozus* sp., *Chrysoperla* sp., *C. septumpunctata* and *Orius* sp. were chosen as they attack different stages throughout the pest's life cycle; which is a distinguished point in this study, *i.e.* trapping eggs and larvae of the pest by the natural enemies and stops 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. Chrysoperla carnea*, *Orius* spp. and *Bracon hebetor*. 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.

Generally, it was noticed that pests infestation in the control farms continued to increase when the natural enemies were absent either in El Bahariya or Siwa, whereas in the treated farms continues infestation reduction occurred till sometimes 0% was achieved in both oases. The high infestation% of *A. sabella* in El Bahariya control farm by the end of the season, *i.e.* 92.1% lies in the range found by Abdel Rahman et al. (2007), who stated that percent of impressively infested trees with *A. sabella,* in El Bahariya, ranged between 41and 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%. Imam (2012) ensured this finding when he stated that *A. sabella* is one of the most devastating pests that threats 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%. *A. sabella* is considered one of the key pests in Jordan due to the high infestation rates, that might exceed 55% of bunches during season (Al Antary et al. 2015). 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. 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 the two locations and the degree of temperature and humidity suitability 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 1.1% after 2 months post-release, and recorded 0% in both locations during the third month. 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, (= 2.2% infestation).

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%, by July (after 3 months of release), in both El Bahariya and Siwa Oases, respectively. The differences in infestation rates between the two Oases can be also attributed to the weather conditions that might affect natural enemies' activity. Several authors stated that environmental conditions have great influence on the natural enemies' performance, mainly temperature. Mohammad et al. (2015) reported 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 instability in climate conditions towards the extreme, especially increasing in temperature and decreasing in relative humidity, is considered a big challenge to biological control programs.

Most of the research work found in the literature concerning the lesser date moth was mainly related to *Trichogramma* sp. Mohammad et al. (2015) believed that *T. evanescens* is 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 infestations of lesser date moth in date palm orchards in El-Bahriya Oasis. The release of the egg parasitoid *T. evanescens* for one time to control *A. sabella* and *B. amydraula* in the New Valley is recommended (Gameel et al. 2014). 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.

Although insecticides play a critical role in the management of pomegranate butterfly, the frequent of their use prompted the development of resistance of *V. livia* (Abd-Ella 2015). To our knowledge, this is the first time *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 by Sep. In addition, natural enemies used were highly capable of decreasing the infestation of *V. livia* till it reached, by the end of the season, 1.1 and 2% in both Oases, respectively, in Sep. 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 found that percentage parasitism with *T. brassicae* to pomegranate butterfly ranged between 0 and 52.7%, with an average of 20.9%, while in case of *T. evanescens* it ranged between 0 and 15.4% with an average of 9.9%. Nonetheless, our results proved that the group of predator and parasitoid used in this study achieved higher control percentages. Previous work of Ksentini et al. (2010) highlighted that rearing and releasing of *Trichogramma* as indigenous beneficially insects might help in controlling *V. livia* attacks.

In 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 tools 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.

Table 1. Names, pest infected stages, usage per feddan and sources of the natural enemies used in the study

Natural Enemy	Name	Pest infected stage	Usage/ feddan	Source
Parasitoids	*Trichogramma* sp.	Egg	10.000 eggs	Plant Protection Research Institute-ARC
	Bracon Sp.	Larva	500 adults	
	Goniozus sp.			
Predators	*Chrysoperla* sp.	Eggs and newly hatched larvae		*Chrysopa* Mass Production Unit, Fac. Agric. Cairo Univ.
	Coccinella sp.			
	Orius sp.			

Table 2. Infestation mean numbers (±SE) of *A. sabella, B. amydruala* and *V. livia*, in control farms of both El Bahariya and Siwa Oases

Location	Pest	May	June	July	Aug.	Sep.
El-Bahariya	*A. sabella*	4.8± 0.48	7.2± 0.66	9.4± 0.50		
	B. amydruala	13.8± 0.91	20± 2.0	27.6± 3.31	34.6± 3.8	
	V. livia			13± 1.04	29± 0.83	44.4± 1.02
Siwa	*A. sabella*	2.6± 0.67	5± 1.64	6.4± 1.77		
	B. amydruala	17.8± 2.1	21± 2.5	33± 5.4	41.4± 6.7	
	V. livia			13.6± 0.93	25.8± 1.2	37± 2.34

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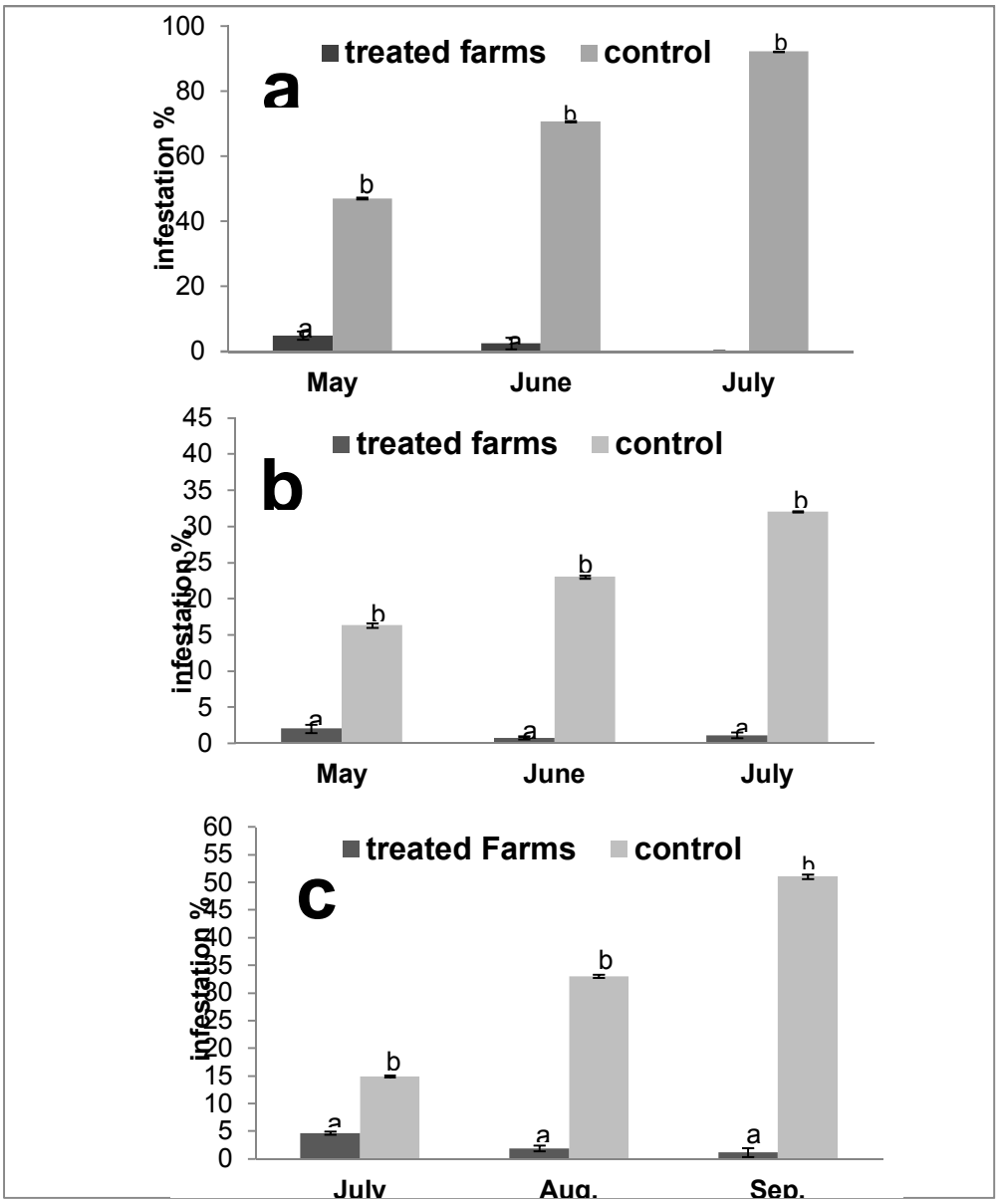
Fig. 1

Average infestation % of *A. sabella* (a), *B. amydruala* (b) and *V. livia* (c) in control and treated farms in El Bahariya Oasis. Different letters on the bars indicate significant differences between control and treatment within the same month. *Error bars* represent SE

Fig. 2

Average infestation % of *A. sabella* (a), *B. amydruala* (b) and *V. livia* (c) in control and treated farms in Siwa Oasis. Different letters on the bars indicate significant differences between control and treatment within the same month. *Error bars* represent SE



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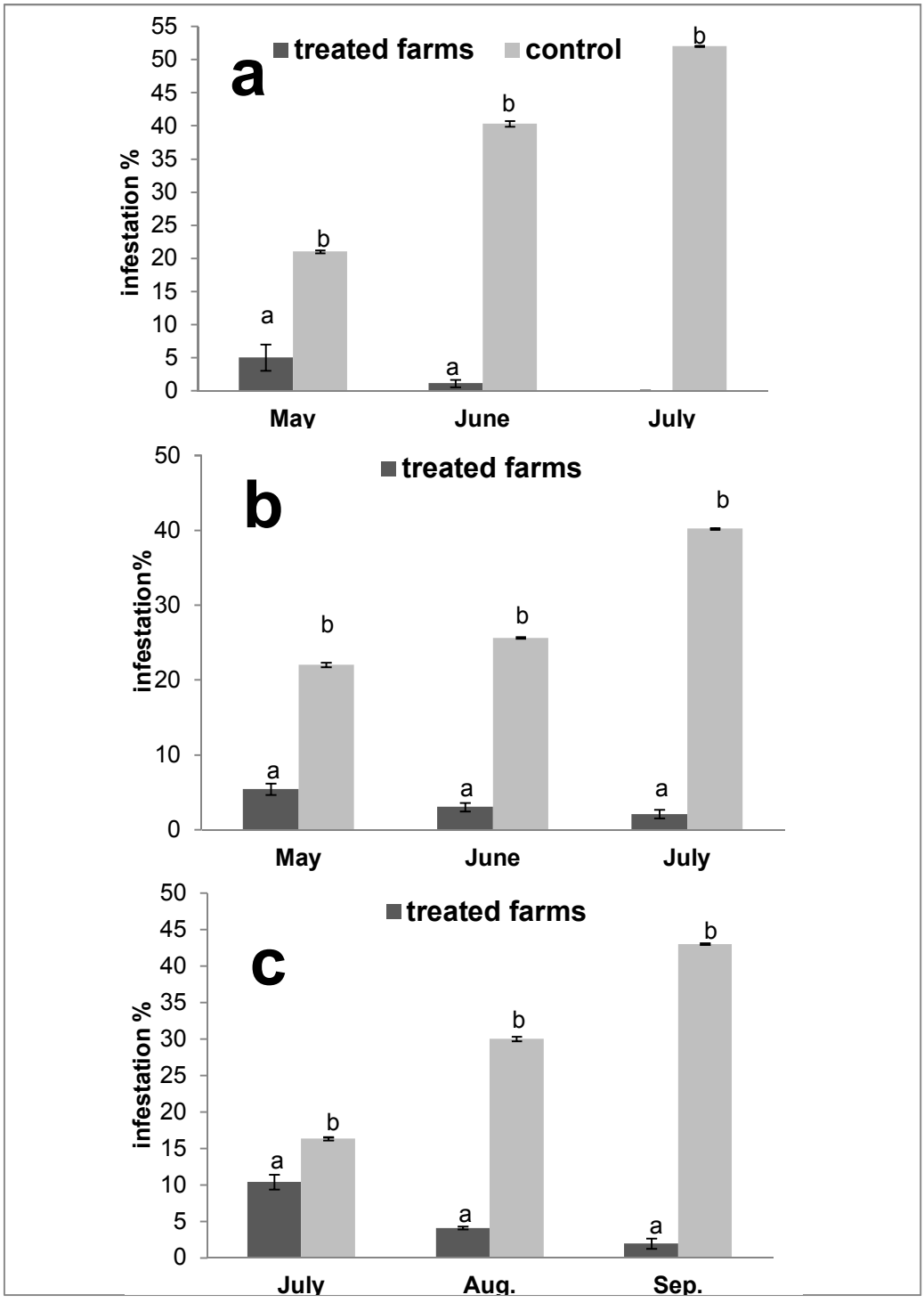

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استراتيجية جديدة لمكافحة ثلاث آفات مدمرة تهاجم زراعات النخيل في الواحات البحرية وسيوة بمصر من خلال استخدام مجموعة متميزة من الأعدء الطبيعية

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1. *معهد بحوث وقاية النباتات– مركز البحوث الزراعية– القاهرة– مصر*
2. *المعمل المركزى للزراعة العضوية بمركز البحوث الزراعية.*

تعتبر مصر من الدول الرائدة علي مستوي العالم في إنتاج البلح، إلا ان كل من دودة البلح الصغري والكبري وابي دقيق الرمان يهددان هذه المكانة. وتهدف الدراسة الحالية إلي وضع استراتيجية جديدة من خلال استخدام ستة انواع من الطفيليات والمفترسات لمحاصرة الاطوار المختلفة من هذه الافات في زراعات النخيل بالواحات البحرية وسيوة. بنهاية الموسم سجلت دودة البلح الكبري وابي دقيق الرمان نسبة اصابة في تجربة المقارنة بالواحات البحرية وصلت إلي 92.1% و51%، علي التوالي، في حين سجلت دودة البلح الصغري نسبة اصابة 40.2%. هذا وقد انخفضت نسبة الاصابة بشكل كبير عندما تم اطلاق الاعداء الحيوية، حيث سجلت صفر و1.1 و1.1%، للآفات الثلاثة علي التوالي. وفي سيوة سجلت نتائج الكونترول 52 و40.2 و43% في حين انخفضت في المعاملات إلي صفر و2 و2% للآفات الثلاث، علي التوالي. كان استخدام هذه التركيبة من الاعداء الحيوية فعالا، ويوصي بإدخال هذه الاستراتيجية ضمن برامج المكافحة المتكاملة للآفات والمطبقة في زراعات نخيل البلح في مصر، وخاصة في المحميات الطبيعية حيث يحرم استخدام مبيدات الآفات.

Key words: Natural enemies, *Batrachedra amydraula*, *Arenipses sabella*, *Virachola livia*, biological control