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BIOLOGICAL CHARACTERISTICS AND PREDATION EFFICACY OF *COCCINELLA UNDECIMPUNCTATA* LINNAEUS ON CEREAL APHID, *RHOPALOSIPHUM PADI* (L.)

El-Maghraby, M. M. A.[1], K. A. A. Hammad[1], Jasmin E. Abd El-Megid[1] and I. M. El-Baz[2]

[1]Dept. of Plant Protection, Fac. of Agric., Zagazig Univ., Egypt.
[2]Plant Protection Research Institute, Dokki, Egypt

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ABSTRACT: The biological characteristics and predation efficacy of *Coccinella undecimpunctata* L. fed on cereal aphid, *Rhopalosiphum padi* (L.), colonized on wheat plants were studied under laboratory conditions of 20.7-25.9°C and 52.8-61.7% RH. The obtained data are summarized as follow: The 1st, 2nd, 3rd and 4th larval durations averaged 2.00±0.00, 2.94 ± 0.04, 3.03±0.07 and 3.55 ± 0.11 days, respectively. The total larval duration ranged between 11 and 13 days, with an average of 11.55 ±0.12 days. The daily consumed aphids by the 1st, 2nd, 3rd and 4th larval instars varied from 7.0 to 12.5, 11.3 to 18.0, 11.5 to 22.3 and 18.8 to 28.3 individuals, respectively. The total consumption during larval stage ranged between 171 and 221 preys per larva, with an average of 192.09±2.70. The 4th and 3rd larval instars are the most efficient as they consumed 43.16 and 27.64% of the total consumed preys during the whole larval stage. The pupal stage lasted an average of 4.33±0.14 days. The pre–oviposition, oviposition, post- oviposition periods lasted averages of 4.82±0.31, 10.76±0.74 and 6.59±0.73 days, respectively. The total consumed preys during the above mentioned periods averaged 113.94±9.04, 337.71±23.20 and 192.18±22.21 aphids per female respectively. The number of deposited eggs per female averaged 98.67±8.11 eggs. The female and male longevities averaged 22.18±0.84 and 19.45±2.41 days, respectively. The total consumed aphids by the adult averaged 643.82±26.04 and 563.63±78.46 individuals per female and male, respectively. The adult female is considered the most efficient predatory stage as it consumed about 3.6 times as much as that of the larva.

Key Words: *Coccinella undecimpunctata* L., biological characteristics, predation efficacy, cereal aphid.

INTRODUCTION

Wheat is one of the most important cereal crops. The Egyptian agricultural policy aims to increase wheat production to reduce the food gap between the consumption and production. The grown wheat area in Sharkia Governorate is about 308489 feddans with an average production of about 2.869 tons / feddan (Anonymus , 2003).

Few pests attack wheat plants from sowing till harvest. The most injurious insect pests are cereal aphids (El-Hag and El-Meleigi, 1991, Abou –Ellhagag and Abdel-Hafez, 1998, Abdel-Rahman *et al.*, 2000, El-Bouhssini *et al.*, 2003, El-Aish-Hana *et al.*, 2004 and El-Heneidy *et al.*, 2004) which sometimes cause severe losses in yield. These losses were estimated by 7.5-18.7% of the total wheat production in middle and upper Egypt (Tantawi, 1985). The injury of aphids comes through either direct feeding and / or transmission of viral diseases.

Chemical insecticides induced major well known problems such as health hazards to human and animals, destruction of biological control agents and increased resistance of insects to insecticides. All wheat producing countries have planned to minimize insecticides application in wheat fields (Picard, 1987). Recently, entomologists suggested Integrated Pest Management (IPM), using all other control methods which emphasize on biological control (Havlickova, 1997, Dent, 1999 and Schuler *et al.* , 1999).

The entomophagous insects especially aphidophagous species play an important role in suppression of aphid populations. Coccinellids are considered among the most important predaceous insects attacking aphids, thus minimizing their population in the fields (Hagen and Bosch, 1968, Grevstad and Klepetka, 1992, Frier and Triltsch, 1996 and Semyanov *et al.*, 1996). *Coccinella undecimpunctata* L. (Coleoptera: Coccinellidae) is the most common predator in the wheat fields (El-Heneidy and Attia, 1988–1989, Ghanim and El-Adl, 1991, Ibrahim and Afifi, 1991, El-Hag, 1992, El-Heneidy, 1994, Abou-El-Hagag and Abdel-Hafez,1998 and El-Heneidy *et al.*, 2004).

Aim of the present work is to evaluate the role of *C. undecimpunctata* as an important biological control agent in suppressing cereal aphids by

studying its biological aspects and predation efficacy under laboratory conditions.

MATERIALS AND METHODS

This study was conducted in the Biological Control Laboratory, Plant Protection Department, Faculty of Agriculture, Zagazig University. The daily maximum and minimum temperature and relative humidity during the experimental period were recorded.

The adults of *C. undecimpunctata* were collected from wheat fields and reared on cereal aphid, *Rhopalosiphum padi* (L.), colonized on wheat plants. The culture of the predator was examined daily, provided with the aphids as prey and the egg-masses were transferred into Petri dishes (10 cm diameter) furnished with a filter paper. The egg-masses were observed daily until hatching.

Thirty five newly hatched larvae were kept singly in Petri dishes (as previously described) and provided daily with enough known number, ca. 50 individuals, of different stages of cereal aphid, *R. padi*, on pieces of wheat plants. The examination was done daily, whereas the devoured aphids were recorded and the rest of aphid individuals and the plant pieces were removed from Petri dishes before introducing the new aphid individuals. Durations and daily number of consumed aphids per larval instars were determined, as well as the pupal period.

The same technique as previously mentioned in case of larvae was used for rearing the adults. The newly emerged adults were coupled in Petri dishes (one female and one male each) and provided daily with enough known number of aphids. The experiment comprised fifteen replicates. After copulation took place, adult females and males were kept singly, each in a Petri dish. The dishes were inspected daily and the deposited eggs were counted and removed. The daily number of consumed preys, pre- oviposition, oviposition, post-oviposition periods and longevity of each female and male were estimated. The obtained data were statistically analyzed according to Snedecor and Cochran (1987).

RESULTS AND DISCUSSION

Larval Stage

Larval durations

Data given in Table 1 clearly showed that the 1^{st}, 2^{nd}, 3^{rd} and 4^{th}

larval instars lasted 2, 2-3, 2-4 and 3-5 days with averages of 2.00 ± 0.00, 2.94 ± 0.04, 3.03 ± 0.07 and 3.55 ± 0.11 days, respectively. The prevailing means of temperature and relative humidity during the larval period were 21.4°C and 58.8% RH, consecutively. The total larval duration ranged between 11 and 13 days, with an average of 11.55 ± 0.12 days.

Eraky and Nasser (1993) mentioned that the larval stage of this predator was completed in 7, 7.5, 12, 16 and 23 days at 30, 26, 22, 18 and 14°C, respectively. Ahmed (2000) revealed that the four larval instars of *C. undecimpunctata* preyed on *R. maidis* colonizing maize plants under constant laboratory conditions (28°C and 70% RH) lasted 2, 1.57 ± 0.11, 1.05 ± 0.08 and 1.68 ± 0.12 days, respectively. The larval stage lasted an average of 6.30±0.24 days. El-Aish–Hana *et al.* (2004) indicated that the 1st, 2nd, 3rd and 4th larval instars of *C. septempunctata* reared on cereal aphids infesting wheat plants under room temperature lasted 3,2,2 and 4 days, successively.

Predation efficacy

Data obtained in Table 1 showed that the daily feeding capacity of the 1st larval instar varied from 7.0 to 12.5 aphids, with an average of 9.01±0.22 preys. The total consumed aphids by this instar was 14 to 25, with an average of 18.03±0.44.

The second larval instar preyed on 11.3 to 18.0 aphids daily, with an average of 12.96±0.27 individuals. This instar consumed a total of 29 to 54 preys, with an average of 38.06±0.85.

The daily consumed aphids by the third larval instar varied from 11.5 to 22.3 individuals, with an average of 17.55±0.39. The total feeding capacity of this instar ranged between 32 and 75 aphids, with an average of 53.09±1.58.

The daily feeding capacity of the fourth larval instar varied from 18.8 to 28.3 preys, with an average of 23.70 ± 0.42. The total consumption by this instar averaged 82.91±1.75 aphids, with a range of 71 to 113.

The daily consumed aphids during the total larval developmental period ranged between 14.4 and 19.2 preys per larva, with an average of 16.66 ± 0.21. The total consumption during this stage averaged 192.09±2.70 aphids per larva, with a range of 171 to 221.

Table 1: Duration and predation efficacy of *Coccinella undecimpunctata* L. larvae predated on cereal aphid, *Rhopalosiphum padi* (L.), colonized on wheat plants under laboratory conditions (20.7-22.8°C and 52.8-61.7% RH)

Biological characteristics	Duration (in days)		Daily consumed aphids		Total consumed aphids		Consumption %	Means of	
	Range	Mean	Range	Mean	Range	Mean		Temp. °C	RH%
Larval stage	11-13	11.35±0.12	14.4-19.2	16.66±0.21	171-221	192.09±2.70	100.00	21.4	58.8
1st instar	2-2	2.00±0.00	7.0-12.5	9.01±0.22	14-25	18.03±0.44	9.39	20.9	58.5
2nd instar	2-3	2.94±0.04	11.3-18.0	12.96±0.27	29-54	38.06±0.85	19.81	22.5	54.3
3rd instar	2-4	3.03±0.07	11.5-22.3	17.55±0.39	32-75	53.09±1.58	27.64	20.7	60.8
4th instar	3-5	3.55±0.11	18.8-28.3	23.70±0.42	71-113	82.91±1.75	43.16	21.5	61.7
Pupal stage	3-6	4.33±0.14						22.8	52.8

The 1st, 2nd, 3rd and 4th larval instars consumed 9.39, 19.81, 27.64 and 43.16% of the total consumed preys during the whole larval stage, respectively. These findings indicated that the greatest number of aphids was consumed by the 4th and 3rd larval instars.

These results are in agreement with those of Ahmed (2000) who mentioned that the 3rd and 4th larval instars are the most efficient in predation, as they fed on 78.06% of the total number of consumed aphid (*R. maidis*) during the larval period. El-Aish-Hana *et al.* (2004) reported that the larva of *C. septempunctata* consumed daily 26.9 individuals of cereal aphids at room temperature.

Pupal Stage

As shown in Table 1, the pupal period ranged between 3 and 6 days, with an average of 4.33±0.14 days at means of 22.8°C and 52.8% RH.

Eraky and Nasser (1993) revealed that the pupal period of the predator averaged 2.5 days at 30°C and 7.5 days at 14°C. Ahmed (2000) stated that the pupal stage of *C. undecimpunctata* under constant laboratory conditions (28°C and 70% RH) averaged 3.75 ± 0.11 days. On the other hand, El-Aish-Hana *et al.* (2004) reported that the pupal stage of *C. septempunctata* lasted 8 days at room temperature.

Adult Stage

Female

Pre-ovipostion period

The pre-oviposition period varied from 3 to 7 days, with an average of 4.82±0.31 days at means of 24.4°C and 55.0% RH (Table 2). During this period, the female consumed 19.7 to 29.0 aphids daily, with an average of 23.38±0.51 individuals. The total consumed preys by one female during this period ranged between 59 and 203 individuals, with an average of 113.94 ± 9.04 aphids.

These results are in full agreement with the findings of Ahmed (2000) who mentioned that the total consumed aphid by one female during the pre-oviposition period was 112.40 ± 23.63 individuals of *R. maidis*.

Oviposition period

Data presented in Table 2 showed that the oviposition period lasted 5 to 15 days, with an average of 10.76 ± 0.74 days at means of 25.3°C and 55.0% RH. The female consumed 27.4 to 33.7 aphids daily, with an average of 31.42 ± 0.42 individuals. The total consumed aphids by one female during this period ranged between

158 and 450 individuals, with an average of 337.71±23.20 aphids. The number of deposited eggs per female averaged 98.67 ± 8.11, with a range of 67 to 155.

Eraky and Nasser (1993) reported that the egg production per female averaged 142.33 at a constant temperature of 26°C. Ahmed (2000) indicated that the adult female during the oviposition period consumed daily an average of 85.96 aphids (*R. maidis*). This variation may be due to the different rearing conditions in temperature, relative humidity and prey species, as Eraky and Nasser (1993) mentioned that the temperature increased predation on *R. padi* by *C. undecimpunctata*. The present results are in harmony with those of Ahmed (2000) who revealed that the greatest number of consumed aphids by adult female was during the oviposition period.

Post-oviposition period

As indicated in Table 2, the post-oviposition period varied from 3 to 13 days, with an average of 6.59±0.73 days at means of 25.9°C and 57.1% RH. During this period, the female consumed 23.3 to 33.0 aphids daily, with an average of 28.96 ± 0.63 preys. The total consumption during this period averaged 192.18±22.21 aphids per female, with a range of 70 to 367 individuals.

These results are in agreement with those of Ahmed (2000) who mentioned that the mean number of consumed aphids by adult female during the post-oviposition period was relatively higher and lower as compared with those consumed during pre-oviposition and oviposition and oviposition periods, respectively.

Longevity

The female longevity ranged between 11 and 28 days, with an average of 22.18±0.84 days at means of 24.8°C and 56.7% RH (Table 2). The female consumed 26.1 to 30.5 aphids daily, with an average of 29.09±0.26 individuals. The total consumed aphids by one female during its life span varied from 287 to 854 individuals, with an average of 643.82±26.04 preys.

Male

Data given in Table 2 revealed that the male longevity lasted 10 to 37 days, with an average of 19.45±2.41 days at means of 24.8°C and 56.7% RH. One male during its longevity consumed 26.4 to 31.6 aphids daily, with an average of 28.54 ± 0.48 preys. The total consumed aphids by male during its life span was 264 to

Table 2: Longevity , predation efficacy and fecundity of adults of *Coccinella undecimpunctata* L. predated on cereal aphid, *Rhopalosiphum padi* (L.), colonized on wheat plants under laboratory conditions (24.4-25.9°C and 55.0 – 57.1% RH)

Biological characteristics	Duration (in days)		Daily consumed aphids		Total consumed aphids		Fecundity / female		Means of	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Temp. °C	RH%
Female:										
Pre-oviposition period	3-7	4.82±0.31	19.7-29.0	23.38±0.51	59-203	113.94±9.04			24.4	55.0
Oviposition period	5-15	10.76±0.74	27.4-33.7	31.42±0.42	158-450	337.71±23.20	67-155	98.67+8.11	25.3	55.0
Post-oviposition period	3-13	6.59±0.73	23.3-33.0	28.96±0.63	70-367	192.18±22.21			25.9	57.1
Longevity	11-28	22.18±0.84	26.1-30.5	29.09±0.26	287-854	643.82±26.04			24.8	56.7
Male longevity	10-37	19.45±2.41	26.4-31.6	28.54±0.48	264-1153	563.63±78.46			24.8	56.7

1153 individuals, with an average of 563.63±78.46 aphids.

On basis of the previously discussed results, it could be concluded that the adult female is considered the most efficient aphidophagous stage as it consumed about 3.6 times as much as that of the larva. This may be due to larger size and longer longevity of the adult (El-Agamy *et al.* 1994). Also, the female consumed about 1.14 times as much as that consumed by the male.

These results are in harmony with the findings of El-Aish – Hana *et al.* (2004) who revealed that the adult of *C. septempunctata* consumed 46.13 aphids daily, while the larva consumed 26.9 and the predation efficacy showed significant difference between larvae and adults.

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الخصائص البيولوجية والكفاءة الإفتراسية لأبى العيد ذو الإحدى عشر نقطة على من النجيليات *Rhopalosiphum padi* (L.)

محمد مصطفى المغربى[1] - كامل عبداللطيف عبدالله حماد[1] -
يسمين الهادى عبدالمجيد[1] - إبراهيم محمد الباز[2]
[1]قسم وقاية النبات- كلية الزراعة- جامعة الزقازيق – الزقازيق – جمهورية مصر العربية
[2]معهد بحوث وقاية النباتات – الدقى - مصر

أجريت هذه الدراسة بهدف التعرف على الخصائص البيولوجية والكفاءة الإفتراسية لأبى العيد ذو الإحدى عشر نقطة على حشرة من النجيليات تحت الظروف المعملية، ولقد خلصت النتائج إلى مايلى :-

أن متوسط الأعمار اليرقية الأول والثانى والثالث والرابع هو ٢,٠، ٢,٩٤، ٣,٠٣، ٣,٥٥ يوماً على التوالى، واستغرق الطور اليرقى ١١-١٣ يوماً بمتوسط ١١,٥٥يوماً.

تراوح عدد المن المفترس يومياً بالأعمار اليرقية الأول والثانى والثالث والرابع مابين ٧,٠- ١٢,٥ ، ١١,٣-١٨,٠ ، ١١,٥-٢٢,٣، ١٨,٨-٢٨,٣ فرداً على التوالى . كما تراوح أيضاً عدد الضحايا من المن خلال فترة نمو يرقة واحدة من المفترس مابين ١٧١-٢٢١ بمتوسط ١٩٢,٠٩ فرداً . وكذلك أتضح أن العمرين اليرقيين الثالث والرابع هما الأكثر كفاءة حيث إفترسا ٢٧,٦٤، ٤٣,١٦% من إجمالى الضحايا المستهلكة خلال الطور اليرقى.

واستغرق طور العذراء ٤,٣٣ يوماً فى المتوسط، بينما متوسط فترات ماقبل وضع البيض، وضع البيض، ما بعد وضع البيض ٤,٨٢، ١٠,٧٦، ٦,٥٩ يوماً على التوالى . كذلك فإن متوسط العدد الكلى للمن كضحايا خلال الفترات السابقة ١١٣,٩٤، ٣٣٧,٧١، ١٩٢,١٨ فرداً لكل أنثى من المفترس على التوالى. وضعت الأنثى ٩٨,٦٧ بيضة فى المتوسط.

وبلغ متوسط طول عمر الأنثى والذكر ٢٢,١٨ ، ١٩,٤٥ يوماً على التوالى . وبلغ متوسط ماتفترسة الأنثى خلال فترة حياتها ٦٤٣,٨٢ ضحية واستهلك الذكر ٥٦٣,٦٣ فرداً من المن فى المتوسط . ولاشك أن الأنثى تعتبر من أكثر الأطوار كفاءة فى الإفتراس حيث بلغ ما تفترسه ٣,٦ مرة قدر ما يستهلكه الطور اليرقى.

وتوضح تلك النتائج أن أبى العيد ذى الإحدى عشر نقطة يلعب دوراً هاماً فى السيطرة على تعداد من النجيليات مما قد يفيد كثيراً فى وضع برامج المكافحة المتكاملة لهذه الآفة.