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Seasonal activity of jasmine moth *Palpita unionalis* (Lepidoptera: Pyralidae) in response to true spiders and temperature degrees in olive orchard

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Abstract:

The jasmine moth *Palpita unionalis* (Hübner) (Lepidoptera: Pyralidae) is one of the serious pests infesting olive trees. The present study aimed to study some ecological aspects of *P. unionalis* and true spiders in olive orchard at Dakahlia Governorate during two successive years (from the 25th of January 2018 till the 16th of January 2020). The obtained results indicated that larval population of *P. unionalis* exhibiting four and five peaks of abundance during the first and second year and the highest activity was recorded during autumn and spring of the first and second year. With respect to true spiders, it exhibited six and five peaks of abundance during the first and second year and the highest activity was recorded during spring of the two studied years. On contrary, the lowest activity of *P. unionalis* and true spiders was recorded during winter of the first year and summer of the second year. Statistical analysis indicated that *P. unionalis* population exhibited positively responses to the true spider population during the first ($r = 0.092^{ns}$) and second ($r = 0.601^{*}$) year. Both of *P. unionalis* and true spiders exhibited insignificant responses maximum, minimum and average temperature during the two studied years.

Introduction

Olive (*Olea europaea* L.) growing is of great economic and socio-cultural significance for the Mediterranean region, where 98% of the world's olive production is located (Civantos, 2001). The olive tree is attacked by various insect pests, which can cause considerable yield losses, and current olive cultivation involves regular use of plant protection products. However, frequent insecticide applications pose the risk of environmental pollution and contamination of the olive products (Jardak and Ksantini, 1996; Calbras *et al*., 1997; Cirio 1997 and Moustafa *et al*., 2009). The jasmine moth *Palpita unionalis* (Hübner) (Lepidoptera: Pyralidae) is an international lepidopteran pest originating in the Mediterranean Basin (Hegazi *et al*., 2012 and Ghoneim, 2015). It is a highly mobile moth and is known to disperse

even to Northern Europe (Tremewan, 2002). It attracted a considerable attention of some researchers during the last few decades because of its serious attack against young olive trees in nurseries. Where, it is feeding damage by larvae can reach up to 90% of the leaf area, thereby seriously affecting the development of the plant shoots. During the fruit ripening season, high larvae infestations may also reduce the fruit yield by 30% (Solaiman, 1997; Lopez-Villalta, 1999; Hegazi *et al*., 2007 a, b and 2012 and Ghoneim, 2015). In years of high population densities, larvae attack also olive fruits, making them unsuitable for marketing (Antonelli and Rossi , 2004 and Mazomenos *et al.*, 2002). This pest is one of the serious olive pests in Egypt and several countries (Vassilaina-Alexopoulou and Santorini, 1973; Tremewan, 2002 and Hamadah and Abo Elsoud, 2018).

Spiders represent an abundant group of predators within the agroecosystems, and in olive groves of Europe spiders are important predators and may significantly reduce the attack of pests. Spiders comprise a large fraction of predator species in agroecosystems, where insects (especially flies and moths) are the main preys. These arachnids are more sensitive to pesticide application than their prey, and therefore are good bioindicators of the risk of an outbreak of pests in olive groves (Loverre and Addante, 2011). The intensive use of many conventional insecticides led to several dramatic problems, such as destruction of the natural enemies, environmental hazards and serious toxicological problems to humans, as well as the development of insect resistance toward different insecticides (Davies *et al.*, 2007; Costa *et al*., 2008; Mosallanejad and Smagghe, 2009 and Sharifian *et al*., 2012). There are several attempts to use different bio control tactics to control *P. unionalis* populations such as *Trichogramma* spp. (Hegazi *et al*., 2007a) and pheromone traps (Anthanassiou *et al*., 2004 and Hegazi *et al*., 2007b). Spiders are important predators of the olive moth *Prays oleae* (Bernard, 1788) (Lepidoptera: Yponomeutidae) and may reduce its population by 80%, being *Philodromus* spp., *Salticus* spp. and *Iciushamatus* the most common. They feed on eggs and larvae and in some cases have reduced the pest population by 60 to 80% in olive groves in Spain (Morris *et al.*, 1999 and Ghavami, 2006). The occurrence of spiders in olive groves can be an important contribution to reducing natural populations of phytophagous arthropods due to their exclusively predator diet (Rei *et al*., 2011).

Efficient control of economic insect pests requires detailed investigations of its ecology as well as the recorded natural enemies. Some certain are essential for the control of insect pests such as population dynamics and peaks times of the pest and its associated natural enemies (Öztürk and Ulusoy, 2012 and Abdel Kareim *et al*., 2018). According to Witzgall *et al*. (2010), the first step in managing any pest species begins with a proper monitoring program. Therefore, the present study deals with some ecological aspects of jasmine moth *P. unionalis* and true spiders in olive orchard at Dakahlia Governorate.

Material and methods

An area of two feddans (One feddan = 4200 m^2) cultivated with olive trees was selected for the present study at Mansoura district, Dakahlia governorate. The present study lasted two successive years, starting from the 25th of January 2018 till the 16th of January 2020. Five trees (Homogenous in size and age) were selected randomly from all the area. Every week, five newly branches (Each branch was about 20 cm) of each tree were cut from the

cardinal direction (North, south, east and west) and center of the tree (On branch per direction). Then, branched were put in paper bags, well tied and transported to laboratory for investigation. On each branch, numbers of *P. unionalis* larvae and true spiders were counted and recorded. Among the available meteorological data of Dakahlia region, daily averaged temperature degrees (Maximum, minimum and average) were obtained from the Central Laboratory for Agricultural Climate, Agricultural Research Center, during the period from the 25th of January 2018 till the 16th of January 2020. The daily records of each temperature degree were grouped into weekly means according to the sampling dates. The mean weekly numbers of *P. unionalis* larvae as well as true spiders were correlated with each temperature degree and the simple & multi regressions in addition to explained variance were analyzed by using the computer program of CoHort Software (2004).

Results and discussion

As shown as in Figure (1), larval population of *P. unionalis* occurred in olive trees during the period from 17th of May till 29th of November 2018 during the first year. The pest population was recorded four peaks. These peaks were recorded on the 17th of May (4 individuals / sample), 23th of August (6 individuals / sample), 13th of September (5 individuals / sample) and 11th of October (16 individuals / sample).

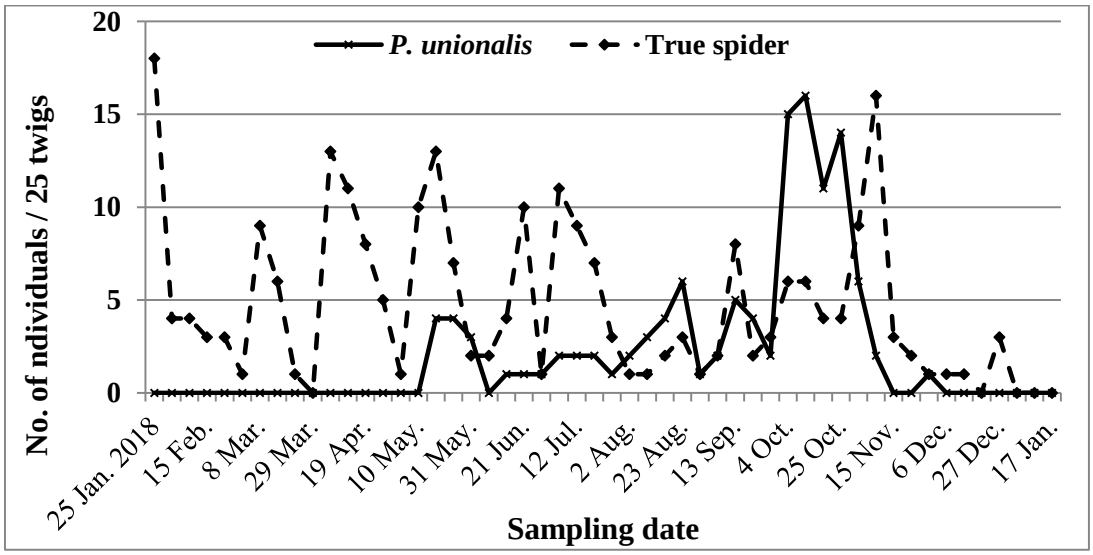

Figure (1): Seasonal abundance of *Palpita unionalis* and true spiders population on olive trees in Dakahlia Governorate during 2018/19.

With respect to true spiders, it was recorded all over the first year (Figure 1). True spiders exhibited six peaks of abundance recorded as 18, 9, 13, 13, 11, 6 and 16 individuals / sample (On 25th January, 8th of March, 5th of April, 17th of May, 5th of July, 4th of October and 8th of November 2018, respectively). During the second year, *P. unionalis* showed two periods of activity. The first period was recorded from the 21st of March till the 23rd of May 2019; while, the second period was recorded from the 12th of September till the 26th of December 2019 (Figure 2). *P. unionalis* exhibited five peaks during the second year. These peaks were recorded during 11th of April (15 individuals / sample), 2nd of May (10 individuals / sample), 19th of September (6 individuals / sample), 10th of October (6 individuals / sample) and 19th of December 2019 (6 individuals / sample).

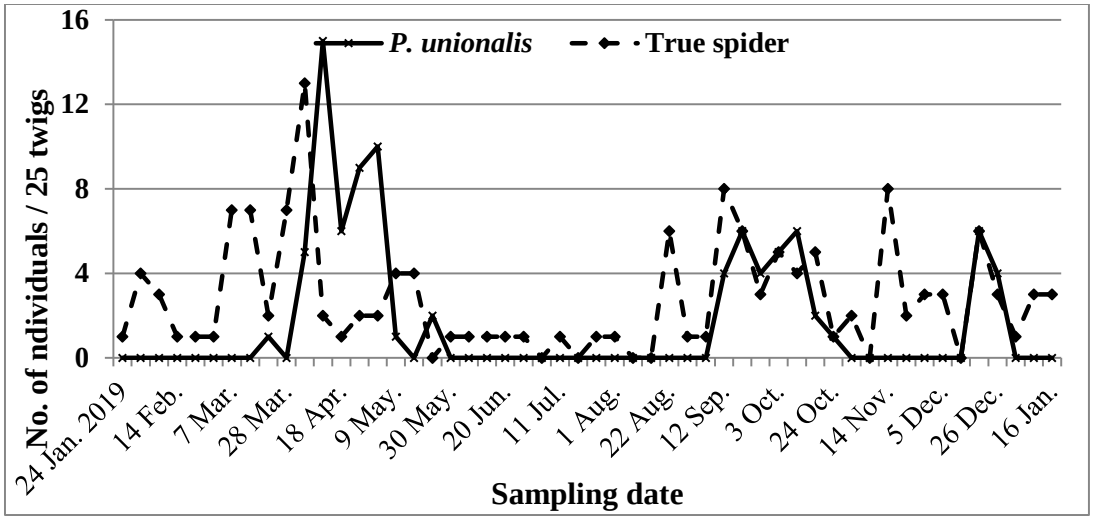

Figure (2): Seasonal abundance of *Palpita unionalis* and true spiders population on olive trees in Dakahlia Governorate during 2019/20.

As shown as in Figure (2), true spiders exhibited five peaks of activity during the second year. These peaks were recorded as 13, 4, 8, 8 and 6 individuals / sample on the 4th of April, 9th of May, 12th of September, 14th of November and 19th of December, respectively. Data illustrated in Figure (3) indicated that *P. unionalis* was recorded with no numbers during January and February. On the contrary, this pest showed its highest population during October of the first year (with a mean of 14 individuals / sample) and during April of the second year (with a mean of 7 individuals / sample). During all of the rest months, the pest population showed moderate numbers and varied from year to other.

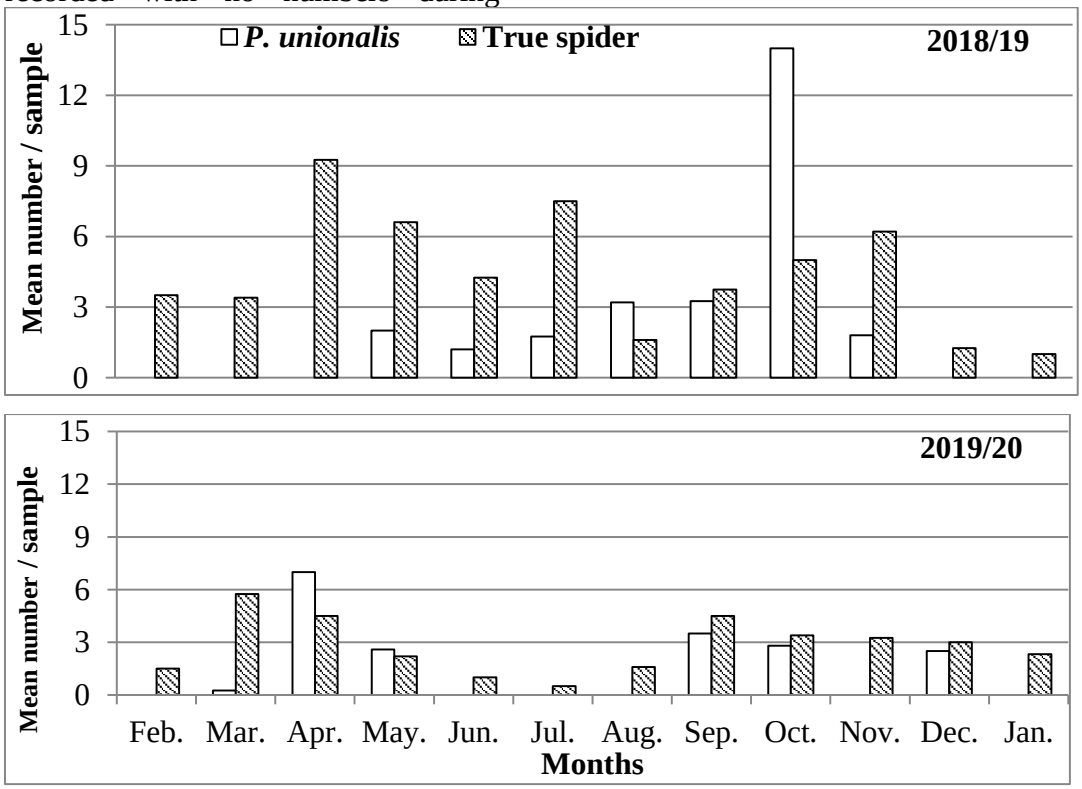

Figure (3): Monthly mean numbers of *Palpita unionalis* and true spiders on olive trees in Dakahlia Governorate during 2018/19 and 2019/20.

True spiders showed its highest activity during April and July of the first year with monthly means of 9.25 and 7.5 individuals / sample. While, during the second year, true spiders showed its highest population during March (with a mean of 5.75 individuals / sample) and April (with a mean of 4.50 individuals / sample). As shown as in Figure (4), the highest mean numbers of *P. unionalis* were recorded during autumn of the first year and spring of the second year. On contrary, there were no recorded individuals of *P. unionalis* during winter of the first year and summer of the second year. The general mean number of *P. unionalis* was 2.21 and 1.67 individuals / sample all over the first and second year.

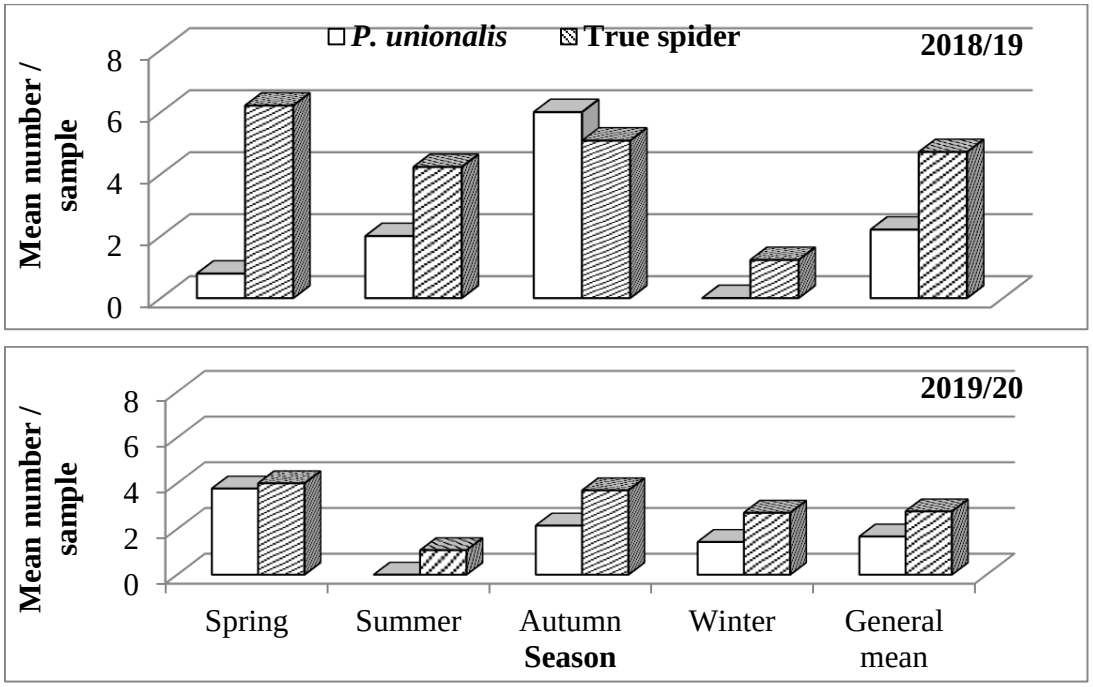

Figure (4): Mean of numbers of *Palpita unionalis* larvae and true spiders during annual seasons as well as all year on olive trees in Dakahlia Governorate during 2018/19 and 2019/20.

True spider recorded its highest activity during spring of the two studied years. While, its lowest activity was recorded during winter of the first year and summer of the second year. The general mean number of true spiders reached 4.71 and 2.77 individuals / sample all over the first and second year (Figure 4). The seasonal activity of *P. unionalis* in response to true spiders and temperature degrees was evaluated during two years of study. To determine the relation between these factors and population of *P. unionalis*, simple correlation (r) and regression (b) were done, as well as multi regression analysis (Table 1). Correlation analysis indicated that *P. unionalis* population exhibited positively responses to the increase of true spider population during the first ($r = 0.092^{ns}$) and second ($r = 0.601^{*}$) year. With respect to temperature degrees, *P. unionalis* exhibited positively insignificant responses maximum, minimum and average temperature during the two studied years.

Table (1): The correlation and regression coefficients between *Palpita unionalis* population and true spiders as well as temperature degrees on olive orchard in Dakahlia Governorate during 2018/19 and 2019/20.

Factors	Simple correlation and regression				Multi regression		
	R	B	P	R^2	B	P	E.V %
2018/19							
True spider	0.092	0.066	0.777	0.8%	0.014	0.981	15.2
Max. T.	0.342	0.516	0.276	11.7%	0.680	0.557	
Min. T.	0.287	0.413	0.365	8.2%	-0.670	0.703	
Av. T.	0.305	0.457	0.335	9.3%	0.190	0.920	
2019/20							
True spider	0.601	0.344	0.039	36.1%	0.992	0.128	39.9
Max. T.	0.079	0.175	0.808	0.6%	1.520	0.654	
Min. T.	0.020	0.047	0.952	0.0%	1.060	0.668	
Av. T.	0.045	0.105	0.889	0.2%	-2.470	0.664	

The simple regression indicated that every increase of true spiders by one individual increased the pest population by 0.066 and 0.344 individuals during the first and second years (Table, 1). On another hand, every increase of maximum, minimum and average temperature by one degree increased *P. unionalis* population by 0.516, 0.413 and 0.457 individuals, respectively during the first year and by 0.175, 0.047 and 0.105 individuals, respectively during the second year. Also, regression analysis showed that the highest effective factor on *P. unionalis* population during the first year was that of maximum temperature (R^2 = 11.7%); while, during the second year was that of true spiders (R^2 = 36.1%). The explained variance attributed to combined effects of true spiders in addition to maximum, minimum and average temperatures on *P. unionalis* population reached 15.2 and 39.9% of the total factors affecting the pest population during the first and second year (Table 1). Multi regression analysis explained that the relationship between *P. unionalis* population and all of true spiders (T.s.), maximum temperature (Max.T.), minimum temperature (Min.T.) and average temperature (Av.T.) could by represented as follows:

During the first year:

P. unionalis = - 6.84 + 0.014 T.s. + 0.66 Max.T. - 0.67 Min.T. + 0.19 Av.T.

During the second year:

P. unionalis = - 4.94 + 0.992 T.s. + 1.52 Max.T. + 1.06 Min.T. - 2.47 Av.T.

Data represented in Table (2) showed the effect of temperature degrees on true spiders' population. These data explained that true spiders' population were insignificantly correlated with temperature degrees during the two studied year. The correlation coefficient values (r) between true spiders' population and maximum, minimum and average temperature degrees were 0.394^{ns}, 0.401^{ns} and 0.425^{ns} during the first year, and were -0.101^{ns}, -0.194^{ns} and -0.154^{ns} during the second year, respectively.

Table (2): The correlation and regression coefficients between population of true spiders and temperature degrees on olive orchard in Dakahlia Governorate during 2018/19 and 2019/20.

Factors	Simple correlation and regression				Multi regression		
	R	B	P	R^2	B	P	E.V%
2018/19							
Max. T.	0.394	0.734	0.266	12.2%	-0.558	0.409	26.8
Min. T.	0.401	0.805	0.196	16.1%	-0.280	0.798	
Av. T.	0.425	0.890	0.168	18.1%	1.010	0.376	
2019/20							
Max. T.	-0.101	-0.41	0.734	1.1%	2.030	0.308	20.7
Min. T.	-0.194	-0.82	0.547	3.7%	1.070	0.469	
Av. T.	-0.154	-0.62	0.632	2.4%	-3.070	0.362	

Regression analysis showed that average temperature was the most effective factor of true spiders' population during the first year (R^2 = 18.1%); while, during the second year was that of minimum temperature (R^2 = 3.7%). Multi regression explained that the combined effects of the three tested temperature degrees on true spiders' population was 26.8 and 20.7% of the total factors affecting true spiders' population during the first and second year (Table 2). In Egypt, lepidopterous pests are important constraints for olive production, especially in recently established, intensively managed olive plantations (Hegazi *et al*., 2012). The present study showed that there were observed differences in either weekly numbers of *P. unionalis* larvae or the time of its peaks. Similar findings were obtained by Osman *et al*. (2001), Hegazi *et al*. (2011) and Hegazi *et al*. (2012), they reported that the number of *P. unionalis* was generally varied from year to other and from site to other.

Many authors reported that *P. unionalis* is a multivoltine species with several overlapping generations per year (Ghoneim, 2015). As reported by Grossley (2000), the pest has 2-3 generations in cold to mild regions while more than 5-6 in mid-tropical and tropical regions. It has 5 generations per year in in Spain (Fodale and Mule, 1990), 4-5 in Italy (Martelli, 1916 and Fodale and Mule, 1990). The present results showed that *P. unionalis* exhibited four to five peaks of activity on olive orchard annually in Dakahlia governorate. These results are approximately in agreement with those of Hegazi *et al*. (2011), they reported that *P. unionalis* exhibiting six to seven and three to four overlapping flight peaks in Alexandria governorate. Also, in Alexandria, Hegazi *et al*. (2012) reported that this pest recorded three to four peaks of activity annually. On another hand, the obtained data showed that the heist activity of *P. unionalis* was recorded during autumn (Especially in October) and spring (Especially in April). While, in Alexandria, the heist activity was recorded during summer especially in June (Hegazi *et al*., 2012). In the coastal region and Middle Egypt, *P. unionalis* recorded its highest populations in May (El-Kenawy, 2012). In Iran, field observations indicated that the first generation being completed by the end of March and in early April. However, the population reaches its peak during the third and fourth generations (Noori and Shirazi, 2012). The differences between the present results and others may explained by the study of Ghoneim (2015), who reported that *P. unionalis* has varied number of generations annually in the same country, depending on the host plant, seasonal

temperature and other environmental conditions of over its universal or regional distribution. Also, Kacar and Ulusoy (2013) observed that shoot development and climatic factors (Temperature and humidity) affected the larval population fluctuation.

According to the present study, true spiders exhibited five to six peaks of annual activity. The highest activity was recorded during spring of the two studied years. On contrary, its lowest activities were recorded during winter and summer. These results approximately came in the same line with Mohafez *et al.* (2010), they reported that the population numbers of true spiders had two highest peaks in September and July on mango trees in Sohag Governorate; while, it started to increase gradually during Spring months to reach the first peak in early Summer season, then a sharp decline in spider population in late Summer, Autumn and winter; then, started to increase gradually to reach peak in September.

Statistically, the true spider population exhibited positively responses to the increase of *P. unionalis* population during the two studied years. So, it could play an efficient role as a biological control agent to reduce the pest population. This suggestion is supported by Morris *et al*. (1999) and Ghavami (2006) in Spain, they reported that spiders are important predators of the olive moth, *P. oleae* and may reduce its population by 80%. The same authors added the spiders feed on eggs and larvae in olive groves. Also, Rei *et al*. (2011) reported that the occurrence of spiders in olive groves can be an important contribution to reducing natural populations of phytophagous arthropods due to their exclusively predator diet.

On another hand, the present study explained that jasmine moth, *P. unionalis* (Pyralidae) exhibited positively insignificant responses maximum, minimum and average temperature during the two studied years. Also, Halder *et al*. (2017) reported *Diaphania indica* (Saunders) (Lepidoptera: Pyralidae) exhibited positive responses to maximum, minimum and average temperature degrees in India. In contrary, Rahmathulla *et al*. (2012) recorded negative responses of the pyralid, *Diaphania pulverulentalis* Hampson in mulberry plantations. The variation between the present results and other may be attributed to the variation of agroecosystems, ecological factors and/or the behavior of pest species. Dahi *et al*. (2017) reported that the most favorite temperature for *P. unionalis* (which recorded high hatch rate, emergence rate and sex ratio) was that of 22°C followed by 27°C. This may explain the highest activity of *P. unionalis* during April and October months (which the average temperature ranged between 21 and 25°C). Also, the same authors conducted a study which aimed to calculate temperature thresholds (t_0) and accumulated heat units (DD's) for each stage of *P. unionalis* as a primary step for developing a forecasting system that will help to define the most precise time for different control programs. They found that the time required for development through egg, larva, pupa and pre-ovipostion increased at lower temperatures. The lower threshold of development (t_0) to complete a generation was 12.04°C and the average accumulated heat units required for its development was 443.07 degree-days.

According to Mohafez *et al.* (2010), true spider population in some fruit orchards in Sohag governorate decreased to form the lowest activity in winter and exhibited its highest activity during spring months. This may confirm the positively insignificant correlation between true spiders and

temperature degrees especially in the first year of the present study.

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