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BIOLOGICAL CONTROL OF SOME PIERCING-SUCKING INSECT PESTS OF THE BEAN (*PHASEOLUS VULGARIS* L.) UNDER OPEN FIELD AND GREENHOUSE CONDITIONS

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ABSTRACT: *This work was conducted to study the biological impact of releasing the eleven-spotted ladybeetle, Coccinella undecimpunctata , Linnaeus (Coleoptera: Coccinellidae) in the control of the cotton whitefly, Bemisia tabaci , Gennadius, the cotton aphid, Aphis gosspyii , Glover infesting common bean, Phaseolus vulgaris, Linnaeus. Experiments were carried out during the period of 15 February, till 15 May 2014 at a private farm and a greenhouse located at El-Menoufia Governorate, Egypt. Biweekly leaf samples were examined for the different stages of insects under study to determine the efficacy and the optimum time for releasing the predator. The obtained results indicated that the highest reduction percentages of preys (83.1%) at the level of 15 larvae/ plant under greenhouse conditions, were recorded four weeks after releasing. The grand mean reduction percentages of aphid and whitefly stages under greenhouse conditions along ten weeks of releasing were 38.24, 45.86, and 49.68 % for the treatments of 5, 10 and 15 newly hatched larvae/plant, respectively. Under open field conditions, the results revealed that the highest reduction percentages of preys were recorded at the eighth and tenth week after releasing. The grand mean reduction percentages of aphid and whitefly stages under open field conditions along ten weeks of releasing were 38.0, 39.9, and 40.9 % for the treatments of 5, 10 and 15 freshly hatched larvae/plant, respectively.*

Key words: *Biological control, bean (Phaseolus vulgaris), Coccinella undecimpunctata, Aphis gossypii, Bemisia tabaci.*

INTRODUCTION

In Sub-Saharan Africa (SSA) the conventional agrosystems are minimal, due to the high costs which make the farmers unable to do this. (Neuenschwander, 2004). As well as, pesticides using have unintended effects on environment. As an example, over 98% of sprayed insecticides reach the station other than their target species including non-target species, air, water, and food (Miller, 2004). The best solution to control unneeded organisms use biological control with natural enemies (van Lenteren and Woets, 1988, Herren and Neuenschwander, 1991). Coccinellids are important to biological control more often than any other predatory organisms (Hodek and Honek, 2009; Jervis and Kidd, 1996). Coccinellids are important natural enemies of pest species, especially whiteflies (Gerling, 1990), aphids (Frazer, 1988), mealy bugs (Hagen, 1974), scale insects (Drea and Gordon, 1990), and mites (Chazeau, 1985). Over 50 species of Coccinellidae attack eggs and immature stages of whitefly (Gerling, 1990) of which, 13 species prey on *Bemisia* species (Nordlund and Legaspi, 1996 and Gerling 1986), whereas 40 species prey on *A. disperses* (Ramani, 2000). For instance, *Serangium parcesetosum* feeds on various whitefly species on citrus (Uygun *et al*., 1997), and *Clitostethus arcuatus* is a predator of several whitefly species in various crops (Booth and Polaszek, 1996). *Serangium* spp. were found to prey on whiteflies in cassava throughout the growing period (Asiimwe *et al*., 2007). Additionally, Coccinellids such as *Anegleis cardoni*, *A. perrotteti*, *Axinoscymnus puttarudriahi, Chelomenes sexmaculata*, three species of *Jauravia* and *Cryptolaemus montrouzieri* were found heavily feeding on the spiraling whitefly (Mani and Krishnamoorthy, 1997).

People in the food industry and governments around the world have come to conceive the vital need for green houses to supplement food supplies. Over population in the world need more greenhouses to provide more food.

Egypt has about 3000 feddan greenhouses divers between greenhouses and tunnels. Vegetables are the main crops grown in these greenhouses such as pepper, tomatoes, cucumber, squash and beans which are infested with a lot of pests.

Piercing-sucking pests are of the important pests which infest plants and need to wreck completely. The way of feeding causes damage by their stylet-like mouthparts through plant tissue directly. The most important enemies of piercing-sucking pests were coccinellids which control several pests. (Brown, 2004).

Most species of ladybirds are considered beneficial because they are predators of Homoptera or Acarina, some are considered pest species. These predatory ladybirds contribute to the regulation of populations of their prey, and in some situations contribute a high level of regulation. During The 20th century, Coccinellid species have spread in North America including *Coccinella undecimpunctata* (Gorden&Vandenberg 1991; Hoebeke & Wheeler 1996 and Atuncha *et al*., 2013). Biological control with using predators against insect pests was successively applied under field conditions or in greenhouse shields (Simmons and Abd- Rabou 2011).

This article was conducted to evaluate the possibility of using *Coccinella undecimpunctata* in the control of some piercing sucking insects infesting common bean, *Phaseolus vulgaris* under shield and field conditions.

MATERIALS AND METHODS

Rearing of *Coccinella undecimpunctata*:

Prey culture:

Broad bean, *Vicia faba* plants naturally infested with the aphid species, *Aphis gossypii* or with the whitefly *Bemisia tabaci* were collected from the field, transferred to the laboratory and re-cultivated in 20 cm plastic pots filled with clay loam soil to be a continuous source of aphids and whitefly as preys for the predator culture and release experiments.

Predator culture:

Adult individuals of ***C.*** *undecimpunctata* were collected from vegetable crops at Shebin Elkom, Menoufia Governorate, Egypt. Collected predator adults were placed in a plastic tube contains moistened cotton pads and transferred to the laboratory. Under laboratory conditions, trapped predators were placed in plastic containers (40 x 40 x 40 cm) each contain about 500 individuals provided with fresh aphids infested broad bean leaves to feed on. Pieces of white paper 200 g (4 x 4 cm) were placed in the container for predators to lay egg on. The paper sheets with the eggs were collected and placed in Petri dishes for experimental applications under laboratory conditions (Zhang and Feng , 1983 & Jin *et al*., 2010).

Greenhouse site:

A private greenhouse (25 x 8 m), located at Shebin Elkom, Menoufia Governorate, was cultivated by the common bean (*Phaseolus vulgaris* L.), var. Bronco. Seeds were planted at rows with 50 cm distance between rows and 20 cm between holes. The area was divided into 12 plots each was (4 x 4 m). There was a free row as border between plots to prevent treatment contamination.

Field site :

In a private farm located at Shebin El-Kom, Menoufia Governorate an area of 25 x 8 m (about 200 m^2) of land was also cultivated by the common bean (*P. vulgaris*), var. Bronco , in rows with 50 cm distance between rows and 20 cm between holes. This area was divided into 12 plots each plot was (4 x 4 m). There was a free row as border between plots to prevent treatment contamination.

Releasing process:

All treatments of both shield and field experiments were arranged in a complete randomized block design. Each treatment was applied at 3 plots as three replicates.

Thirty days of seed cultivation, grown plants were manually infested with 100 aphid and 100 white fly stages /plant, at both shield and field plots.

Seven days later, the predator was released at the levels of 5, 10 and 15 newly hatched larvae / plant, (about 100 plant per replicate) while control plots were left without release process. Plants were sprayed with 1% sugar solution at sunset, using a hand sprayer, to prevent, escaping of predators. The average means of air temperature degree and relative humidity was about 25±7ºC and 60±10 R.H % in field and 25±2ºC and 65±5 R.H % in shield plots.

Weekly counts of both prey and predator individuals were done per 5 leaves / replicate for 10 weeks at the laboratory with the aid of dissecting stereomicroscope. Investigations were done for 3 replicates per each treatment.

Statistical analysis:

Obtained data was statistically analyzed using analysis of variance (ANOVA) at 5 % probability. The measurements were separated using Duncan's Multiple Range Test (DMRT) through CoStat software program (Version 6.400) 1998-2008. Reduction percentages were calculated according to Henderson and Tilton (1955).

RESULTS AND DISSCUTION

Greenhouse experiments:

Data presented in Table (1) indicated that releasing *C. undecimpunctata* under greenhouse conditions reduced the average numbers of aphid and whitefly stages infesting common bean leaves. Statistical analysis of data revealed that there were significant differences in the numbers of preys between control and all other treatments, while there were insignificant differences among the three levels of release.

As for reduction percentages, results in Table (1) indicated that the highest reduction percentages of preys were recorded four weeks after releasing. The grand mean reduction percentages of aphid and whitefly stages along ten weeks of releasing were 38.24, 45.86, and 49.68 % for the treatments of 5, 10, 15 newly hatched larvae/plant, respectively.

Open field experiments

Data presented in Table (2) indicated that releasing C*. undecimpunctata* under open field conditions reduced the average numbers of aphid and whitefly stages infesting common bean leaves. Statistical analysis of data revealed that there were significant differences in the numbers of preys between control and all other treatments, as well as there were significant differences in the observed numbers of preys among the three levels of release.

As for reduction percentages, results in Table (2) indicated that the highest reduction percentages of preys were recorded in the 8^{th} and 10^{th} weeks after releasing at all evaluated levels of predator. The grand mean reduction percentages of aphid and whitefly stages along ten weeks of releasing were 38.0, 39.9, and 40.9 % for the treatments of 5, 10, 15 newly hatched larvae/plant, respectively.

Table (1): Average numbers of aphid and whitefly stages attacking bean plants post releasing *C. undecimpunctata* and the reduction percentages , under greenhouse conditions

Release level	Ave. no of aphid & whitefly stages /5 leaves (Reduction percentages)						The grand mean reduction%
	Period post release (weeks)						
	Pre-release	2	4	6	8	10	
5 larvae /plant	42 a	35 a (12.3)	8 b (80.7)	11 b (10.3)	6 b (55.7)	4 b (42.2)	(38.24)
10 larvae/ plant	36 b	25 b (26.9)	6 b (79.7)	9 b (2.2)	4 b (63.9)	2 b (56.6)	(45.86)
15 larvae/ plant	39 ab	15 c (59.5)	3 b (83.1)	5 b (8.7)	2 b (67.5)	2 b (29.6)	(49.68)
Control	40 ab	38 a	45 a	69 a	85 a	98 a	-
LSD 5%	3.8	5.5	4.9	6.1	4.7	3.8	

Means in each column followed by the same letter are not significantly different at 5% level.

Table (2): Average numbers of aphid and whitefly stages attacking bean plants post releasing *C. undecimpunctata* under open field conditions

Release level	Ave. no of aphid & whitefly /5 leaves						The grand mean reduction%
	Period post release (weeks)						
	Pre-releasing	2	4	6	8	10	
5 larvae/ plant	65 a	52 a (2.9)	37 b (45.4)	27 b (35.0)	14 b (54.8)	12 b (52.0)	(38.0)
10 larvae/ plant	44 b	39 b (6.7)	30 c (40.9)	20 b (40.7)	12 b (47.7)	8 c (62.7)	(39.9)
15 larvae/ plant	48 b	23 c (17.2)	16 d (46.6)	13 c (27.7)	6 b (59.7)	5 d (53.4)	(40.9)
Control	68 b	56 a	73 a	82 a	94 a	168 a	-
LSD 5%	6.6	5.2	5.9	12.5	13.5	2.8	

Means in each column followed by the same letter are not significantly different at 5% level.

Obtained results, indicated that the release process was more effective in reducing aphid and whitefly numbers in greenhouses than those under open field conditions; this may be due to the relatively controlled conditions inside the greenhouses.

These results are in agreement with Bratu (1998) who determined the efficiency of the predator *C. septempunctata* L. released in the egg stage to reduce populations of the pest *Myzus persicae* (Sulz.) in pepper crops, El-Habi *et al*.(1999) controlled *A. gossypii* on cucumber under glass by *C. septempunctata*. Also, the obtained results are in harmony with those obtained in Egypt by Zaki *et al.* (1999) ; Al-Eryan *et al*. (2001) who used *C. 11-punctata* (Coleoptera: Coccinellidae) against *A. gossypii* . on okra plant; Halima (2005) stated a program for the biological control of *A. gossypii* on pepper plant using *Coccinella algerica*. Abd-Rabou (2008) studied mass production, releasing and evaluation of *C. undecimpunctata* for controlling of aphids in Egypt. In addition, Obrycki *et al.* (2009) reported that coccinellids and aphids interact in a wide range of agricultural and forest habitats and the value of coccinellid predation for aphid suppression in these systems varied from a minor role to significant reductions leading to within-season control. Furthermore, Hodek and Honek (2009) stated a review survey of food relationships of coccidophagous, aleurodophagous and psyllophagous coccinellids, and found that while in cold temperate climate aphids are the dominant prey group (68% of ladybird species), globally, coccids are the dominant prey group of (36%) of coccinellid species, and only (20%) prey primarily on aphids. Special attention was given to the physiological and environmental factors that affect the nutritive suitability of prey. Recently in Egypt Simmons and Abd-Rabou (2011) reported that The use of predators as a biological control method against many insect pests was successively applied under field conditions or in greenhouse shields (Simmons and Abd- Rabou 2011).

From the obtained results, it could be concluded that the releasing process significantly controlled aphid and whitefly insects and could be successively applied in greenhouses at the rate of 10 larvae of lady bird predator at a threshold of 100 insect stages of aphids or /and white fly per plant.

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المكافحة البيولوجية للحشرات الثاقبة الماصة التى تصيب الفاصوليا تحت ظروف الحقل والصوبة

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الملخص العربى

تم اجراء هذا البحث تحت الظروف المعملية وتحت الظروف الحقلية بمزرعة وصوبة خاصة بمركز شبين الكوم، محافظة المنوفية ، مصر ، وذلك فى الفترة من منتصف فبراير وحتى منتصف مايو للعام 2014 ، لمكافحة كل من حشرة المن والذبابة البيضاء على نبات الفاصوليا (صنف برونكو) باستخدام احد وسائل المكافحة البيولوجية وهى اطلاق مفترس ابى العيد ذى الاحدى عشرة نقطة تحت ظروف الحقل والصوبة.

أوضحت النتائج المتحصل عليها أنه عند اطلاق المفترس تحت ظروف الصوبة البلاستيكية فإن اعلى متوسط عام لنسبة موت للفرائس (المن والذبابة البيضاء) كانت 49,68 ٪ عند اطلاق 15 يرقة حديثة الخروج للمفترس لكل نبات ، اما عند اطلاق 10 يرقات حديثة الخروج للمفترس لكل نبات كانت نسبة الموت 45,86 ٪ واخيرا أقل نسبة موت كانت عند اطلاق 5 يرقات حديثة الخروج للمفترس لكل نبات حيث اعطت 38,24 ٪ ، وسجلت اعلى نسبة موت للفرائس بعد 4 اسابيع من الاطلاق (83,1٪) عند مستوى اطلاق 15 يرقة /نبات .

أما عند اجراء المكافحة البيولوجية لحشرتى المن والذبابة البيضاء باستخدام مفترس ابى العيد ذى الاحدى عشرة نقطة تحت ظروف الحقل المفتوح ، سجلت النتائج أن أعلى نسبة موت للفرائس (المن والذبابة البيضاء) كانت 40,9 ٪ عند اطلاق 15 يرقة حديثة الخروج للمفترس لكل نبات ، وعند اطلاق 10 يرقات حديثة الخروج للمفترس لكل نبات اعطت نسبة موت 39,9 ٪ ، وأخيرا اقل نسبة موت كانت عند اطلاق 5 يرقات حديثة الخروج للمفترس لكل نبات وأعطت 38 ٪ ، ويوصى البحث بإمكانية استخدام المفترس بنجاح ضد الحشرات الثاقبة الماصة فى كل من الحقل المفتوح والصوب وان كان الاطلاق فى الصوب اعطى نتائج عالية.