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Effect of Faba Bean Weeds on The Population of Cowpea Aphid *Aphis craccivora* (koch.) And it's Associated Predatory Insects

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ABSTRACT

These trial was carried out to study the influence of weed cover on population abundance of *Aphis craccivora* (Koch.) (Hemiptera: Aphididae) and its associated predatory insects in faba bean fields during two successive growing seasons (2012/13 and 2013/14). The population abundance of cowpea aphid *A. craccivora* in weedy fields of faba bean reached the highest (99.25 and 93.75 individuals) populations during the two successive seasons, respectively. While, in free weedy fields, the highest populations of *A. craccivora* were 32.75 and 51.25 individuals during the two years, respectively. Results of statistical analysis showed that there was a significant difference in the average number of *A. craccivora* between weedy and free-weedy fields in the first and second seasons of plantation with the highest averages in weedy fields. The main predatory insects associated with *A. craccivora* in weedy faba bean fields or free weedy fields were *Chrysoperla carnea* (Steph.), *Coccinella undecimpunctata* L., *Paederus alferii* Koch., *Scymnus syriacus* Muslant and *Orius laevigatus* (Fiber). Weeds almost had significant effect of the number of observed predatory adults in faba bean fields. Further, the number of attracted predators to faba bean plants differed significantly in weedy fields during both seasons, but did not in free-weedy fields specifically in the first season.

Keywords: Faba bean, free-weed fields, weedy fields, population abundance

INTRODUCTION

The Faba bean, *Vicia faba* L. is one of the most important leguminous crops in Egypt. It is considered a main source of food for the mankind and its domestic animals, where it contains a great proportion of proteins (28%) and carbohydrates (58%) in addition to many vitamins and other nutrients (Mahmoud *et al*., 1996). It plays also an essential role in improving the soil as it fixes nitrogen by amount of 45-552 Kg/h, which influences the following crop in a rotation.

Several serious insect pests attacking faba bean crop involving the plant lice and aphids. In the recent years, the yield of faba bean affected widely by attack of aphids which play an important role in transmitting virus diseases, that cause a considerable loss to the quantity and quality of the crop yield (Jackai, 1995; Mohamed and Slman, 2001; Ward *et al*., 2002). One of the most injurious insect pests attacking leguminous crop is the cowpea aphid, *A. craccivora* (Soliman, 2004). The population of *A. craccivora* on faba bean plants is fluctuated from season to season due to climatic conditions and rising in water table and crop rotation (El-Defrawi *et al.,* 1994; Abdel-Samad and Ahmed, 2007).

Absent of refuge for natural enemy through times of heat, coldness, rainfall, or chemical applications is highly deleterious to its survival. Availability of suitable habitats may foster searching, resting, overwintering, or nesting of natural enemies. Resting and aggregations of many natural enemies during winter are often noted in crop fields. Ideal places for such aggregations differ between species, and include grassy and woody plants (Beane and Bugg, 1998). Traditionally, weeds are reported as unsuitable plants, competing with main crops, and harboring insect pests and plant pathogens resulting in crop yield reduction (van Emden, 1965; Thresh, 1981). In the presence of weeds, however, pest populations associated with the crop are reduced in many agricultural systems.

Existence or lack of some weeds may participate to minimize insect populations in crops (White and Whitham, 2000). Accordingly, weed management strategies can influence insects and vice versa. The reduction in cowpea density, flowers, pods and grain yields was related to plots in that weeds and insect pests were not successfully controlled (Akinyemiju and Olaifa, 1991). Evidences from several studies revealed that the non-cropped habitats adjacent to or within the crop fields could play an essential function in increasing natural enemies' populations and conserving their diversities in agroecosystems (Gurr *et al*., 2003; Bianchi *et al*., 2006; Tscharntke *et al*., 2007; Griffiths *et al*., 2008; Gardiner *et al*., 2009; Werling and Gratton, 2010; Woodcock *et al*., 2010). For examples, Ostman *et al.* (2001) mentioned that the growth of aphid was faster in conventional than organic farms, and fields established in landscapes with extra field margins extradited more biological control benefits. The fall armyworm *Spodoptera frugiperda* (Smith) (Lepidoptera: Noctuidae) larvae was highly attacked to Maize plants that grown in the USA and Colombia when cultivated as a single crop in comparison to that hosted weeds (Altieri, 1980). Plant diversity therefore increases shelters, alternative prey and food resources availabilities for natural enemies. Accordingly, plant diversity is perceived as a means for minimizing grower reliance on chemical measures, and thus optimizing the biological pest control impacts (Altieri and Whitcomb, 1979; Dent, 1991; Gurr and Wratten, 1999). Thus, it is essential to observe that, the weeds are one of the main sources affecting the population of natural enemies of aphids by providing predators with oviposition sites and food sources, consequently the lower aphid population were recorded in weedy fields (Smith, 1976; Edward *et al.,* 1979; Dedryver, 1983). Therefore, the current work aims to evaluate the effect of weeds on the abundance of cowpea aphid, *A. craccivora* and its associated predatory insects on faba bean fields.

MATERIALS AND METHODS

The trials were conducted to evaluate the effect of weed cover on population of *A. craccivora* and its predators inhibiting faba bean during two successive growing seasons. The faba bean, *Vicia faba* L. cultivar

Sakha 1 was cultivated in the beginning of November for both seasons (2012/13 and 2013/14), samples were taken 15 days after cultivation and continued weekly till the end of the harvesting time. A sample of 25 leaflets was randomly chosen from each replicate. The number of nymphs and adults was directly counted and recorded in the field. Five plants were chosen at random from each replicate, monitored, and the numbers of the adult predators were monitored and recorded in the field. To study the influence of weed cover on the population abundance of *A. craccivora* and its associated predators on faba bean field, trials were designed in Sidi-Salem district, Kafr El-Sheikh Governorate. For each crop species, an area of approximately 600 m^2 was divided into two strips, each was 300 m^2. Each strip was divided to four replicates, each was 75 m^2. In the first strip, weeds were mechanically removed once germinated (≈ every two weeks), while the second one was left neglected. All weeds appeared in faba bean field were classifield (Table 1). All agricultural practices regarding timing of plantation, varieties, and sampling technique was followed as recommended. The number of aphids and its associated predators were counted in each trial.

Populations of cowpea aphid and its predatory insects were statistically compared between both weedy and free-weedy fields in each growing season using *t*-test. Further, populations of all observed predators were analyzed in each field type, i.e. weedy or free-weedy, in each growing season using one-way ANOVA. Prior to ANOVA, data were tested for assumptions of normality (Shapiro–Wilks test) and equality of variance (Levene's test). Means were separated by the Bonferroni test (α = 0.05).

Table (1): The weed species appeared in Faba bean field during the season of study.

No.	Common name	Scientific name
1	Milk thistle	*Sonchus asper* (L.)
2	Garden sorrel	*Rumex dentatus* (L.)
3	Leaf Beet	*Beta vulgaris* (L.)
4	Blue Mallow	*Malva parviflora* (L.)
5	California Bur Clover	*Medicago polymorpha* (L.)
6	Annual Rabbit	*Polypogon monspeliensis* (L.)

RESULTS

1. Effect of weeds on the population of cowpea aphid and its insect predators

***Aphis craccivora* (Koch.)**

Data presented in Figure (1) showed that, during the first year of the study (2012/13), the population of cowpea aphid started to increase gradually after plantation to record the highest abundance on 6th of February 2013 in weedy field of faba bean, whereas the population of cowpea aphid was very low in free-weedy fields. The population of cowpea aphid in the weedy field of faba bean showed two distinct peaks of abundance, the first peak was (94.5 individuals) on 27th of December 2012 and the second peak was (99.25 individuals) on 6th of February 2013. Similarity, two periods of limited abundance were observed for cowpea aphid in free-weedy field. The first peak was recorded (31 individuals) on 10th of January 2013 and the second peak was recorded (35.5 individuals) on 31st of January.

The data presented in Figure (1) indicated that, during the second year plantation 2013/14, the population of cowpea aphid started to increase gradually after plantation to reach the highest abundance on 10th of January 2014 in weedy field, whereas the population of cowpea aphid was very low. The population of cowpea aphid in the weedy field showed two distinct peaks of abundance, the first peak was (41 individuals) on 13th of December 2013 and the second peak was (93.75 individuals) on 10th of January 2014. Whereas, two periods of limited abundance were observed for cowpea aphid in free-weedy fields. The first peak was recorded (32.75 individuals) on 27th of December and the second peak was recorded (51.25 individuals) on 17th of January 2014.

Results of statistical analysis arranged in Table (2) showed that there was a significant difference in the average number of *A. craccivora* between weedy and free-weedy fields in the first and second seasons of plantation (t = 3.34; P = 0.002 and t = 2.84; P = 0.01, respectively.

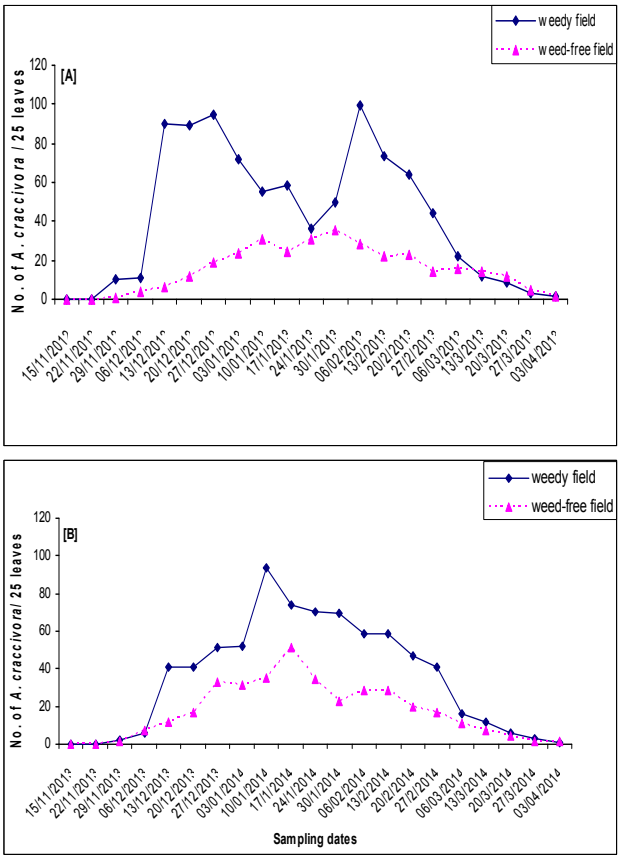

Fig (1): Mean number of cowpea aphid, *A. craccivora* in both weedy (neglected) and free-weedy (clean) faba bean fields during 2012/13 (A) and 2013/14 (B) plantation seasons at Sidi-Salem district, Kafr El-Sheikh Governorate.

***Chrysoperla carnea* (Steph.) (Chrysopidae, Neuroptera)**

Data illustrated in Figure (2) indicated that, the population of green lacewing, *C. carnea* higher population in weedy faba bean field in both years of study than free-weedy fields. In the weedy field of faba bean, *C. carnea* showed three distinct peaks of abundance during the first year 2012/13, the first peak was (3.25 individuals) on 3rd of January 2013, the

second peak was (3.75 individuals) on 13th of February 2013, and the third peak was (2 individuals) on 13th of March 2013. In free-weedy field, two peaks of abundance were observed for *C. carnea*. The first one was recorded (1 individuals) on 27th of December 2012 (1 individual) and the second peak was recorded (1.25 individuals) on 24th of January 2013 (Fig. 2).

Data represented in Figure (2) showed that, in the second year of plantation (2013/14), the population of *C. carnea* in the weedy field showed four peaks of abundance with the highest one (2 individuals) on 27th of December 2013. Whereas, three periods of limited abundance were observed for *C. carnea* in free-weedy fields with the highest abundance (1.25 individuals) was on 6th of February 2014.

Results of statistical analysis arranged in Table (2) showed that there was a highly significant difference in the average number of *C. carnea* between weedy and free-weedy fields in the first and second seasons of plantation ($t = 4.11$; $P = 0.001$ and $t = 4.59$; $P = 0.001$, respectively.

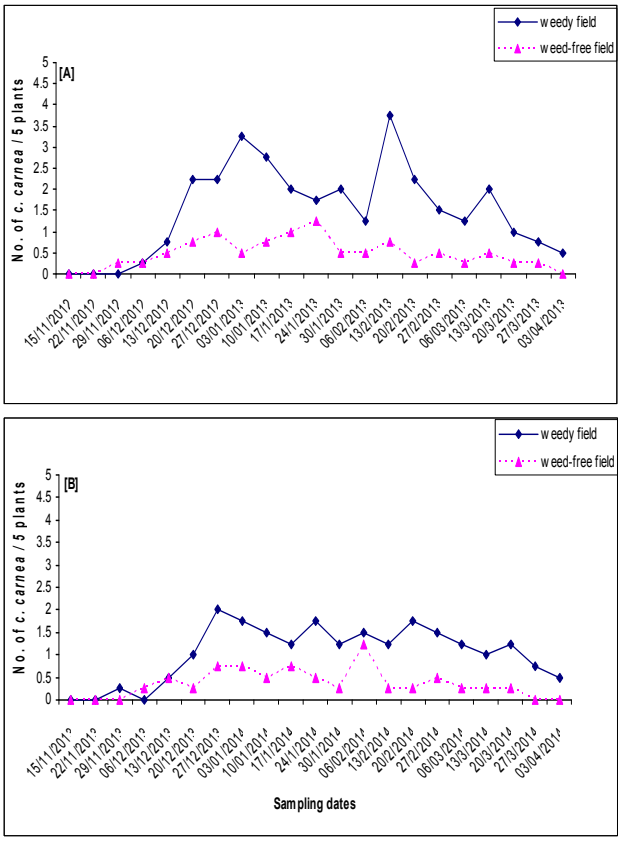

Fig (2): Mean number of green lacewing, C. *carnea* in both weedy (neglected) and free-weedy (clean) faba bean fields during 2012/13 (A) and 2013/14 (B) plantation seasons at Sidi-Salem district, Kafr El-Sheikh Governorate.

***Coccinella undecimpunctata* L. (Col., Coccinellidae)**

Data presented in Figure (3) indicated that, the population of Lady beetle, *C. undecimpunctata* higher population in weedy faba been field in both years of study than free-weedy fields. In the weedy field of faba bean, *C. undecimpunctata* showed two distinct peaks of abundance during the first year 2012/13, the first peak was (2.5 individuals) on 24th of January 2013, the second peak was (3 individuals) on 27th of February 2013. In free-weedy field, one peak of abundance was observed for *C. undecimpunctata*. One peak was recorded (2 individuals) on 6th of February 2013.

Data represented in Fig. (3) showed that, in the second year of plantation (2013/14), the population of *C. undecimpunctata* in the weedy field showed two peaks of abundance with the highest one (5 individuals) on 31th of January 2014. Whereas, two periods of limited abundance were observed for *C. undecimpunctata* in free-weedy fields with the highest one (2.5 individuals) on 6th of March 2014.

Results of statistical analysis arranged in Table (2) showed that there was a significant difference in the average number of *C. undecimpunctata* between weedy and free-weedy fields in the first season of plantation ($t = 2.07$; $P = 0.04$), but did not in the second year ($t = 1.39$; P = 0.17, respectively).

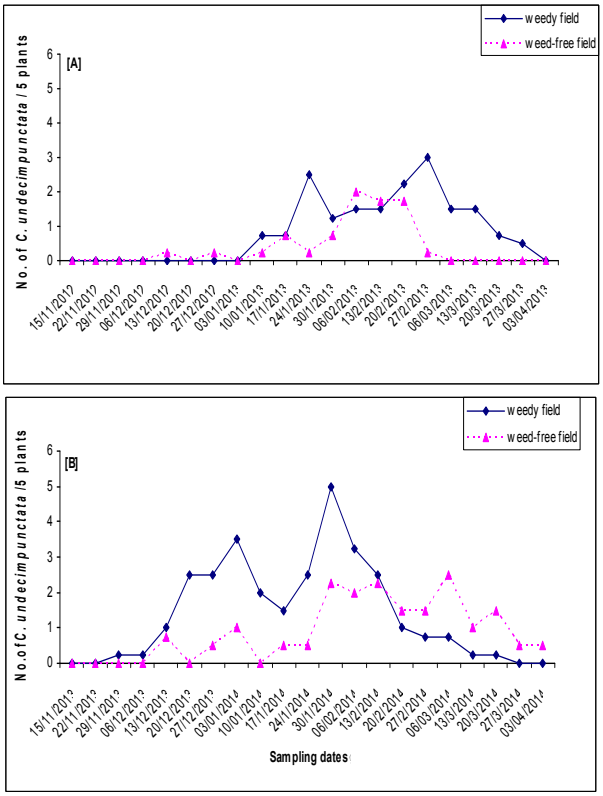

Fig. (3): Mean number of ladybeetle, *C. undecimpunctata* in both weedy (neglected) and free-weedy (clean) faba bean fields during 2012/13 (A) and 2013/14 (B) plantation seasons at Sidi-Salem district, Kafr El-Sheikh Governorate.

***Paederus alferii* Koch. (Col., Staphylinidae)**

Data illustrated in Figure (4) indicated that, the population of *P. alferii* higher population in weedy faba bean field in both years of study than free-weedy fields. In the weedy field of faba bean, *P. alferii* showed two distinct peaks of abundance during the first year 2012/13, the first peak was (1.5 individuals) on the 17th of January 2013, the second peak was (2.25 individuals) on 6th of February 2013. In free-weedy field, two peaks of abundance were observed for *P. alferii*. The first

peak was recorded (1.25 individuals) on 10th of January 2013 and the second one was recorded (1 individual) on 13th of February 2013.

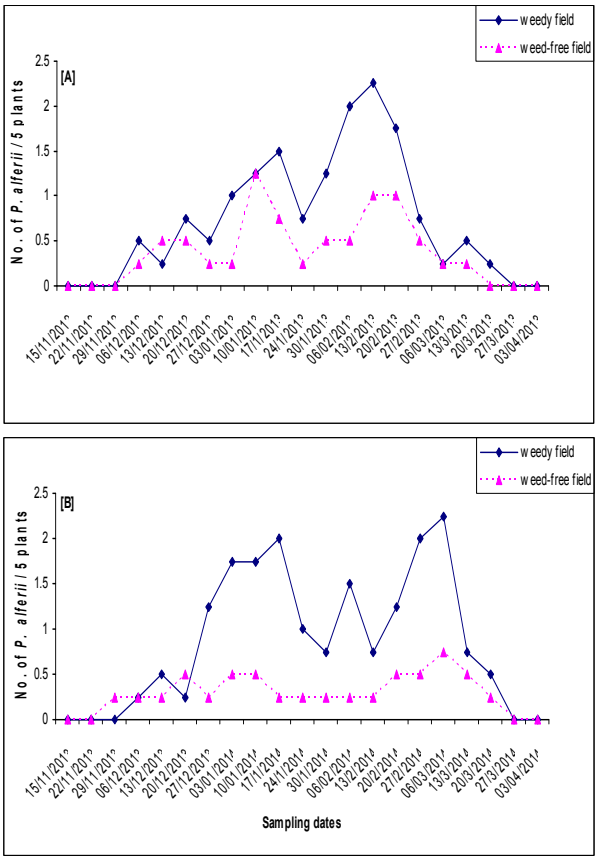

Fig. (4): Mean number of Egyptian Rove beetle, *P. alferii* in both weedy (neglected) and free-weedy (clean) faba bean fields during 2012/13 (A) and 2013/14 (B) plantation seasons at Sidi-Salem district, Kafr El-Sheikh Governorate.

Data represented in Figure (4) showed that, in the second season of plantation (2013/14), the population of *P. alferii* in the weedy field showed three peaks of abundance with the highest one (2.25 individuals) on 6th of March 2014. Whereas, three periods of limited abundance were observed for *P. alferii* in free-weedy fields with the highest abundance (0.75 individuals) was on 6th of March 2014.

Results of statistical analysis arranged in Table (2) showed that there was a highly significant difference in the average number of *P. alferii* between weedy and free-weedy fields in the first and second seasons of plantation (t = 2.08; P = 0.04 and t = 3.22; P = 0.003, respectively.

***Scymnus syriacus* Muslant (Col., Coccinellidae)**

Data presented in Figure (5) indicated that, the population of *S. syriacus* higher population in weedy faba bean field in both seasons of study than free-weedy fields. In the weedy field of faba bean, *S. syriacus* showed two distinct peaks of abundance, the first peak was (2 individuals / 5 plants) on 3rd of January 2013, the second peak was (4.75 individuals) on 6th of February 2013. In free-weedy field, two peaks of abundance were observed for *S. syriacus*. The first peak was recorded (1.5 individuals) on 10th of January 2013 and the second peak was recorded (1.5 individuals) on 6th of February 2013.

Data represented in Figure (5) showed that, in the second year of plantation (2013/2014), the population of *S. syriacus* in the weedy field showed two peaks of abundance with the highest one (2.5 individuals) on 6th of February 2014. Whereas, one periods of limited abundance were observed for *S. syriacus* in free-weedy fields with the highest abundance (1.5 individuals) was on 24th of January 2014.

Results of statistical analysis arranged in Table (2) showed that there was a highly significant difference in the average number of *S. syriacus* between weedy and free-weedy fields in second season of plantation (t = 3.04; P=0.004), but did not in the first season (t = 1.59; P = 0.13, respectively.

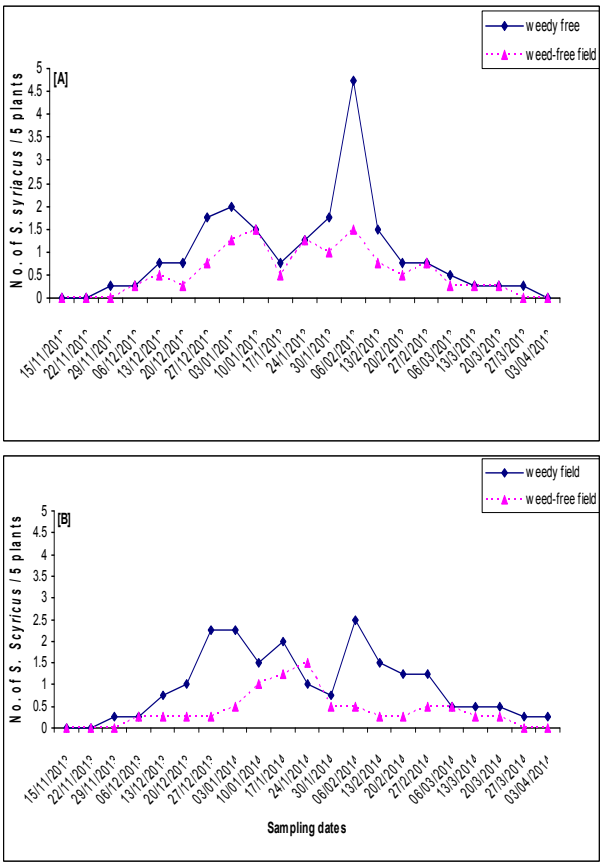

Fig. (5): Mean number of ladybeetle, *S. syriacus* in both weedy (neglected) and free-weedy (clean) faba bean fields during 2012/13 (A) and 2013/14 (B) plantation seasons at Sidi-Salem district, Kafr El-Sheikh Governorate.

***Orius laevigatus* (Hemiptera: Anthocoridae)**

Data illustrated in Figure (6) indicated that, the population of *O. laevigatus* showed higher population in weedy faba bean field in both years of study than free-weedy fields. In the weedy field of faba bean, *O. laevigatus* showed three distinct peaks of abundance, the first peak was (1.25 individuals / 5 plants) on 17th of January 2013, the second peak was (2 individuals) on 6th of February 2013 and the third peak was (2 individuals)

on 27th of February 2013. In free-weedy field, three peaks of abundance were observed for *O. laevigatus*. The first one was recorded (0.75 individuals) on 27th of December and the second peak was recorded (1.25 individuals) on 17th of January 2013 and the third peak was (1 individual) on 6th of March 2013.

Data represented in Figure (6) indicated that, in the second year of plantation (2013/14), the population of *O. laevigatus* in the weedy field showed three peaks of abundance with the highest one (1.25 individuals) on 6th of February 2014. Whereas, three periods of limited abundance were observed for *O. laevigatus* in free-weedy fields with the highest abundance (0.75 individuals) was on 3rd of January 2014.

Results of statistical analysis arranged in Table (2) showed that there a was non-significant difference in the average number of *O. laevigatus* between weedy and free-weedy fields in first season of plantation (t = 1.73; P = 0.09), and the second season (t = 1.27; P = 0.21).

One-way ANOVA revealed that there was significant effect of weed plants in fabe bean field on mean number of predators visually monitored per five plants ($F_{4,104}$ = 2.58; P = 0.04), but did not on free-weedy fields ($F_{4,104}$ = 0.89; P = 0.47) in the first season of plantation. Whereas, there was significant effect of both weedy and free- weedy fields of faba bean on mean number of predators visually monitored per each replicate ($F_{4,104}$ = 4.16; P = 0.004 and $F_{4,104}$ = 7.46; P = 0.001, respectively) in the second season of plantation (Table2).

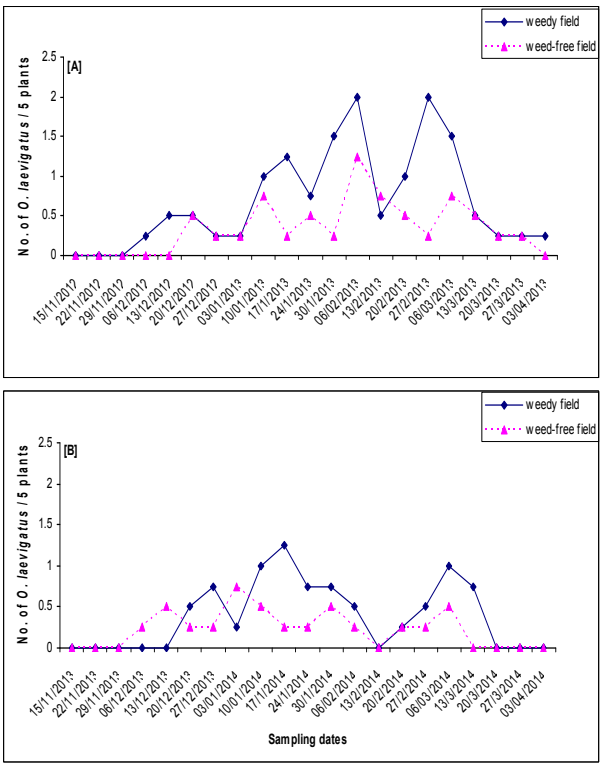

Fig. (6): Mean number of the minute pirate bug, *O. laevigatus* in both weedy (neglected) and free-weedy (clean) faba bean fields during 2012/13 (A) and 2013/14 (B) plantation seasons at Sidi-Salem district, Kafr El-Sheikh Governorate.

Table (2): Mean number (± SE) of cowpea aphid and its associated predators in both weedy (neglected) and free-weedy (clean) faba bean fields during 2012/13 (A) and 2013/14 (B) plantation seasons at Sidi-Salem district, Kafr El-Sheikh Governorate.

Species	Weedy field (neglected)		Free-weedy field (clean)		*t*-test		*P*	
	A	B	A	B	A	B	A	B
Aphis craccivora	175.66 ± 32.54	141.38 ± 25.92	61.76 ± 9.89	69.42 ± 12.81	3.34	2.84	0.002	0.01
Chrysoperla carnea	5.91 ± 0.92 a	4.23 ± 0.55 ab	1.91 ± 0.30 a	1.38 ± 0.28 b	4.11	4.59	0.001	0.001
Coccinella undecimpunctata	3.38 ± 0.82 b	5.66 ± 1.23 a	1.38 ± 0.50 a	3.66 ± 0.73 a	2.07	1.39	0.04	0.17
Paderus alferii	2.95 ± 0.61 b	3.33 ± 0.64 c	1.52 ± 0.32 a	1.19 ± 0.17 b	2.08	3.22	0.04	0.003
Scymnus syriacus	3.81 ± 0.94 ab	3.90 ± 0.67 ab	2.23 ± 0.43 a	1.57 ± 0.35 b	1.59	3.04	0.136	0.004
Orius laevigatus	2.38 ± 0.50 b	1.42 ± 0.36 c	1.39 ± 0.28 a	0.91 ± 0.19 b	1.73	1.27	0.09	0.21

Values followed by the same letters in a column are not significantly different at the 5% probability level

DISCUSSION

Field borders play an essential role in maintaining ladybeetle cycles and their predators, contributing to the cyclic movements within the same area from weeds to crop and *vice versa*. Mowing of weeds and wildflowers in that time could be harmful means for ladybeetle species, and the time of mowing practices for field margins have to be taken into account the phenology of these predators (Honek, 1982; Leather *et al*., 1999; Hodek and Honek, 1996). The influence of non-crop plants on population of beneficial insects have been discussed in several studies (e.g., Sheenan, 1986; Russell, 1989; Van Emden, 1990; Delucchi; 1997; Altieri, 1999; Andow, 1991; Paoletti, 1999; Landis *et al*., 2000; Altieri *et al*., 2003). Ecological infrastructure of a field, involving weedy field margins, are deemed as an important factor of sustainable agriculture due to their importance in improving functional biodiversity and supporting cyclic movement of predators between crops and infrastructures (Landis and Wratten, 2002; Winkler, 2005). Competition between weeds and crops is explicated by altered growth and development of both plant species.

The clearest result of weed competition in crops is to reduce the crop yield and this means that the competitive ability of weed species out-weigh the crop plants. The second consequence of such competition is to harbor insect pests by weed species and these insect pests feed on reproductive parts of the plant causing more economic damage to the crops (Adebayo *et al.,* 2007). Data collected from faba bean and cowpea field are not significantly differed between weedy and free-weed margin fields for *A. craccivora* and its insect predators. In faba been field, weedy situation supported the higher population for *A. craccivora* and most of their predators except *S. syriacus* and *O. laevigatus* during the first and second season, respectively. The population of *A. craccivora* on faba bean plants is fluctuated from season to season due to weather

conditions and rising in water table and crop rotation (El-Defrawi *et al*., 1994; Abdel-Samad and Ahmed, 2007). In the first season of cultivation, *S. syriacus* and *O. laevigatus* populations did affect by removal or existence of weeds. In the second season, weedy situation in the faba bean ecosystem supported higher insect populations of *A. craccivora*, *C. carnea*, *S. syriacus*, *P. alferii* and *O. laevigatus*. Weeds are one of the main infrastructures affecting the population of aphid predators by providing them with oviposition sites and food sources. Consequently, the lower aphid populations are in weedy fields (Smith, 1976; Edward *et al.,* 1979; Dedryver, 1983). Partially contrast to other reports, the population of predators in weedy fields was higher than that in free-weedy fields, however population of *A. craccivora* still higher in weedy fields. This is probably because free-weedy fields did not support aphids with the required humidity for multiplying its rate of growth, whereas weedy fields did.

The cowpea aphid, *A. craccivora* recorded the highest abundance during December and January-February in weedy field, whereas *C. undecimpunctata* recorded the highest population during December-January. This implies that there is synchronization between *A. craccivora* and *C. undecimpunctata* populations and *A. craccivora* starts to move from weeds to faba bean crop earlier than *C. undecimpunctata* almost a month. Afterwards, the first larval generation may complete its development depend on the rest of aphids in weeds or may complete its development in the main crop through migration from weeds to attack aphids in the crop.

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تأثير الحشائش على تعداد من اللوبيا والمفترسات المصاحبة له فى حقول الفول البلدى

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أجريت هذه التجارب لدراسه تأثير الحشائش على الوفرة العددية لحشرة من البقوليات والمفترسات الحشرية المصاحبة له فى حقول الفول البلدى خلال موسمي الزراعة ٢٠١٢/٢٠١٣ و ٢٠١٣/٢٠١٤. تم زراعة صنف الفول البلدى سخا١ فى بداية شهر نوفمبر فى كلا موسمى الدراسه ٢٠١٢/٢٠١٣ و ٢٠١٣/٢٠١٤. الوفرة العددية لحشرة من البقوليات فى حقول الفول التى بها حشائش وصلت لأعلى تعداد (٩٩.٢٥ ، ٩٣.٧٥ فرد) خلال موسمى الدراسة على التوالى . بينما فى الحقول الخالية من الحشائش فإن أعلى تعداد من حشرة من البقوليات كان (٧٥ ,٣٢ ، ٥١,٢٥ فرد) خلال موسمى الدراسة على التوالى. نتائج التحليل الإحصائى أوضحت أن هناك اختلاف معنوى فى متوسط حشرة من البقوليات بين الحقول التى بها حشائش والخالية من الحشائش فى السنة الأولى والثانية مع تعدادات أعلى تم تسجيلها من الحشرة فى الحقول التى بها حشائش. وأهم المفترسات الحشرية التى تم تسجيلها مرتبطة بمن البقوليات فى حقول الفول التى بها حشائش أو الخالية من الحشائش كان أسد المن الأخضر ، أبو العيد ١١ نقطة ، الرواغة ، الاسكمنس وبقة الأوريس. الحشائش تقريباً كان لها تأثير معنوى على معظم الحشرات الكاملة للمفترسات فى حقول الفول علاوة على ذلك فإن أعداد المفترسات المنجذبة لنباتات الفول اختلفت بصورة معنوية فى الحقول التى بها حشائش خلال موسمى الدراسة بينما لم يحدث ذلك فى الحقول الخالية من الحشائش خاصة فى السنة الأولى من الدراسة.