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Biological Control of Cowpea aphid, *Aphis craccivora* Koch infesting Squash Plants by Releasing Predator, *Coccinella septempunctata* under Glasshouse Conditions

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Biological control, *Aphis craccivora*, *Cucurbita pepo* L., *Coccinella septempunctata* L.

ABSTRACT

This study was carried out to evaluate the management of Cowpea aphid, *Aphis craccivora* Koch (Homoptera: Aphididae) which infesting squash plants, *Cucurbita pepo* L. by releasing three levels of the seven spotted lady beetle, *Coccinella septempunctata* L. (Coleoptera: Coccinellidae) (40, 80, 120 eggs/plant). This study was carried out at two locations (Governorates), Perkash (Giza Governorate) and Tokh (Qaliobya Governorate) during successive season 2020 under glasshouse conditions.

At Giza Governorate, in the first level of release (40 eggs/plant), the reduction percentages in the population of *A. craccivora* increased gradually whereas they were 21.9, 31.9, 40.6, 46.5 and 55.4% on mid-February, first-March, mid-March, first-April and mid-April respectively. Also, in the second level of release (80 eggs/plant), the reduction percentages in the population increased gradually whereas they were 25.5, 35.5, 43.2, 50.9 and 58.0% on the same dates respectively. Lastly, in the third level of release (120 eggs/plant), the reduction percentages in the population increased gradually whereas they were 28.3, 38.8, 46.1, 52.1 and 63.7% on the same dates, respectively. The same trend was achieved at Qaliobya Governorate.

INTRODUCTION

Squash (*Cucurbita pepo* L.) fruits are considered one of the most important vegetable crops in Egypt and all over the world which are cultivated in the open field and under greenhouses conditions. Also, its cultivated area increased gradually during the last years, especially in the newly reclaimed areas for purposes of local consumption and exportation to the foreign markets. It contains some nutritional compounds for human feeding such as a moderate quantity of mineral salts, it is eaten cocked as an immature fruit which is rich with fibers and vitamins or consumed for the mature seed which is a good source of fats and protein (Abdein 2016).

Squash plants infested with a large scale of different insects such as Cowpea aphid, *Aphis craccivora* Koch (Homoptera: Aphididae) which consider one of the most damaging insects infesting squash plants and other vegetables crops either in the open field or under greenhouses conditions whereas it causes numerous damage in both quantity and quality for the crop directly by plant juice to loosen or indirectly by plant disease-transmitting (Abd El-Salam *et al*., 1982; Masaki *et al.*, 1991 and Ibrahim 2005).

The seven spotted lady beetle, *Coccinella septempunctata* L. (Coleoptera: Coccinellidae) is the commonest lady beetle known in Egypt, it is an important predator of many aphid species; eggs and small nymphs of mealybugs, jassids, eggs and larvae of cotton leafworm (Bilashini *et al.* 2017). The adults and small stages are often encountered in large numbers on the plants infested with aphids. They feed on these harmful insects and often play a great role in suppressing them under control. Both the adult and larval stages feed on insects harmful to plants, such as aphids and scale insects (Anonymous 1997). Adults can be killing up to 100 aphids per day (Arnett *et al.* 2015). The seven spotted lady beetle, *C. septempunctata* lives in a wide variety of habitats, any place where there are plants and aphids may attract these species (Fleming 2000). The lady beetle kills its prey outright and then devours it (Waldbauer 2007). Under field conditions, numerous coccinellids consume nectar, honeydew, pollen, fruit, vegetation, and fungus. These non-prey foods are used by coccinellids to increase survival when prey is scarce, reduce mortality during diapause, fuel migration, and enhance reproductive capacity. Each of these non-prey foods has unique nutritional and defensive characteristics that influence its suitability for lady beetles (Lundgren 2015).

This study was carried out to evaluate the management of Cowpea aphid, *A. craccivora* which infesting squash plants (*C. pepo*) by releasing three levels of the seven spotted lady beetle, *C. septempunctata*.

MATERIALS AND METHODS

This study was carried out to evaluate the management of Cowpea aphid, *Aphis craccivora* Koch (Homoptera: Aphididae) which infesting squash plants, *Cucurbita pepo* L. by releasing three levels of the seven spotted lady beetle, *Coccinella septempunctata* L. (Coleoptera: Coccinellidae) (40, 80, 120 eggs/plant). This study was carried out at two locations (Governorates), Perkash (Giza Governorate) and Tokh (Qaliobya Governorate) during successive season 2020 under glasshouse conditions.

Release of *C. septempunctata*:

Releasing was conducted on squash plants grown at the two locations, Perkash (Giza Governorate) and Tokh (Qaliobya Governorate) during successive season 2020 under glasshouse conditions. Both at the two places, glasshouse divided into three replects (5x8m for each) for squash plants which were sown beginning of January month 2020. Each replect for each release level and each replect also divided into six plots three plots for that release level and the other three plots used as control. The normal release and recommended agricultural practices were applied, also no chemical control against aphid was used during the whole experimental period.

Naturally, the numbers of *C. septempunctata* stages were recorded. Therefore, three levels of *C. septempunctata* eggs; the first level consists of 40 eggs (one card), the second level consists of 80 eggs (two cards) and the third one consists of 120 eggs (three cards) were released to encouragement the normal predator population to reduce the aphid. *C. septempunctata* were released (one time) by the beginning of February on squash plants at both two locations in 2020 season.

Samples were randomly taken bi-weekly at both two locations and counting started from the beginning of February in squash plants. Ten new plants were examined from each plot (three leaves for each plant), were made by a hand lens for counting the alive insects and the predator and took the mean numbers. Both surfaces of the leaf were inspected for the presence of aphid (Mangoud 2000).

Statistical Analysis:

The obtained results were statistically analysed and the percent reduction of *A. craccivora* after *C. septempunctata* was released was calculated according to Henderson and Tilton equation (1955).

The data were subjected to analysis of variance (ANOVA) and the means were compared by L.S.D. test at 0.05 level, using SAS program (SAS Institute 1988).

RESULTS AND DISCUSSION

Giza Governorate:

Three levels of *Coccinella septempunctata* L. eggs; first level (40 eggs on one card), second level (80 eggs on two cards) and the third level (120 eggs on three cards) were released (one time) at the beginning of February on squash plants during 2020 season.

First Level of Release (40 eggs/plant):

Results in Table (1) and Fig. (1) indicated that the number of *A. craccivora* in the 1st release plot decreased gradually from 49 on the 1st February to 40, 29, 20, 12 and 5 individuals/plant, in mid-February, first-March, mid-March, first-April and mid-April, respectively as compared to control which aphid populations changed from 45 individuals/plant, on first-February to 47, 50, 58, 65 and 70 individuals/plant, at the same dates, respectively. The present results showed that the percent reduction of *A. craccivora* in the 1st release plot increased gradually to reach 21.9, 31.9, 40.6, 46.5 and 55.4% at the same dates respectively.

Table 1: Population fluctuations of *A. craccivora* in the 1st plot release at level (40eggs) of *C. septempunctata* at Giza Governorate.

Date	Release plot	Chick plot (Control)	% Reduction
First February	49	45	-
Mid February	40	47	21.9
First March	29	50	31.9
Mid-March	20	58	40.6
First April	12	65	46.5
Mid April	5	70	55.4
F (0.05)	**345.67**		
L.S. D	**1.25**		

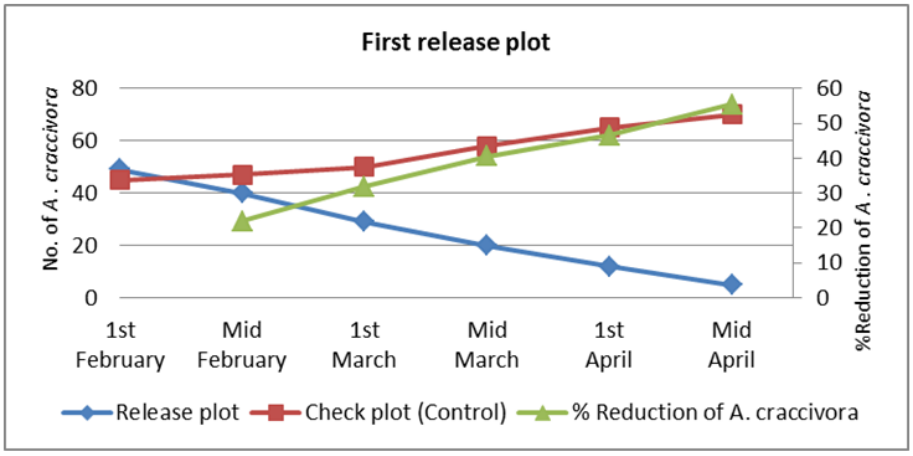

Fig.1: Population fluctuations of *A. craccivora* in the 1st plot release at level (40eggs) of C. *septempunctata* at Giza Governorate.

Second Level of Release (80 eggs/plant):

Results in Table (2) and Fig. (2) indicated that the number of *A. craccivora* in the 2nd release plot decreased gradually from 52 on the 1st February to 42, 31, 20, 11 and 5 individuals/plant on mid-February, first-March, mid-March, first-April and mid-April, respectively as compared to control which aphid populations changed from 48 individuals/plant, on first-February to 52, 59, 67, 75 and 82 individuals/plant, at the same dates, respectively. The obtained results showed that the percent reduction of *A. craccivora* in the 2nd release plot increased gradually to reach 25.5, 35.5, 43.2, 50.9 and 58.0% at the same dates respectively.

Table 2: Population fluctuations of *A. craccivora* in the 2nd plot release at level (80eggs) of *C. septempunctata* at Giza Governorate.

Date	Release plot	Chick plot (Control)	% Reduction
First February	52	48	-
Mid February	42	52	25.5
First March	31	59	35.5
Mid-March	20	67	43.2
First April	11	75	50.9
Mid April	5	82	58.0
F (0.05)	**233.43**		
L.S.D	**1.08**		

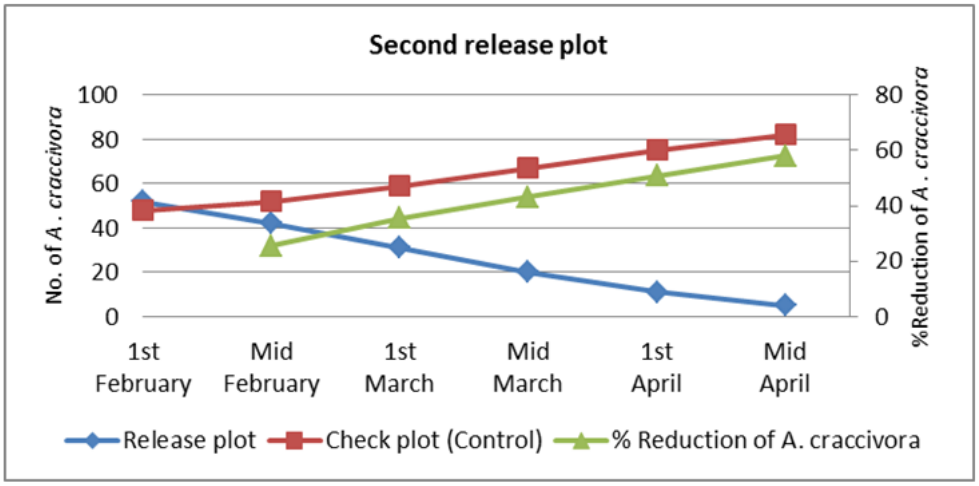

Fig.2: Population fluctuations of *A. craccivora* in the 2nd plot release at level (80eggs) of *C. septempunctata* at Giza Governorate.

Third Level of Release (120 eggs/plant):

Results in Table (3) and Fig. (3) indicated that the number of *A. craccivora* in the 3rd release plot decreased gradually from 55 on the 1st February to 45, 30, 18, 10 and 4 individuals/plant, in mid-February, first-March, mid-March, first-April and mid-April, respectively as compared to control which aphid populations changed from 50 individuals/plant, on first-February to 57, 62, 69, 80 and 88 individuals/plant, at the same dates, respectively. The results showed that the percent reduction of *A. craccivora* in the 3rd release plot increased gradually to reach 28.3, 38.8, 46.1, 52.1 and 63.7% at the same dates respectively.

Table 3: Population fluctuations of *A. craccivora* in the 3rd plot release at level (120eggs) of *C. septempunctata* at Giza Governorate.

Date	Release plot	Chick plot (Control)	% Reduction
First February	55	50	-
Mid February	45	57	28.3
First March	30	62	38.8
Mid-March	18	69	46.1
First April	10	80	52.1
Mid April	4	88	63.7
F (0.05)	**212.33**		
L.S.D	**1.18**		

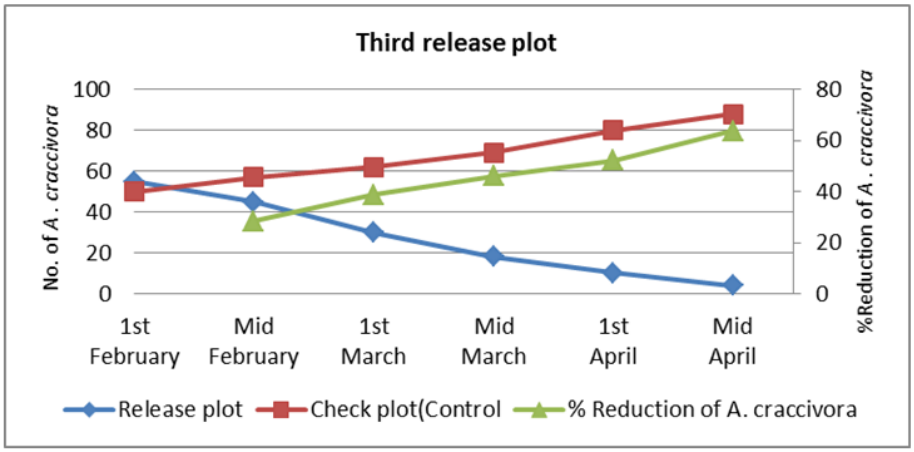

Fig.3: Population fluctuations of *A. craccivora* in the 3rd plot release at level (120eggs) of *C. septempunctata* at Giza Governorate.

At Qaliobya Governorate:

First Level of Release (40 eggs/plant):

Results in Table (4) and Fig. (4) indicated that the number of *A. craccivora* in the 1st release plot decreased gradually from 50 on the 1st February to 45, 32, 20, 11 and 5 individuals/plant, on mid-February, first-March, mid-March, first-April and mid-April, respectively as compared to control which aphid populations changed from 47 individuals/plant, on first-February to 55, 60, 67, 72 and 75 individuals/plant, at the same dates, respectively. In addition, the results showed that the percent reduction of *A. craccivora* in the 1st release plot increased gradually to reach 23.1, 34.9, 44.1, 48.9 and 56.4% at the same dates respectively.

Table 4: Population fluctuations of *A. craccivora* in the 1st plot release at level (40eggs) of *C. septempunctata* at Qaliobya Governorate

Date	Release plot	Chick plot (Control)	% Reduction
First February	50	47	-
Mid February	45	55	23.1
First March	32	60	34.9
Mid-March	20	67	44.1
First April	11	72	48.9
Mid April	5	75	56.4
F (0.05)	**251.71**		
L.S.D	**1.37**		

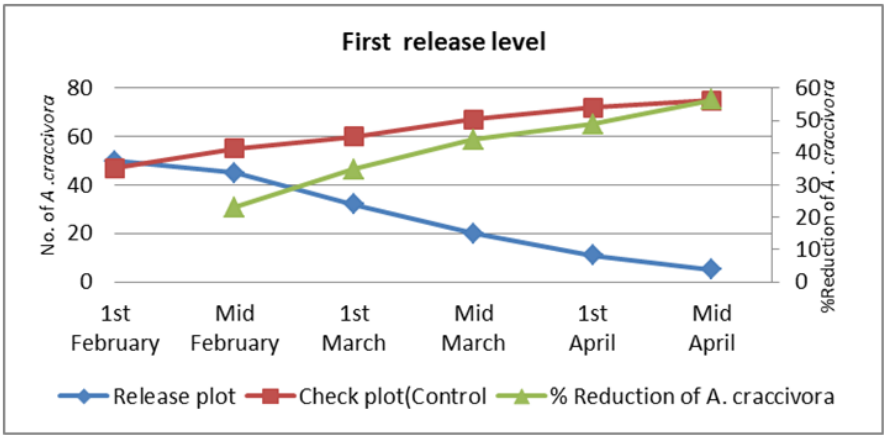

Fig.4: Population fluctuations of *A.craccivora* in the 1st plot release at level (40eggs) of *C. septempunctata* at Qaliobya Governorate.

Second Level of Release (80 eggs/plant):

Results in Table (5) and Fig. (5) indicated that the number of *A. craccivora* in the 2nd release plot decreased gradually from 52 on the 1st February to 42, 30, 19, 10 and 4 individuals/plant, in mid-February, first-March, mid-March, first-April and mid-April, respectively as compared to control which aphid populations changed from 48 individuals/plant, on first-February to 53, 60, 68, 75 and 80 individuals/plant, at the same dates, respectively. In addition, the results showed that the percent reduction of *A. craccivora* in the 2nd release plot increased gradually to reach 26.9, 37.0, 44.2, 52.3 and 62.5% at the same dates respectively.

Table 5: Population fluctuations of *A. craccivora* in the 2nd plot release at level (80eggs) of *C. septempunctata* at Qaliobya Governorate.

Date	Release plot	Chick plot (Control)	% Reduction
First February	52	48	-
Mid February	42	53	26.9
First March	30	60	37.0
Mid-March	19	68	44.2
First April	10	75	52.3
Mid April	4	80	62.5
F (0.05)	**277.31**		
L.S.D	**1.65**		

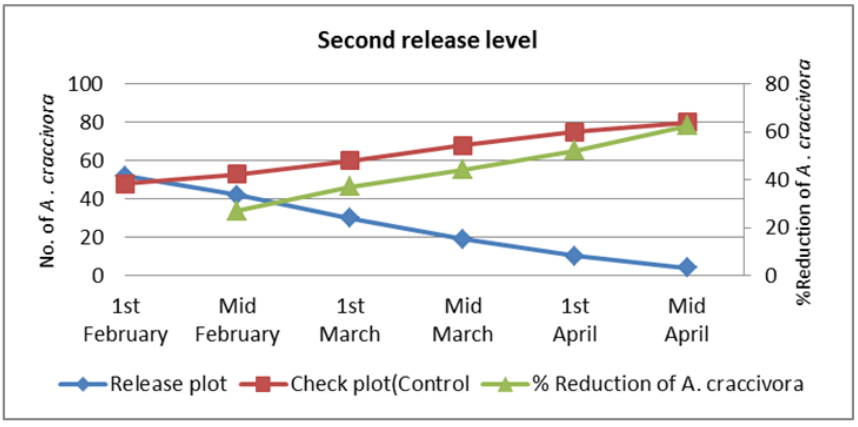

Fig.5: Population fluctuations of *A.craccivora* in the 2nd plot release at level (80eggs) of *C. septempunctata* at Qaliobya Governorate.

Third Level of Release (120 eggs/plant):

Results in Table (6) and Fig. (6) indicated that the number of *A. craccivora* in the 3rd release plot decreased gradually from 53 on the 1st February to 44, 30, 18, 9 and 3 individuals/plant, in mid-February, first-March, mid-March, first-April and mid-April, respectively as compared to control which aphid populations changed from 49 individuals/plant, on first-February to 58, 68, 79, 85 and 90 individuals/plant, at the same dates, respectively. In addition, the results showed that the percent reduction of *A. craccivora* in the 3rd release plot increased gradually to reach 29.9, 40.1, 48.4, 53.6 and 68.6% at the same dates, respectively.

Table 6: Population fluctuations of *A. craccivora* in the 3rd plot release at level (120eggs) of *C. septempunctata* at Qaliobya Governorate.

Date	Release plot	Chick plot (Control)	% Reduction
First February	53	49	-
Mid February	44	58	29.9
First March	30	68	40.1
Mid-March	18	79	48.4
First April	9	85	53.6
Mid April	3	90	68.6
F (0.05)	**288.93**		
L.S.D	**1.17**		

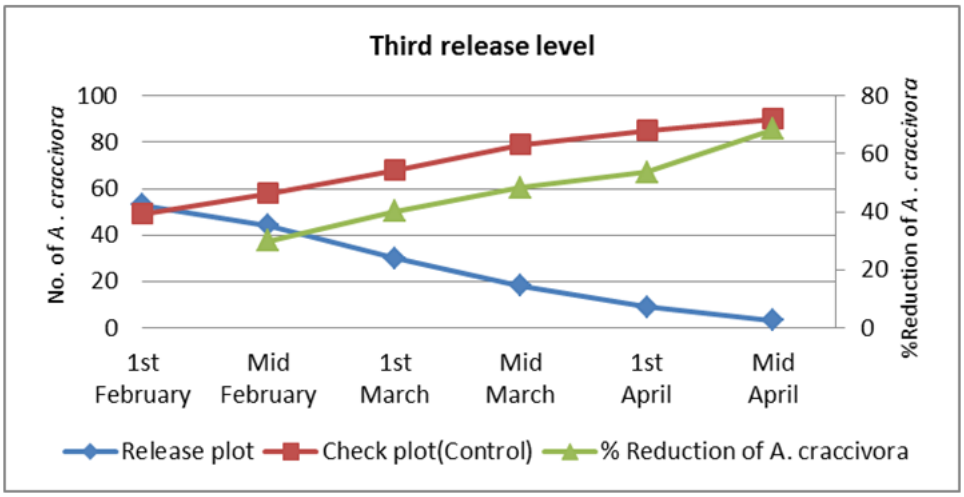

Fig.6: Population fluctuations of *A. craccivora* in the 3rd plot release at level (120eggs) of *C. septempunctata* at Qaliobya Governorate.

Statistical analysis showed that were highly significant differences between the three releasing levels (40, 80 and 120 eggs/plant) of *C. septempunctata* predator in reduction of *A. craccivora* at both the two locations compared to control.

These results obtained are in agreement with those obtained by Mangoud (2009) who found that the seven spotted lady beetle, *C. septempunctata* is an important predator of aphids play a good role in reducing the population density of the woolly apple aphid, *Eriosoma lanigerum* (Homoptera: Aphididae) attacking apple trees. Also, these results are in agreement with those obtained by Mangoud (2003) who stated that the seven spotted lady beetle, *C. septempunctata* is an important predator of aphids play a good role in reducing the population density of the green peach aphid, *Myzus persicae* and the cotton aphid, *A. gossypii* (Homoptera: Aphididae) attacking apple trees.

Also, these results are in harmony with those obtained by Hoyt and Madsen (2005) found that the control of aphid species complex is complicated by the continued dispersal of aphids from the roots to the aerial portions of the tree, and a corresponding dispersal in the opposite direction. Release *C. septempunctata* adopted here can cope very well with this behaviour. Brar and Kanwar (2005) in field experiments in India found *C. septempunctata* was an effective predator against *A. craccivora* infesting fenugreek germplasm. El-Aish *et al.* (2004) stated that the role of the predator *C. septempunctata* in biological suppressing of cereal aphids showed that the eggs last 2-3 days and the 1st, 2nd, 3rd and 4th larval instars have lasted 3, 2, 2 and 4 days, respectively, the pupal stage lasted 8 days at the room temperature. The adult predator consumed 46.13 aphids, while the larval consumed 26.9 aphids daily. Fang *et al.* (2012) found the coccinellids, *C. septempunctata* good controlling *B. brassicae* in cotton fields at yellow Rever valley in China.

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ARABIC SUMMARY

المكافحة الحيوية لحشرة من الفول *Aphis craccivora* علي نباتات الكوسة بإطلاق خنفساء أبو العيد ذو السبع نقاط *Coccinella septempunctata* تحت ظروف الصوب الزجاجية

مرفت قاسم جبر الشربينى وأشرف صلاح إمام

معهد بحوث وقاية النباتات - مركز البحوث الزراعية- الدقي – الجيزة – مصر

أجري هذا البحث لتقييم مستويات مختلفة من إطلاق أبو العيد ذو السبع نقاط *Coccinella septempunctata* L. (40، 80، 120 بيضة/ نبات) في خفض تعداد حشرة من الفول *Aphis craccivora* علي نباتات الكوسة بمحافظتى الجيزة والقليوبية خلال موسم 2020 تحت ظروف الصوب الزجاجية. حيث أدى إطلاق مفترس أبو العيد ذو السبع نقاط بمستوي 40 بيضة/ نبات فى محافظة الجيزة إلي خفض نسبة الإصابة بمن الفول بنسبة تدرجت من 21.9، 31.9، 40.6، 46.5، 55.4 % وذلك في منتصف فبراير، وبداية مارس ومنتصف مارس وبداية أبريل ومنتصف أبريل علي التوالي، بينما أدي إطلاق هذا المفترس بمستوي 80 بيضة /نبات إلي خفض نسبة الإصابة بنسبة تدرجت من 25.5، 35.5، 43.2، 50.9، 58.0% وذلك في نفس التوقيتات على الترتيب. كما أدي إطلاق هذا المفترس بمستوي 120 بيضة / نبات الي خفض نسبة الإصابة بنسبة تدرجت من 28.3، 38.8، 46.1 ،52.1، 63.7% وذلك في نفس التوقيتات على التوالي، وعلى نفس المنوال تدرجت الفاعلية في محافظة القليوبية.

من النتائج السابقة يمكن التوصية بإستخدام المفترس الحشري أبو العيد ذو السبع نقط *C. septempunctata* بنجاح كأحد عناصر المكافحة البيولوجية الفعاله في برامج المكافحة المتكاملة لحشرة من الفول *A. craccivora* علي نباتات الكوسة .