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# Population fluctuations of the main pests infesting kidney beans and its relation with some weather factors

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**Abstract**

The present work was conducted during the two summer successive seasons, 2014 and 2015 to study the population fluctuations of the red spider mite *Tetranychus urticae* Koch, cow pea aphid *Aphis craccivora* Koch, American serpentine leaf miner *Liriomyza trifolii* (Burgess), cotton whitefly *Bemesia tabaci* (Genn.), potato leafhopper *Empoasca decipiens* (Paoli), cotton thrips *Thrips tabaci* L. and cotton aphid *Aphis gossypii* Glover infesting kidney bean plants at Abo Hammad district, Sharkia governorate, Egypt. The aforementioned pests were collected by two different methods from kidney bean plantation using plant samples and sweeping net. The obtained results showed that the plant samples proved to be the best method to investigate mite, aphids, leaf miner (larvae), whitefly and thrips pests, while sweeping net proved to be the best technique to investigate the potato leafhoppers. The seasonal abundance of *T. urticae* and *L. trifolii* showed three peaks of population density, while the results of *A. craccivora, B. tabaci, E. decipiens* on kidney bean plants showed two peaks of population density during two seasons. On the other hand *T. tabaci* recorded one peak of population density. Regarding to the effect of mean temperature and atmospheric relative humidity as well as their total combined effect on the numbers of certain investigated pests, it is obvious that the effect was clear.

**Key Words:** Population fluctuations, *Tetranychus urticae* Koch, *Aphis craccivora* Koch *Liriomyza trifolii* (Burgess), Kidney beans (*Phaseolus vulgaris* L.).

## Introduction

Kidney bean (*Phaseolus vulgaris* L.) is considered one of the most important leguminous vegetable crops in Egypt. It has a great economic importance because of its use for local and global trading. It occupies the second grade in export among the legume crops, according to the report of the Department of Agricultural Economy, Ministry of Agriculture **(2003)**. Green beans have been reported to contain 6.2% protein, 0.2% fat, and 63% carbohydrate **(Sandsted, 1980**) while kidney bean seeds are rich in A, B and D vitamins, and protein content of between 17–35% **(Piha & Munns, 1987)**.

In Egypt kidney bean usually infested by different pests that cause considerable damage in both quantity and quality of pods, viz, aphids, leaf miner, leafhoppers, thirps and red spider mite which causes serious damage to plant and subsequently yield (**Schuster and Everett, 1983; Parrella *et al*., 1985; Abd El-Gawwad, 2008 and Saleh, 2011**). This study aimed to evaluate the population fluctuations of the main pests infesting kidney beans (*Phaseolus vulgaris* L.) and also study the combined effects of principle climatic factors on tested pests and utilize the obtained results in developing the integrated pest management (IPM) programs against these pests on kidney bean plants through the effect of both temperature and relative humidity on these pests.

## Materials and Methods

These experiments were carried out during two growing summer seasons of kidney bean plants (2014 and 2015). An experimental area of about 1/4 faddan was divided into three replicates (each replicate about 350 $m^2$). An experimental area was designed according to a complete randomized block design and sown by kidney bean seeds (*Phaseolus vulgaris* L.) variety Giza- 6 on 1st week of March at Abo Hammad district, Sharkia governorate, Egypt. Two different sampling techniques for investigating of the main infesting kidney bean plants were used when the age of plants reached about 21 days and continued weekly throughout the growing season until the second week of June. These points were studied as followed by:

**1- Sampling techniques**

- **Plant samples:** samples of 25 leaves were picked at early morning randomly at weekly from each replicate representing the different plant levels. Samples were put in paper bags and transferred to the laboratory in the same day for examination and counting the number of each investigated pest by aid of stereoscopic microscope. A simple apparatus was used for counting aphid populations, which was consisted of a wooden box, a white cardboard paper divided into 3 cm apart columns, was put in the bottom, on which a glass plate was placed and the upper surface of the glass plate was allowed to be wet with fine droplets of water to reduce the movement of counted aphids. The leaves were carefully shaken on the plate and the aphid insects were counted, using a small brush, in each column **(Abd Allah, 1984; Hegab *et al.*, 1987 and Hashem, 2005)**.

- **Sweeping net:** To evaluated population fluctuation activity, a sweeping net technique was applied. For this purpose a sweeping net 35cm diameter and 60cm in depth of the conical fine muslin and a long wooden handle (1.6m) was used. Each sample represented by 100 double strokes taken weekly from each replicate both diagonal directions randomly of the experimental area. Sweeping net was the best technique to investigate the potato leafhoppers. Captured insects were transferred in well tied plastic sacs to the laboratory for examination and counting.

**2- Influence of daily mean temperature and relative humidity on the seasonal abundance of the main pests of kidney bean plants:-**

The daily mean of minimum, maximum temperature and relative humidity were obtained from the Meteorological Department of the Agricultural Research Station at Sharkia governorate. Records of these factors were recalculated to get the daily averages within a week corresponding with sampling dates. The total numbers were registered and the number mean, peaks of different pests were calculated. The obtained data were statistically analysis by simple correlation (r), the partial regression (b) and coefficient of determination (C.D.) were calculated between each of temperature, relative humidity (R.H %) and the weekly numbers of these pests according to **Fisher (1950) and Snedecor (1966).**

**Results and Discussion**

**1. The main pests attacking kidney bean(*Phaseolus vulgaris* L.) plants:-**

The obtained data in Table (1) recorded the main pests during two successive summer seasons 2014 and 2015. A total number of 4131.92 individuals/ 25 leaf which represented by four order, six family, six genera and seven species. Restricted identification and counting of the genera and species during 2014 and 2015 proved to include the red spider mite, *T. urticae* Koch total numbers of 1028.97, 777.64 individuals/25 leaf and cow pea aphid, *A. craccivora* Koch total numbers of 694.25, 523.26 individuals/25 leaf, American serpentine leaf miner, *L. trifolii* total numbers of 211.28, 178.96 individuals/25leaf, the cotton whitefly, *B. tabaci* immature stages 101.97 and 88.97 individuals/25leaf, potato leafhopper *E. discipiens* of 214.92, 142.6 individuals/25leaf, the cotton thrips, *T. tabaci* L. of 64.3 and 47.29individuals/25leaf and cotton aphid *A. gossypii* of 30.94 and 26.57 individuals/ 25leaf, respectively. These results are in agreement with those obtained by **Abo-zaid (2011)** who showed that the main pests infesting green bean plants during three successive seasons 2008, 2009 and 2010 in summer plantation were *T. urticae* which the most abundant pest in first season, followed by *L. trifolii, A. craccivora, B. tabaci, E. discipiens*.

**Table 1**. Total number of the main pests recorded on kidney bean plants during summer seasons, 2014 and 2015 at Abo Hammad district, Sharkia governorate, Egypt.

| Pest species | 2014 | | 2015 | | General total numbers |
|---|---|---|---|---|---|
| | Plant samples | Sweeping net | Plant samples | Sweeping net | |
| *T. urticae* | 1028.97 | - | 777.64 | - | 1806.61 |
| *A. craccivora* | 668.95 | 25.3 | 506.96 | 16.3 | 1217.51 |
| *L. trifolii* | 211.28 | - | 178.96 | - | 390.24 |
| *B. tabaci* (immature stages) | 101.97 | - | 88.97 | - | 190.94 |
| *E. decipiens* | 76.97 | 137.95 | 49.63 | 92.97 | 357.52 |
| *Thrips tabaci* | 64.3 | - | 47.29 | - | 111.59 |
| *A. gossypii* | 27.64 | 3.3 | 22.28 | 4.29 | 57.51 |
| Total | 2180.08 | 106.55 | 1671.73 | 70.54 | 4131.92 |

**2.Population abundance of the main pests attacking kidney bean plants:-**

**a) The red spider mite, *T. urticae* Koch**

Data presented in Table (1) indicated that total numbers of 1028.97 & 777.64 individuals were recorded during season 2014 and 2015, respectively. Fig. (1,2) showed the activity period of *T. urticae* had three peaks, the first one occurred in the 2nd week of April with the mean number of 29.66 and 16.66 individuals / 25leaf at the mean of 19. 4 ºC., 17.3 ºC. with 64.7% and 66.7% R.H. for the two seasons of study, respectively. The second peak occurred in the fourth week of April with the mean number of 52.33 and 30.33 individuals / 25leaf at the mean of 18.4 ºC., 18.1 ºC. with 65.6% and 60.9% R.H. for the two seasons, respectively. While the third peak occurred in the first week of June with the mean number of 381and 307.66 individuals/ 25leaf at the mean of 24.9 ºC., 25.7 ºC. with 57.0% and 57.1% R.H. for the two seasons. These results are in agreement with that obtained by **Abdel- Gawwad (2004)** who showed that the population density of *T. urticae* was the main pest within Tetranychidae Family infesting common bean plants.

**b) The cow pea aphid, *A. craccivora* Koch:**

As shown in Fig. (1,2) the population density recorded two peaks the first one occurred in the third week of April (252.66 and 175insects /25leaf) at the mean of 19.4 ºC., 16.2 ºC. with 64.7% and 69.0% R.H. while, the second one occurred in the fourth week of May (48.33 and 32.66 insects / 25 leaf) at the mean of 25.0 ºC., 25.3 ºC. with 59.0% and 59.4% R.H. for the two seasons, respectively. These results agree with the findings of **El -Gindy (2002) and Hashem (1997)** who mention that both of *A. craccivora* and *A. gossypii* has two generations of bean plants.

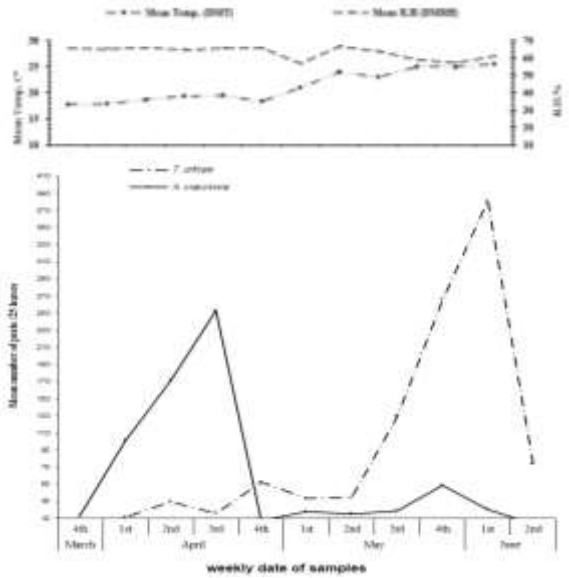


**Fig. (1)** :Population density of *T. urticae* and *A. craccivora* infesting kidney bean plants using plant samples method during summer season 2014 at Sharkia governorate.

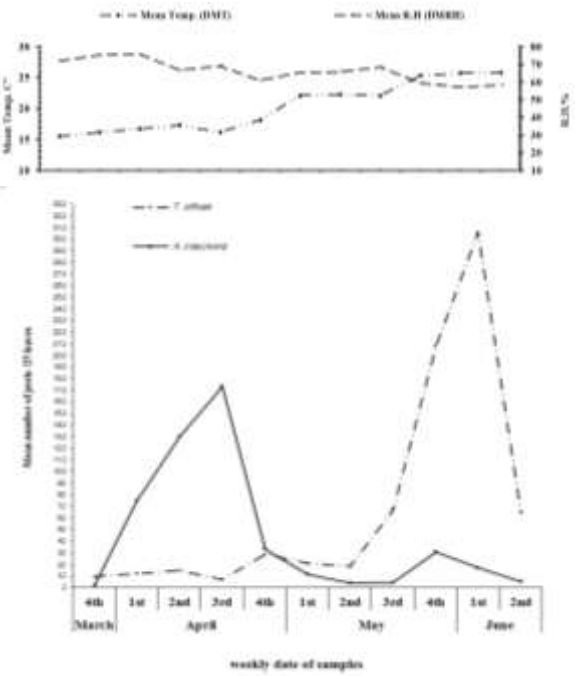


**Fig. (2)** :Population density of *T. urticae* and *A. craccivora* infesting kidney bean plants using plant samples method during summer season 2015 at Sharkia governorate.

**c) The American serpentine leaf miner, *L. trifolii* (Burgess)**

Data in Fig. (3,4) revealed that the population of *L. trifolii* was higher during the first season than the second one, the population density recorded three peaks. The first one occurred in the 2nd week of April with the mean number of 24.33 and 21.33 larvae/ 25 leaf at the mean of 19.4ºC., 17.3 ºC. with 64.7% and 66.7% R.H. for the two seasons, respectively. The second peak occurred in the first week of May with the mean number of 32.33 and 27 larvae / 25leaf at the mean of 21.0 ºC., 22.1 ºC. with 56.7% and 64.4% R.H. for the two experimented seasons, respectively. While the third peak occurred in the first week of June with the mean number of 30.66 and 25 larvae / 25leaf at the mean of 24.9 ºC., 25.7 ºC. with 57.0% and 57.1% R.H. for the two seasons. These results are in agreement with those obtained by **Abd El-Gawwad (2008)** who indicated that the mean number of *L. trifolii* population on kidney bean plants reached its maximum on April during the two seasons (2005 and 2006) in the summer plantation.

**d) The cotton whitefly, *B. tabaci* (immature stages)**

Two peaks were recorded for the population density. The first one occurred in the first week of May with the mean number of 15 and 12.66 insects / 25 leaf at the mean of 21.0 ºC., 22.1 ºC. with 56.7% and 65.4% R.H. The second peak occurred in the first week of June with the mean number of 21.33 and 17 insects / 25leaf at the mean of 24.9 ºC., 25.7 ºC. with 57.0% and 57.1% R.H. for the two seasons, respectively, in Fig. (3,4). These results agree with the findings of **EI-Sayed *e t al.* (1991)** who showed that high rate of infestation with *B. tabaci* immature stages on bean leaf in all plantations (early summer, summer and winter). Also **El-Khayat *et al.* (1994)** estimated the relative population density of *B. tabaci* stages on leaves of summer vegetable crops at two locations in Qalubiya Governorate (Moshtohor and, El-Kanater ElKhaireia).

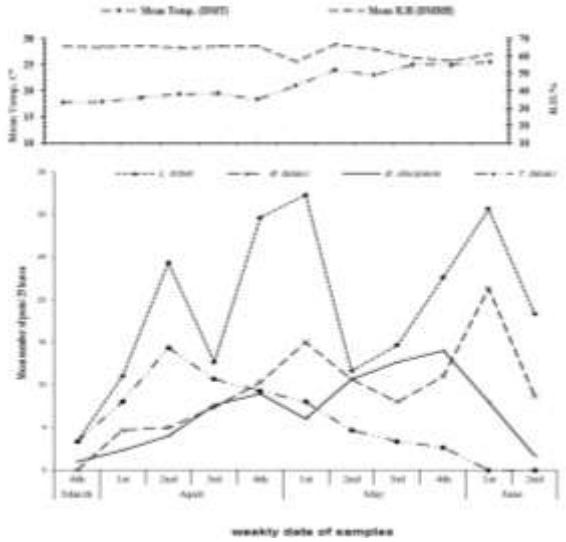

**Fig. (3)** :Population density of *L. trifolii* , *B. tabaci* , *E. discipiens* and *T. tabaci* infesting kidney bean plants using plant samples method during summer season 2014 at Sharkia governorate.

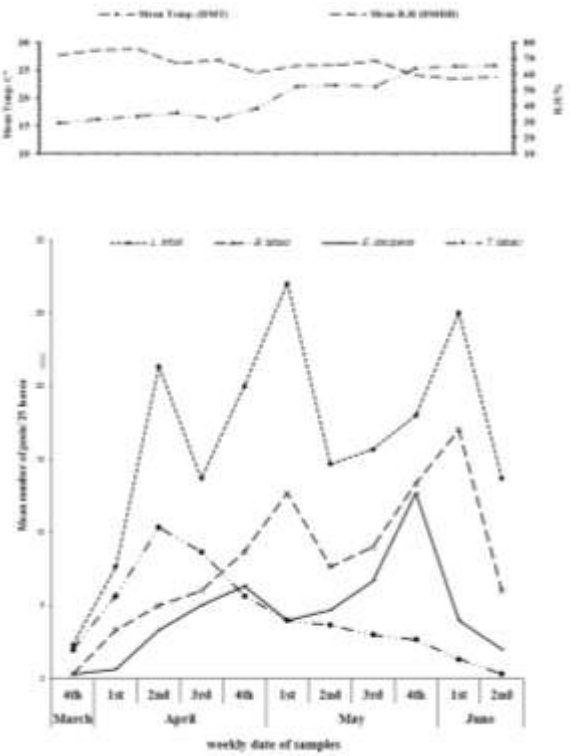


**Fig. (4)** :Population density of *L. trifolii* , *B. tabaci* , *E. discipiens* and *T. tabaci* infesting kidney bean plants using plant samples method during summer season 2015 at Sharkia governorate.

**e) The potato leafhopper, *E. decipiens***

Data of the seasonal population abundance of *E. decipiens* on kidney bean plants in 2014 and 2015 are shown in Fig. (3,4). Two peaks of population density were recorded for *E. decipiens*. The first one occurred at the fourth week of April with a mean number of 9 and 6.33individuals/sample at mean of 18.4 ºC, 18.1ºC with 65.6% and 60.9% R.H. for the two seasons, respectively. The second peak occurred at the fourth week of May with a mean number of 14 and 12.66 individuals/sample at a mean of 25.0 ºC and 25.3 ºC with 59.0 % and 59.4 % R.H. for the two seasons respectively. These results agree with the findings of **Mahmoud *et al.* (2011)** who studied population fluctuation of the leafhopper, *E. decipiens* (Paoli) on some plantations (broad bean, green bean, pea, lupine, potato and squash) during winter season 2008-2009 at El-Kanater El-Khairia farm, Kalubia Governorate. The data indicated that *E. decipiens* had two peaks during its winter activity.

**f) The cotton thrips, *T. tabaci* :**

The population density recorded one peak the occurred in the second week of April with the mean number of 14.33 and 10.33 insects / 25leaf at the mean of 19.4 ºC., 17.3 ºC. with 64.7% and 66.7% R.H. in Fig. (3,4). These results are in agreement with those obtained by **Amaar *et al.* (2014)** who surveyed the most pests infesting green bean plants during 2011&2012 growing seasons at Qalubiya governorate and recorded that *T. tabaci* as one of the main insect pests of these plants. In conclusion, the heaviest infestation levels of the studied pests on kidney bean plants coincided with temperature and relative humidity.

**3) Influence of daily mean temperature (DMT) and relative humidity (DMRH) on the activity of the main pests:**

Data presented in Table (2) showed the simple correlation (r), simple partial regression (p) coefficients and coefficient of determination (C.D.) for relationship between the daily mean temperature (DMT), daily mean relative humidity (DMRH) and the main pests activity attacking kidney bean plants during the two successive seasons 2014 and 2015.

**a)** ***T. urticae*** : The effect of (DMT) on the activity of *T. urticae* had significant positive ($r_1$ = 0.6701* and 0.7082*) during 2014 & 2015 respectively. On the other hand, the relationship between (DMRH) and the mean number of this pest had significant negative effect in both seasons ($r_2$ = -0.6631* and -0.6559*) during 2014 & 2015 respectively. The coefficient of determination percentage (C.D.%) of relationship between these ecological factors were responsible as both of 56.88 % and 52.7 % effects on the populations of *T. urticae* throughout both seasons, respectively in Table(2). These results are in disagreement with those obtained by **Amaar *et al.* (2014)** revealed that minimum, maximum temperature had insignificant negative effects on seasonal fluctuation of *T. urticae* during 2011, but in the second season recorded significant negative effects for the tested factors, respectively. While the mean percentages of relative humidity had insignificant positive effect in both seasons.

**b)** ***A. craccivora***: These results in Table (2) revealed insignificant positive and negative effects of (DMT) on the mean number of *A. craccivora* population throughout both seasons where ($r_1$ = 0.3974 and -0.5895) during 2014 and 2015, respectively, while (DMRH) had insignificant positive effect in both seasons where ($r_2$ = 0.3397 and 0.2673) respectively. The combined effect (C.D. %) of these ecological factors on *A. craccivora* showed that these factors were responsible as both of 17.77 % and 44.94 % throughout both seasons, respectively. Similar trends were found by **Ali *et al.* (2013)** who studied the effect of maximum, minimum temperature and mean relative humidity on the population density of *A. craccivora* on bean and cowpea plants and found that highly positive significant correlation between population of *A. craccivora* and maximum, minimum temperature and mean relative humidity.

**c)** ***L. trifolii***: The obtained results appeared that the correlation coefficient between population density of *L. trifolii* and mean temperature was positive and insignificant ($r_1$= 0.2341 and 0.4674) in the two seasons, respectively (Table, 2). Whereas, the effect of relative humidity was negative and significant ($r_2$ = -0.6518*and -0.6815*) in the two successive seasons, respectively. The C.D. % of these ecological factors

was responsible as both of 45.05 % and 47.7% throughout both seasons, respectively.These results are in disagreement with those obtained by **Saradhi and Patnaik (2004)** studied the correlation of the serpentine , *L. trifolii* revealed that diurnal temperatures variation were negatively correlated.

**d)** ***B. tabaci*** : Statistical analysis (Table, 2) revealed that the fluctuation of the immature stage *B. tabaci* populations were insignificant and significant positive correlated with (DMT) where ($r_1$ =0.5974 and 0.7307*) during 2014& 2015 respectively. While (DMRH) showed had significant and highly significant positive and negative correlation where ($r_2$ = 0.7232* and -0.7463**) in both seasons of study, respectively. The C.D. % of these ecological factors were responsible as both of 57.62 % and 61.09 % throughout both seasons, respectively. These results are in agreement with those obtained by **Jesus *et al.* (2009)** observed a negative and non significant linear correlation between average temperatures of whitefly population.

**e)** ***E. decipiens*** : In Table (2) the correlation coefficient between population density of *E. decipiens* and mean temperature was positive and insignificant ($r_1$ = 0.4441 and 0.4209) in two seasons respectively. But the correlation coefficient between population density and relative humidity was negative and insignificant ($r_2$= -0.1296 and -0.5063) during 2014 and 2015 seasons, respectively. The C.D. % of these ecological factors were responsible as both of 21.84 % and 25.76 % throughout both seasons, respectively. Similar trends were found by **Abd- Elsamed *et al.*(2011)** who indicated that the correlation coefficients between maximum, minimum temperature, relative humidity and the *E. decipiens* population ,which infesting soybean plants at Diarb – Nigm district, Sharkia governorate during two successive seasons 2009 and 2010, were positively insignificant, significant and highly significant during the two seasons of 2009 and 2010.

***T. tabaci*:** The correlation coefficient between population density of *T. tabaci* and mean temperature was positive and significant ($r_1$ = 0.7210* and 0.7054*) in two seasons, respectively. But, the relative humidity was positive and insignificant ($r_2$= 0.4588 and 0.3502) during 2014 and 2015 seasons, consecutively. The C.D.% of these ecological factors were responsible as both of 52.41 % and 60.85 % throughout both seasons, consecutively in Table (2). These results are in agreement with those obtained by **Waiganjo *et al.* (2008)** who studied the correlation coefficients between environmental data included daily minimum, maximum atmospheric temperature, relative humidity and *T. tabaci* population, which infesting onion plants at Kenya, where results showed that the temperature had a positive correlation with thrips population and relative humidity (minimum and maximum) established significant negative correlation with thrips population increase**.**

**Table 2**. Effect of daily mean temperature (DMT) and relative humidity (DMRH) on the population of the main pests on kidney bean plants during summer seasons, 2014 and 2015 at Abo Hammad district, Sharkia governorate.

| Pests | Simple correlation coefficient | | | | Partial regression coefficient | | | | C. D. % | |
|---|---|---|---|---|---|---|---|---|---|---|
| | $r_1$ | | $r_2$ | | $p_1$ | | $p_2$ | | | |
| | 2014 | 2015 | 2014 | 2015 | 2014 | 2015 | 2014 | 2015 | 2014 | 2015 |
| *T. urticae* | 0.6701* | 0.7282* | -0.6631* | -0.6559* | 0.0241 | 0.0147 | 0.0261 | 0.0284 | 56.88 | 52.70 |
| *A.craccivora* | 0.3974 | -0.5895 | 0.3397 | 0.2673 | 0.2261 | 0.0563 | 0.3066 | 0.4267 | 17.77 | 44.94 |
| *L. trifolii* | 0.2341 | 0.4674 | -0.6518* | -0.6815* | 0.4883 | 0.1472 | 0.0298 | 0.0209 | 45.05 | 47.70 |
| *B. Tabacc*i (immature stages) | 0.5974 | 0.7307* | 0.7232* | -0.7463** | 0.0523 | 0.0106 | 0.0119 | 0.0083 | 57.62 | 61.098 |
| *E. decipens* | 0.4441 | 0.4209 | -0.1296 | -0.5063 | 0.1711 | 0.1972 | 0.7039 | 0.1120 | 21.84 | 25.76 |
| *T. tabaci* | 0.7210* | 0.7054* | 0.4588 | 0.3502 | 0.0123 | 0.0153 | 0.1558 | 0.2910 | 52.41 | 60.85 |

**($r_1$)** simple correlation coefficient between pest population and mean temperature.
($r_2$) simple correlation coefficient between pest population and mean relative humidity.
($p_1$) partial regression coefficient between pest population and mean temperature.
($p_2$) partial regression coefficient between pest population and relative humidity.
**(C.D.)** coefficient of determination.
* significant
** highly significant

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## تقلبات التعداد لأهم الآفات التى تصيب الفاصوليا وعلاقتها ببعض العوامل الجوية.

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أجريت هذه الدراسة خلال موسمى الزراعة الصيفية ٢٠١٤ و ٢٠١٥ فى منطقة أبوحماد – محافظة الشرقية لدراسة تقلبات التعدادلأهم الآفات التى تصيب نباتات الفاصوليا وهى كالتالى:

أكاروس العنكبوت الأحمر *T. urticae* و من اللوبيا *A. craccivora* و صانعة أنفاق الأوراق *L. trifolii* وذبابة القطن البيضاء *B. tabaci* ونطاطات أوراق البطاطس *E. decipiens* وتربس القطن *T. tabaci* وأخيرا من القطن *A. gossypii* . تم حساب تعداد تلك الآفات باستخدام طريقتين لجمع الحشرات و هما العينات النباتية و شبكة جمع الحشرات و أوضحت النتائج أن طريقة العينات النباتية هى الأفضل فى جمع الأكاروس و صانعة الأنفاق و المن و الذبابة البيضاء و التربس بينما شبكة جمع الحشرات كانت الأفضل فى جمع نطاطات الأوراق. كما تم دراسة الوفرة الموسمية للآفات تحت الدراسة و لوحظ أن أكاروس العنكبوت الأحمر و حشرة صانعة الأنفاق لهما ثلاث قمم نشاط بينما من اللوبيا و ذبابة القطن البيضاء و نطاطات أوراق البطاطس سجلوا قمتى نشاط خلال موسمى الدراسة كما سجل تربس القطن قمة نشاط واحدة خلال موسمى الدراسة. وكذلك تم دراسة تأثير كل من متوسط درجة الحرارة وكذلك الرطوبة النسبية على تعداد هذه الآفات وقد أوضحت النتائج أن التأثير كان واضحا بالنسبة لعاملى الحرارة و الرطوبة النسبية .