Comparative studies for the arthropod fauna of cowpea plantations and their associated predators in two agro-ecological zones with climatic studies on the lima bean pod borer, *Etiella zinckenella* (Treit.)

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Abstract: The present work was conducted for two seasons (2011-2012) at Fayoum and Qalubiya Governorates to carry comparative studies for the arthropod fauna of cowpea plantations and their associated predators in two agro-ecological zones with climatic studies on the lima bean pod borer, *Etiella zinckenella* (Treit.) and determine the heat units required for its activity. The obtained results revealed the same arthropod fauna and their associated predators in the two agro-ecological zones at Fayoum and Qalubiya Governorates. The populations of the arthropod fauna and their associated predators were varied in the two seasons in the two locations. The arthropod fauna include 9 insect species (*C. purureipennis*, *E. inconspicuus*, *N. viridula*, *E. kerri*, *B. tabaci*, *M. sjostedti*, *E. zinckenella, H. armigera*, *L. boeticus*) as well as *Aphis* spp. & *Liriomyza* spp. and one spider mite (*T urticae*) associated with cowpea plantations as Arthropod pests. The associated predators are *Chrysoperla carnea*; *Coccinella undecimpunctata*; *Scymnus interruptus* and *Orius* spp. as well as one unidentified species of true spider mite. Order Heteroptera and Lepidoptera have the highest number of insect species (3 insect species/ each). The heteropteran species are *C. purureipennis*; *E. inconspicuus* and *N. viridula* whereas the lepidopteron species are *E. zinckenella; H. armigera and L. boeticus*. Order Homoptera came in the third order with Aphid species *(Aphis* spp.) and one Aleyrodid species *(B. tabaci*) followed by order Diptera with *Liriomyza* spp. The lowest insect orders are Hemiptera and Thysanoptera, each one presented with one insect species as well as one spider mite, *Tetranychus urticae*. The dominance percentages of arthropod pests were relatively lower in Qalubiya Governorate compared with Fayoum Governorate in the two growing seasons. Data showed contrast differences for the population density of eggs and larvae of *E. zinckenella* in the two studied seasons. The eggs were recorded on the 2nd week of June and larvae were appeared with few numbers in the 2nd week of June in the both locations. The eggs of *E. zinckenella* peaked on 1st week of July whereas the larval population peaked during 3rd week of July in both seasons. Fluctuation of daily mean temperatures showed negative relation on *E. zinckenella* population during the studied periods in the two locations. Calculated DDU confirmed the variability of insect population in the two locations and growing seasons. Results indicated positive relationships between accumulated DDU and the population density of *E. zinckenella* in the two ecosystems during two successive seasons. The present study has created new opportunities to study such effects by methodological developments and for dynamic program of integrated pest management under different ecological conditions in Egypt.

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Key Words: Arthropod pests, predators, heat units, integrated pest management.

1. Introduction

Cowpea (blackeye pea), *Vigna unguiculata* L (Walp) is cultivated throughout the tropics and subtropics countries between 35ºN and 30ºS across Asia and Oceania, the Middle East, Southern Europe, Africa, Southern USA, and Central and South America. It uses in different forms either eaten directly as green seeds, green pods and dry grains for human as well as for animal feeding.

In Egypt, cowpea consider as one of the most important legume crops, it grown as vegetable crop or as dry seed crop which is favorable for the Egyptian consumers especially in form of dry seeds. The dry-seeds have high percentage of protein (20 - 30%) that characterized as a complete protein compared with those of other vegetables.

Cowpea has been subjected to attack with several pests (El-Kifl *et al*., 1974). Abdel-Alim (1994) and Nosser (1996) found that, the sucking piercing pests are the most serious pests of cowpea which include the tow-spotted spider mite, *Tetranychus urticae* Koch; tomato whitefly, *Bemisia tabaci* (Genn.); potato leafhopper, *Empoasca discipinens* Padi. and the bean aphid, *Aphids craccivora* Koch. Abou El-Saad (1998) reported that, *B. tabaci* and *T. urticae* are severe cowpea pests in Upper Egypt.

Climatic conditions could profoundly effect on the population dynamics and the status of insect pests of crops (Woiwod 1997). These effects could be directly through the influence that weather may have on the insect's physiology and behavior (Parmesan, 2007; Merrill *et al.,* 2008) or may be mediated by host plants, competitors or natural enemies (Cammell and Knight, 1992; Harrington *et al*., 2001; Bale *et al*., 2002). The present work was conducted to carry comparative studies for the arthropod fauna of cowpea plantations and their associated predators in two agro-ecological zones at Fayoum and Qalubiya Governorates with climatic studies on the lima bean pod borer, *Etiella zinckenella* (Treit.) and determine the heat units required for its activity.

Materials And Methods

1. Study locations

The present work was carried out on the arthropod fauna of cowpea plantation cultivated in two agro-ecological zones in Delta at Qaha, Qalubiya Governorate and Middle Egypt at Behimo, Fayoum Governorate. The locations are about 115 kilometers apart. Qalubiya Governorate lays in the middle Delta with wet temperate climate conditions whereas Fayoum Governorate located in Middle Egypt and closer to the desert area (Western Desert) as shown in Table (1) and Fig. (1).

Table (1). The coordinates of studied areas at Fayoum and Qalubiya Governorates

Study location	Longitude E	Altitude N
Qaha, Qalyubiya	**31° 10’ 36.69’’**	**30° 15’ 0.16’’**
Senouris, Fayoum	**30° 52’ 54.72’’**	**29° 24’ 24.25’’**

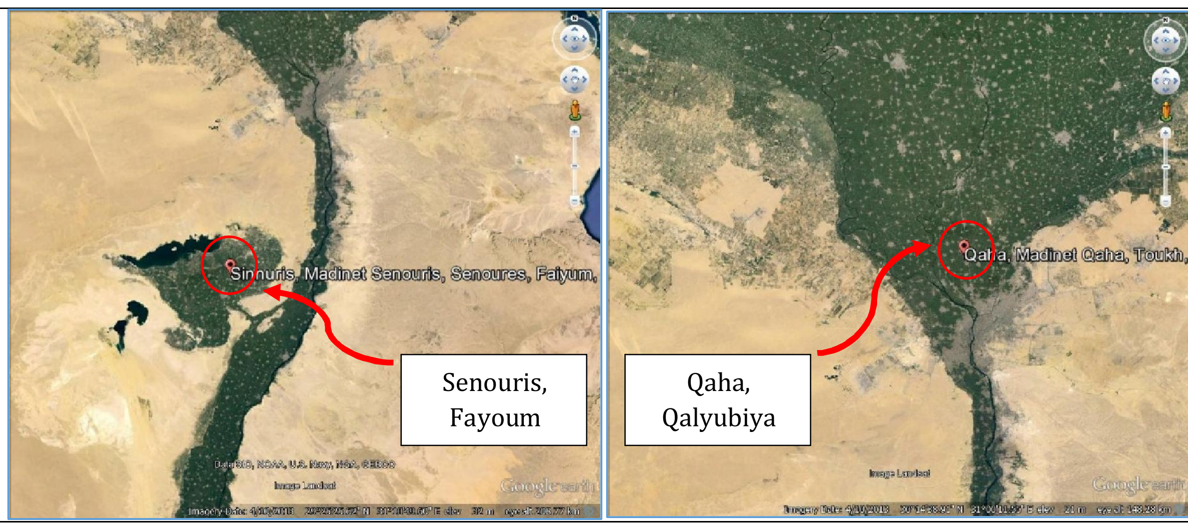


Figure (1): Maps of studied locations at Fayoum and Qalubiya Governorates, Data SIO, NOAA, U.S. Navy. Image landsate, Google Inc. Google Earth, 7.1.2.2041

2. Experimental designing

The field experiments were carried out for two successive seasons (2011 - 2012) cultivated with cowpea var. Kafr El-Sheikh at two locations in Fayoum and Qalubiya Governorates. The experimental area for each season (1750 m^2) was divided into five replicates (350 m^2 each). Cultivated plants were distributed in Randomized Complete Blocks Design (RCBD). The agricultural practices were carried out without using any chemical control measures during the studying periods.

3. Data collection

Survey the arthropod species and their associated predators in the two agro-ecological zones at Fayoum and Qalubiya Governorates and determined the dominance and abundance percentages of the surveyed arthropod species as well as conduct some ecological studies on the lima bean pod borer, *Etiella zinckenella* (Treit.) (Lepidoptera: pyralidae) and determine the relationship between the accumulated heat units and population density as methods of Van Der Waals *et al.,* (2013).

3.1 Arthropod pests and their associated predators in cowpea plantations

The collected samples from the two locations in Fayoum and Qalubiya Governorates were randomly taken weekly (20 days after plantation until harvesting) from the leaves and pods of cowpea plants (10/each replicate). The samples were transferred to the laboratory in paper bags for further examination by using a stereoscopic-microscope at the same day. The arthropod pests and their associated predators on cowpea plants were identified and counted for each sample.

3.1.1 Dominance and frequency (abundance) of arthropod species.

The dominance and frequency percentages of arthropod pests and their predators inhabiting cowpea plantations were determined by Balogh formula (Harde *et al.,* 1984) as follows:

$$D = \frac{a_1}{\sum a_i} \times 100$$

Where:

D= Dominance percentage

a_1= number of identified specimens of one species;

$\sum a_i$= total number of all collected specimens.

The frequency percentage was calculated by Balogh formula:

$$C_{a1} = \frac{U_{a1}}{\sum U_i} \times 100$$

Where C = frequency (abundance) percentage

U_{a1} = number of samples with identified species

$\sum U_i$ = total number of samples.

3.2 Ecological studies on the lima bean pod borer, *E. zinckenella*

Effect of daily mean temperature as day/night temperatures was used to determine its effect on the population fluctuation of *E. zinckenella* during two successive seasons (2011 - 2012) in the two agro-ecological locations at Qalubiya and Fayoum Governorates.

3.2.1 Climatic data

Climatic data (Table, 2) were obtained from the Central laboratory for Agricultural Climate as daily mean maximum and minimum temperatures for Fayoum and Qalubiya Governorates during the studying periods (2011-2012).

Table (2). Selected study areas, average mean and maximum values of temperatures for Qalubiya and Fayoum locations during studies periods of 2011 and 2012

Location / Month	Qalubiya Governorate				Fayoum Governorate			
	1st year (2011)		2nd year (2012)		1st year (2011)		2nd year (2012)	
	Min. Temp. °C	Max. Temp. °C	Min. Temp. °C	Max. Temp. °C	Min. Temp. °C	Max. Temp. °C	Min. Temp. °C	Max. Temp. °C
May	**22.0**	**30.1**	**24.3**	**31.7**	**24.3**	**31.7**	**24.3**	**33.0**
June	**25.1**	**32.8**	**26.4**	**33.6**	**26.3**	**33.6**	**29.4**	**38.4**
July	**26.9**	**34.3**	**28.0**	**34.8**	**28.0**	**34.8**	**32.7**	**41.8**
August	**27.4**	**33.8**	**27.4**	**34.3**	**27.6**	**34.4**	**32.4**	**41.5**
Grand average	**25.4**	**32.8**	**26.5**	**33.6**	**26.6**	**33.6**	**29.7**	**38.7**

3.2.2 Degree Day Units (DDU)

Degree Day Units (DDU) accumulations were calculated and used to confirmed the variability of population density of *E. zinckenell*. The thermal thresholds of *E. zinckenella* stages were collected throughout literatures (Etiella DDU method, SARDI 2014).

4. Data analysis:

The statistical analyses of the obtained data were carried out by using Minitab program (Minitab Inc. © 2009). Methodologies have been used to estimate the population density and patterns at disaggregated levels. Statistical modeling of accumulated degree day units over time series (day after planting) was represented as $y = f(x)$ where y is predicted population and x is **DDU** (Heat Units). Correlations between **(x)** and **(y)** were studied to significantly determine **($0.0 \leq R^2 \leq 1.0$)**. Linearized models form for predicted **(y)** and DDU **(x)** during the studied periods (2011-2012) in the two agro-ecological locations were used.

Results And Discussion

1. Arthropod fauna and their associated predators

Data in Table (3) showed the arthropod fauna of cowpea plantations and their associated predators in the two agro-ecological zones at Fayoum and Qalubiya Governorates. The obtained results revealed the same arthropod fauna and their associated predators in the two locations in the two seasons. The populations of the arthropod fauna and their associated predators were varied in the two seasons (2011- 2012) and two locations. The arthropod fauna include 9 insect species as well as *Aphis* spp. & *Liriomyza* spp. and one spider mite (*Tetranychus urticae*) associated with cowpea plantations as Arthropod pests. The associated predators were

Chrysoperla carnea; *Coccinella undecimpunctata*; *Scymnus interruptus* and *Orius* spp. as well as one unidentified species of true spider mite.

Order Heteroptera and Lepidoptera had the highest number of insect species (3 insect species/ each). The heteropteran species were *C. purureipennis*; *E. inconspicuus* and *N. viridula* from family Pentatomidae whereas the lepidopteran species were *E. zinckenella; H. armigera and L. boeticus* from families Lycaenidae; Noctuidae and Pyralidae, respectively. Order Hompoptera came in the third order with Aphidid species *(Aphis* spp.) and one Aleyrodid species (*B. tabaci*) followed by order Diptera with *Liriomyza* spp. from family Agromyzidae. The lowest insect orders were Hemiptera and Thysanoptera, each one presented with one species (*Empoasca kerri* & *Megalurothrips sjostedti*) as well as one spider mite (*Tetranychus urticae*) from order Trombidiformes and family Tetranychidae.

Table (3): The Arthropod fauna and their associated predators in cowpea plantations cultivated at Fayoum and Qalubiya Governorates during two successive seasons (2011- 2012).

Order	Family	Scientific name	Frequent	
			Qalubiya	Fayoum
Pests				
Heteroptera	Pentatomidae (Stink bugs)	*Carpocoris purureipennis* (De Geer) *Eysarcoris inconspicuus* (H. & S.) *Nezara viridula* (L.)	* * **	* * **
Hemiptera	Cicadellidae (Jassids)	*Empoasca kerri* (Pruthi)	***	***
Homoptera	Aphididae (Aphids)	*Aphis* spp.	***	**
	Aleyrodidae (Whiteflies)	*Bemisia tabaci* (Genn.)	**	***
Thysanoptera	Thripidae (Flour thrips)	*Megalurothrips sjostedti* (Trybom)	**	**
Lepidoptera	Pyralidae (Lima bean pod borer) Noctuidae (Gram pod borer) Lycaenidae (Blue butterfly)	*Etiella zinckenella* (Treit.) *Helicoverpa armigera* (Hüb.) *Lampides boeticus* (L.)	** ** ***	*** ** **
Diptera	Agromyzidae (Leaf miner)	*Liriomyza* spp.	***	**
Trombidiformes	Tetranychidae (Spider mite)	*Tetranychus urticae* Koch	*	**
Predators				
Hemiptera	Anthocoridae (Minute pirate bugs)	*Orius* spp.	**	*
Neuroptera	Chrysopidae (Green lacewings)	*Chrysoperla carnea* Stephens	***	**
Coleoptera	Coccinellidae (Ladybird beetles)	*Coccinella undecimpunctata* L. *Scymnus interruptus* Mars	***	**
Araneida	True spiders	Unidentified species	*	*

*** rare ** frequent *** abundant.**

El-Sayed (1993) recorded 16 insect pests; 8 arthropod predators and 8 parasitoid species associated with cowpea plantations in Minufiya Governorate. On the other hand, Amro (2004) recorded 15 arthropod species belonging to 9 families and 4 orders; 5 arthropod predators belonging to 4 families and 4 orders and unidentified true spiders in cowpea plantations in Assuit Governorate in the two seasons (2000/2001).

2. Dominance and frequency of arthropod pests

Data presented in Table (4) indicated the dominance and frequency (abundance percentages) of arthropod pests and their associated predators in cowpea plantations in Fayoum and Qalubiya Governorates. The dominance percentages of arthropod pests were relatively lower in Qalubiya Governorate (88.3 & 89.5%) than Fayoum Governorate (89.7 & 92.8%) in the two growing seasons (2011 & 2012). On the other hand, the dominance percentages of associated predators were lower in the two locations, it presented by 11.7 & 10.5% in Qalubiya Governorate and 10.3 & 7.2 in Fayoum Governorate during two successive seasons, respectively. The leafhoppers, *Empoasca* spp. had the highest dominance percentages followed by whitefly then lima bean pod borer. The rest of the herbivorous species were presented with lower dominance percentages. The predaceous species, *Chrysoperla carnea* and *Coccinella undecimpunctata* have the highest dominance percentages followed by heteropteran predators, *Orius* spp. Amro (2004) mentioned that, the investigation may be consider as a view on the relationship between the herbivorous cowpea insects and their associated predators which may be maintain their population densities so low that their effect on plant dynamics would be small. Bažok *et al.* (2013) emphasized that, sampling arthropod populations is a cornerstone of basic research on agricultural ecosystems and the principal tool for building and implementing pest management programs.

Table (4): The dominance percentages of the arthropod fauna and their associated predators on the cowpea plantations cultivated at Qalubiya and Fayoum Governorates during 2011 and 2012.

Arthropod pests and their predators	Qalubiya Governorate				Fayoum Governorate			
	Dominance %		frequency %		Dominance %		frequency %	
	2011	2012	2011	2012	2011	2012	2011	2012
Pests	**88.3**	**89.5**			**89.7**	**92.8**		
Carpocoris purureipennis	**0.20**	**0.27**	**44.2**	**43.2**	**0.09**	**0.10**	**40.0**	**0.00**
Eysarcoris inconspicuus	**0.58**	**0.91**	**6.54**	**0.0**	**0.65**	**0.67**	**0.52**	**0.32**
Nezara viridula	**0.70**	**0.94**	**100**	**33.2**	**0.67**	**0.69**	**1.20**	**0.0**
Empoasca kerri	**69.0**	**72.3**	**100**	**100**	**67.4**	**69.7**	**100**	**100**
***Aphis* spp.**	**3.02**	**3.65**	**89.3**	**100**	**3.44**	**3.56**	**80**	**75**
Bemisia tabaci	**8.80**	**9.33**	**100**	**100**	**10.3**	**10.6**	**100**	**100**
Megalurothrips sjostedti	**3.20**	**2.30**	**100**	**100**	**3.04**	**3.15**	**100**	**100**
Etiella zinckenella	**6.90**	**5.21**	**100**	**100**	**7.32**	**5.32**	**100**	**100**
Helicoverpa armigera	**3.32**	**4.11**	**60.5**	**100**	**2.39**	**3.71**	**90**	**90**
Lampides boeticus	**2.12**	**2.76**	**50.5**	**90**	**2.19**	**2.06**	**40**	**55**
***Liriomyza* spp.**	**2.30**	**0.23**	**95**	**90**	**3.89**	**2.64**	**20**	**50**
***Tetranychus* urticae**	**0.21**	**0.28**	**10**	**15**	**0.20**	**0.14**	**40.0**	**50.0**
Predators	**11.7**	**10.5**			**10.3**	**7.2**		
***Orius* spp.**	**19.2**	**15.7**	**80**	**45.0**	**19.1**	**11.2**	**75.0**	**60.0**
Chrysoperla carnea	**39.2**	**32.1**	**100**	**50.0**	**39.5**	**23.2**	**100**	**20.0**
Coccinella undecimpunctata	**29.9**	**42.6**	**90.0**	**85.0**	**29.2**	**47.3**	**45.0**	**50.0**
Scymnus interruptus	**1.90**	**1.56**	**50.0**	**35.0**	**1.81**	**2.92**	**40.0**	**20.0**
Unidentified species	**9.75**	**8.00**	**10.0**	**15.0**	**10.2**	**15.5**	**5.00**	**20.0**

The obtained results revealed the variability of insect population in the two different locations. *Empoasca Kerri* occurred during early season at both locations and more infestations occurred at Qalubiya compared with Fayoum Governorate. The high level of infestation at Qalubiya is indicative of the magnitude of damage to cowpea and its control would be required in the study area. In Japan, Kiritani (1971) reported that, the insects of tropical region such as the green stink bug, *N. viridula* L. and *C. purureipennis* are not often found in Northern regions even though one or two generations would be expected based on the temperature in summer. *N. viridula* is limited to the southern coastal area of Japan where it usually completes three generations a year, while a sibling species, *N. antennata* Scott, completes two generations a year and extends its distribution northward. The flower thrips, *M. sjostedti* occurred at both locations and were slightly more at Qalubiya than Fayoum Governorate. Similar results were observed for *E. zinckenella*. **Amro *et al.* (2007)** recorded high compatibility between the resistance status of the tested soybeans and the mean numbers of *E. zinckenella* individuals attacking the developing pods.

3. Ecological studies on *E. zinckenella*

The ecological studies on the lima bean pod borer, *E. zinckenella* include the effect of temperature fluctuation (day/night differences °C) on the different biological aspects of *E. zinckenella*. Also, calculation

DDU based on daily mean temperature (maximum and minimum) and thermal temperature of *E. zinckenella* (Etiella DDU method, Sardi 2014).

3.1 Population fluctuation

Data in Table (5) showed contrast differences for the population density of eggs and larvae of *E. zinckenella* in the two studied seasons. The eggs were recorded on the 2nd week of June for both locations in the two ecosystems with 19.8% and 7.7% increase in Fayoum than Qalubiya in 2011 and 2012, respectively. The larvae were appeared with few numbers during the mentioned period of June. The eggs of *E. zinckenella* peaked on 1st week of July whereas the larval population peaked during 3rd week of July for both seasons (2011 & 2012). Variation of larval population was 15.7% and 20.1% increase in Fayoum than Qalubiya in 2011 and 2012, respectively.

Table (5): Population dynamics of *E. zinckenella* at Qalubiya and Fayoum Governorates in the two growing seasons

Date	DAP*	Qalubiya Governorate		Fayoum Governorate	
		Eggs	Larvae	Eggs	Larvae
1st year (2011)					
12/6/2011	58	27	4	34	6
19/6/2011	65	133	11	171	15
26/6/2011	72	154	100	197	129
04/7/2011	80	182	129	211	168
12/7/2011	88	125	144	161	184
19/7/2011	95	31	252	43	323
Average		109	107	136	127
2nd year (2012)					
10/6/2012	56	33	5	47	6
20/6/2012	66	162	13	173	33
28/6/2012	74	187	122	199	149
06/7/2012	82	221	143	235	187
13/7/2012	89	152	175	163	223
22/7/2012	98	38	278	44	327
Average		132	123	143	154

* DAP is days after planting

3.2 Effect of fluctuation of daily mean temperatures on *E. zinckenella*

The fluctuation of daily mean temperatures (day/night differences) affected greatly on the population dynamics of *E. zinckenella*. The obtained results showed negative relation between temperature and insect population during the studied periods in the two locations.

Also, results revealed that, there were steady fluctuations in day/night temperatures for 2nd season (2012) compare with the 1st season (2011) in both agro-ecological locations. The fluctuation was highly contrasted in Qalubiya Governorate comparing with Fayoum Governorate (Fig., 2). The matching between temperature fluctuations and population dynamics of *E. zinckenella* indicated steady fluctuation lead to increase the population trends over periods and locations. Similar results were found by Prakasa *et al.* (1971) in India, they suggested that steady temperatures with the least fluctuations between maximum and minimum, coupled with average high relative humidity caused outbreaks of the rice hispa, *Dicladispa armigera* Olivier.

The role of climate as an exogenous factor determining abundance and distribution has attracted the attention of ecologists since the very origin of the discipline (Davidson and Andrewartha 1948; Birch 1957), but even recently few solid and parsimonious theoretical frameworks are available to examine the effect of climate on population dynamics. Because of this, the quest for generalizations and for developing adequate predictive process-based models of change remains difficult (Harrington *et al.* 2001).

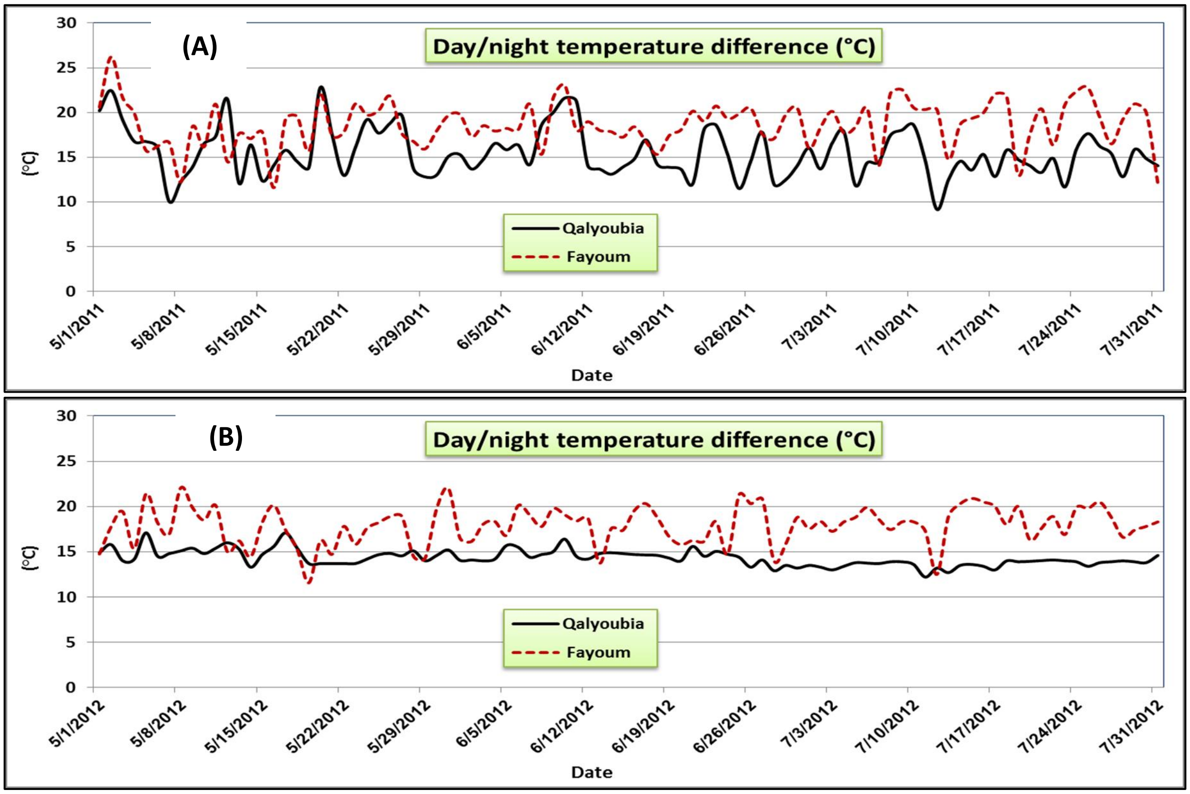


Fig. (2): Fluctuation of daily mean temperatures in the two different ecosystems at Qalubiya and Fayoum Governorates during the two successive seasons of (A) 2011 and (B) 2012.

3.3 Heat requirements (degree day units) for pod borer pest

3.3.1 Variation of heat units during different seasons and locations.

Table (6) summarized the degree day accumulations for *E. zinckenella* in the two ecosystems (Qalubiya and Fayoum Governorates) during two successive seasons (2011 & 2012). The thermal thresholds for insect stages were collected throughout literatures. Results indicated that, the calculated DDU for the studied pest confirmed the variability of insect population at the different locations and growing seasons. The insect population was highly in Fayoum Governorate in both seasons (2011 & 2012) return to high amount of heat units obtained during the studied periods. Differences in accumulated DDU (D°) between 1st and 2nd seasons were 12% and 22% respectively, increase in Fayoum than in Qalubiya. Degree day accumulations for *E. zinckenella* and the relationship between the population density and heat units were illustrated in Fig. (3). Results indicated positive relationships between accumulated DDU and the population densities in the two ecosystems (Qalubiya and Fayoum Governorate) during two successive seasons (2011 & 2012).

Table (6): Degree day accumulations for *E. zinckenella* at the two ecosystems in the two successive seasons.

Date	Qalubiya Governorate		Fayoum Governorate	
	2011	2012	2011	2012
1st May	9.82	13.85	12.63	13.98
1st June	384	459	505.63	486
1st July	854	953	1076.0	1055
31st July	1350	1495	1716	1744
Average	649	730	828	825

For effective control, there needs to be understanding pest interaction with its environment. This is so called concept of "life system" which was initially conceived by Clark *et al.* (1967) to reinforce the idea that population cannot be considered apart from the ecosystem with which it interacts. The life system consists of pest population plus its "effective environment". Most ecological pest management concentrates on the agro-ecosystem, defined as "effective environment" at the crop level (Altieri, 1994). Monitoring the insect pest management can be used to determine the geographical distribution of pests to assess the effectiveness of control measures but in its widest sense monitoring is the process of measuring the variables required for the development and use of forecast to predict pest outbreaks (Conway, 1984). Such forecasts are an important component of pest management strategies because a warning of the timing and extent of pest attack can improve the efficiency of control measures. For successful pest control according to the principles of IPM it is of great importance to have deep knowledge in harmful and beneficial arthropods in particular agro-ecological conditions.

The low of total effective temperature is not applicable when temperature fluctuates below or around the developmental threshold as mentioned by **Messenger (1959)**. **Hokyo (1971)** found that, the accumulated day degrees for *N. cincticeps* above 12.0 °C (tentatively fixed as the threshold for post-diapause development instead of 13.30 °C for non-diapausing development) from January 1, and 50 percent molting date of the overwintering fourth-instar nymph showed a clear linear regression.

3.3.2 Effect of DDU on the population density of *E. zinckenella*

The statistical analysis showed linear model (Fig.4) for the relationships between DDU and population density of *E. zinckenella* during two successive seasons. The population dynamics analyzed as a result of regression analysis for individual population trends and degree day accumulation which presented in the following equations:

$y = 2.48\,x + 614.9,\ R^2 = 0.9477$ ……... **(1)**

$y = 2.6234\,x + 708.54,\ R^2 = 0.947\ 7$ ... **(2)**

Where ***y*** is population density and ***x*** is DDU for *E. zinckenella* as presented in equations 1 and 2 for Qalubiya and Fayoum Governorates, respectively. Correlations between **(x)** and **(y)** were studied to determine which have big fluctuation correlated relationships. However, R^2 was high correlated which were **($0.908 \le R^2 \le 0.948$)**. The study has created new opportunities to study such effects by methodological developments and for dynamic program of integrated pest management under different ecological conditions in Egypt.

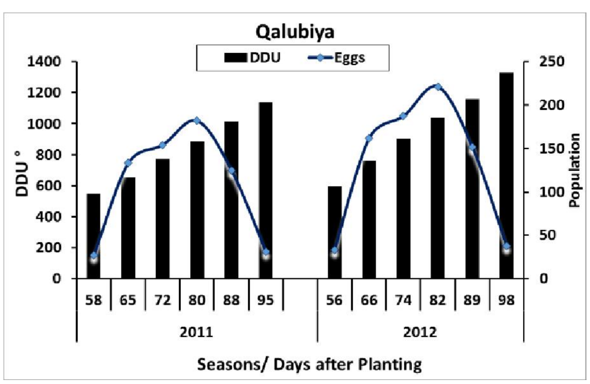
Conclusion

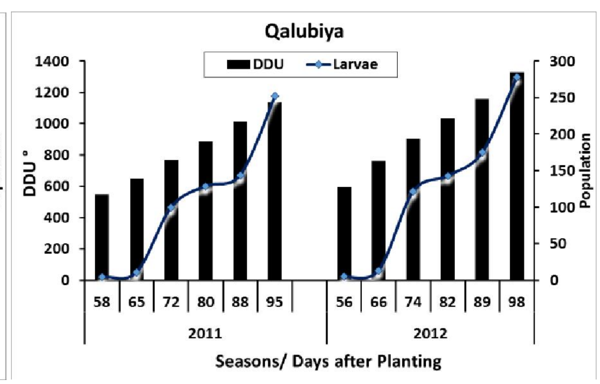
This high infestation level at Qalubiya Governorate is indicative of the magnitude of damage to cowpea and its control would be required in the study area. Investigation may be consider as a view on the relationship between the herbivorous cowpea insects and their associated predators which may be maintain their population densities so low that their effect on plant dynamics would be small.

Degree day units were explained the relationships between population densities in the two seasons in the two locations. In addition the study has created new opportunities to study such effects by methodological developments and for dynamic program of integrated pest management under different ecological conditions in Egypt.

Temperature conditions set the basic limits to insect distribution, and examples are given of distribution patterns in northeastern Asia in relation to temperature extremes and accumulation. The subject of pest control is rarely discussed without the reference to the concept of integrated pest management (IPM).

IPM is essentially a holistic approach to pest control that seeks to optimize the use of a combination of methods to manage whole spectrum of pests within particular cropping system. IPM relies heavily on biological controls with a perspective chemical input only as a last resort.





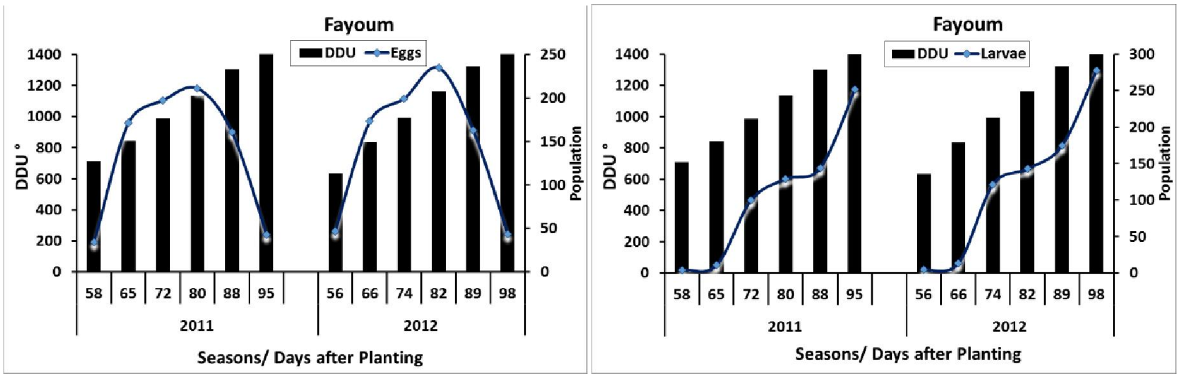


Fig. (3): The population fluctuations of eggs and larvae of *E .zinckenella* at two different ecosystems in Qalubiya and Fayoum Governorates during two successive seasons (2011 & 2012).

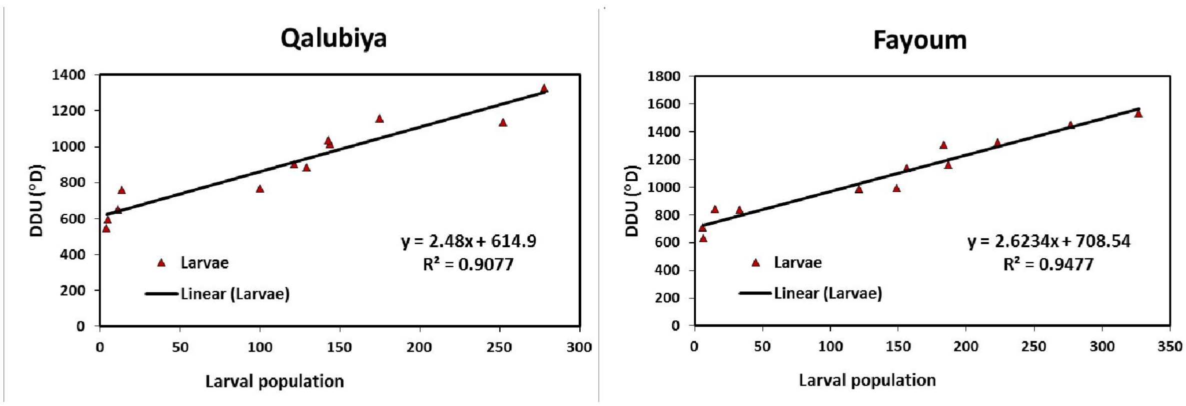


Fig. (4): Degree day accumulations for *E. zinckenella* and the relationship between heat units and the population density depending on thermal temperature thresholds.

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