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Predation Efficacy of the Predator *Coccinella septempunctata* L. on the Aphid Species *Macrosiphum rosae* (L.) in Kastamonu Province, Turkey

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Authors' Contributions
SU designed the study. SU and AE performed field and experimental work. SU, AE and EA analyzed the data. All authors contributed towards the preparation of manuscript.

Key words
***Coccinella septempunctata, Macrosiphum rosae,* Predition efficiency**

ABSTRACT

This study was conducted between the years 2013-2014 in order to determine the phenology of the predator *Coccinella septempunctata* Linnaeus (Coleoptera: Coccinellidae) and to evaluate its efficacy on *Macrosiphum rosae* (Linnaeus) (Hemiptera: Aphididae) in Kastamonu, Turkey. Rearing of *C. septempunctata* was carried out at 21.3±4.00ºC and 78.8±9.44% relative humidity. The first, second, third and fourth larval instars of *C. septempunctata* consumed 20.3, 54.3, 108.2, and 232.7 *M. rosea*, respectively. The predation efficacy of the *C. septempunctata* was increased with the progress of the larval instars up to the fourth which was the most voracious.

INTRODUCTION

Biological control is a method of pest management by using other living organisms such as bacteria, fungi, nematodes, insects, and birds (Machar and Drobilová, 2012). Insects are the most widely used agent group for biological control (Oğurlu, 2000). Family *Coccinellidae* (Coleoptera) is one of the most important insect families which have a potential to be used in biological control in agriculture as well as in forestry (Evans, 2010). *Coccinella septempunctata* Linnaeus is an important species of the family, because it is a natural predator of many aphid species in Turkey. The species predates nymphal instars as well as adults of aphids.

Coccinella septempunctata Linnaeus is an important species of the family Coccinellidae (Coleoptera: Coccinellidae), because it is a natural predator of many aphid species in Turkey. Therefore, it has a potential to be used as biological control agent. The species hunts nymphal instars as well as adults of aphids. *Coccinella septempunctata* can be found on plants in various heights from herbs to trees (Uygun, 1981).

Aphids cause an increment loss on plants and deteriorate to plant health by sap-sucking. Therefore leaves can lose their function and can be mutilated. For biological control against aphids many agents can be used such as birds, larvae of *Syrphidae*, adults and larvae of *Coccinellidae*, earwigs, parasitic bees and fungal diseases (Anonymous, 2014). Various studies have been conducted to determine the predatory efficiency of *Coccinella septempunctata* and other aphidophagous coccinellids consuming different aphid species (Ghanin and El-Adl, 1991; Ferran *et al*., 1996; Sattar *et al*., 2008; Mahyoub *et al*., 2013; Rauf *et al*., 2013).

Macrosiphum rosae (Linnaeus) *(Hemiptera: Aphididae)* is one of the important aphid species that damages rose leaves. Nymphs and adults of this species attack shoots and buds for sucking the plant sap. Besides, *M. rosae* has a potential to transmit 12 different plant viruses such as the Rose mosaic and the Rosa streak virus (Toros, 1991; Blackman and Eastop, 2000; Şahin, 2007).

Kocadal (2006) reported 8 different species from Coccinellidae family including *C. septempunctata* as the natural predators of Aphids. Kocadal (2006) also indicated that *M. rosae* is found only on roses. Kolas (2007) pointed out that Coccinellids belong to the most abundant predator species on poplar. He also defined that they play a role within the natural balance between predators and preys. Şahbaz (2005) identified 21 predator species belonging to 4 families and 2 unidentified predator species belonging to 2 genera which are found on poplar in Konya. Furthermore, he reported that 16 of these species were from the family Coccinellidae. Avcı *et al*. (2011) indicated *A. craccivora* as a main pest on the black locust (*Robinia pseudoacacia)* trees. *Adalia fasciatopunctata revelierei* (Mulsant), *A. decempunctata* (Linnaeus), *A. bipunctata* (Linnaeus),

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Exochomus quadripustulatus (Linnaeus), *Propylaea quatuordecimpunctata* (Linnaeus), *Hippodamia variegata* (Goeze), *H. undecimnotata* (Schneider) and *Oenopia oncina* (Olivier) were also identified as predator species which have an effect on *Aphis craccivora* population (Avcı *et al*., 2011). Sarwar and Saqib (2010) studied the development of *C. septempunctata* by using natural and artificial foods in laboratory conditions, and mentioned that this development cycle lasted 29.0 days using artificial foods and 20.6 days using natural foods. Singh and Singh (2013) determined that *C. septempunctata* total developmental time was 25.57±1.20 days feeding with *Lipaphis erysimi* (Kaltenbach) (Hemiptera: Aphididae) at the temperature of 25±1°C and RH 65±5%. Kaygın *et al*. (2009) recorded *M. rosae* on host plants such as *Rosa* sp., *Rubus fructicosus* L., and *Taraxacum officinale* (L.) in Bartın region. Kaya (2009) identified a total of 34 species belonging to 20 genera in his study about determination of species belonging to Coccinellidae family at orchards in Isparta region in years between years 2007-2008.

Chemical control methods are one of the preferred methods to fight against aphids. However, they can cause some problems such as deterioration of natural balance, killing non-target organisms (natural enemies and wild animals), environmental pollution, health hazard for humans as well as for animals, drug residues on agricultural products and gaining pesticide resistance (Kocadal and Ulusoy, 2008).

The present work was aimed to evaluate the predatory efficacy and phenology of *C. septempunctata* against *M. rosae*. Although there are similar studies in the literature, this study is the first under climatic conditions of Western Blacksea Region.

MATERIALS AND METHODS

This study was conducted at Kastamonu-Central district of Turkey in years 2013 and 2014. Kastamonu is located in the Western Blacksea Region of Turkey (41°22’35.8500’’N, 33°46’35.3892’’E).

Individuals of *M. rosae* were captured from rose twigs in Kastamonu parks and gardens as well open fields. Sweeping nets were used to obtain adult individuals of the *C. septempunctata* in April. In the laboratory, adults were placed in wooden cages with dimensions of 45x50x75 cm, glass-topped and covered by cheesecloth on side rear sides. Crumpled newspapers were placed in to wooden cages to ease the release of mature eggs.

Freshly hatched larvae were fed in separate plastic feeding box to determine predator efficacy of the larval instar of *C. septempunctata. M. rosae* were given to the predators every day during developing of larval instars. Remaining number of aphids were counted on the following day. Thus, consumption of aphids was quantified daily during each larval instar. Six larval groups from 30 eggs were surveyed and also predator oviposition date, incubation period, larval stages, pupa and adult period were determined.

RESULTS AND DISCUSSION

In this study, 6 larval groups from 30 eggs were surveyed and also predator oviposition date, incubation period, larval stages, pupa and adult period were determined (Table I).

Figure 1 shows the life stages of the predator *C. septempunctata* in Kastamonu province. The predator have only one generation per year and hibernated during winter in the study area. Honek and Martinkova (2005) also reported that this predator has only one generation in the Czech Republic per year.

Our study showed that in Kastamonu region under 21.3±4.00ºC average temperature and 78.8±9.44% relative humidity, *C. septempunctata* incubation period lasted 5.33±0.82 days, the first larval instar lasted 4.17±0.75 days, the second larval instar 3.67±0.52 days, the third

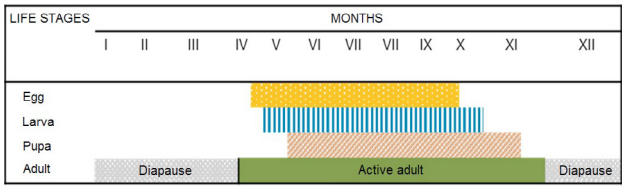

Fig. 1. Phenology of *Coccinella septempunctata* in Kastamonu region.

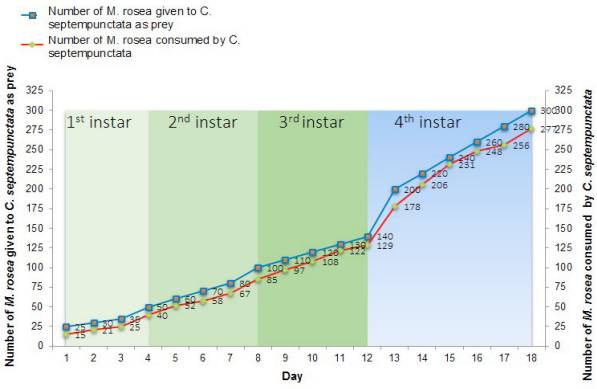

Fig. 2. Predator efficiency of *Coccinella septempunctata* on *Macrosiphum rosae.*

Table I.- Basic data of *Coccinella septempunctata* life stages in the year 2014.

Group (30 eggs)	Egg oviposition date	Incubation period	Larval Periods				Pupal period	Adult period
			1	2	3	4		
1	26.04.14	7	03.05.14	07.05.14	10.05.14	15.05.14	21.05.14	26.05.14
2	02.05.14	5	07.05.14	11.05.14	15.05.14	18.05.14	23.05.14	28.05.14
3	03.05.14	5	08.05.14	12.05.14	16.05.14	20.05.14	25.05.14	29.05.14
4	06.05.14	5	11.05.14	14.05.14	17.05.14	21.05.14	25.05.14	30.05.14
5	07.05.14	5	12.05.14	17.05.14	21.05.14	25.05.14	31.05.14	06.06.14
6	07.05.14	5	12.05.14	17.05.14	21.05.14	26.05.14	31.05.14	05.06.14
*Average time (day)		5.33±0.82	4.17±0.75	3.67±0.52	4.17±0.75	5.17±0.75	5.00±0.63	

Date format, dd.mm.yy.

Table II.- Biological periods of *Coccinella septempunctata* in different temperature and moisture.

Temperature/ relative humidity	Incubation period (Day)	Time of larval period (Day)				Larval stage (Day)	Pupal stage (Day)	References
		First	Second	Third	Fourth			
26±2°C / 65±5%	4.3±0.81	2.9±0.42	4.6±0.47	5.4±0.66	7.5±0.72	18.3±0.53	4.9±0.58	Sattar *et al*. (2008)
23±2°C / 65±5%	2-3	1-2	2-4	2-4	2-4	6-9	5-8	Mahyoub *et al.* (2013)
20±1°C / 60±5%	5.12±0.08	5.99±0.06	6.03±0.11	5.03±0.13	12.49±0.10	29.55±0.18	14.01±0.11	Rauf *et al*. (2013)
25±1°C / 60±5%	3.62±0.12	3.44±0.07	2.78±0.10	2.33±0.09	7.40±0.15	15.96±0.21	9.27±0.11	Rauf *et al*. (2013)
30±1°C / 60±5%	3.20±0.25	1.18±0.01	1.26±0.02	1.63±0.09	4.08±0.04	8.16±0.06	5.22±0.09	Rauf *et al*. (2013)
25±1°C / 65±5%	4.50±0.29	2.86±0.12	2.43±0.11	2.30±0.13	3.55±0.14	11.15±0.5	5.60±0.18	Singh and Singh (2013)
21.3±4ºC/79±9%	5.33±0.82	4.17±0.75	3.67±0.52	4.17±0.75	5.17±0.75	17.17±1.94	5.00±0.63	This study

Table III.- Number of aphids consumed by *Coccinella septempuncta* within different larval stages.

Temperature/ relative humidity	Larval stages				Consumed species	References
	First	Second	Third	Fourth		
26±2°C / 65±5%	21.9	55.9	107.4	227.3	*Aphis gossypii*	Sattar *et al*. (2008)
23±2°C / 65±5%	35	63	96	290	*Aphis fabae*	Mahyoub *et al*. (2013)
20±1°C / 60±5%	37.03±1.28	79.06±2.61	115.50±3.93	342.10±8.15	*Schizaphis graminum*	Rauf *et al*. (2013)
25±1°C / 60±5%	32.13±1.19	57.90±5.30	73.80±2.97	411.33±18.19	*Schizaphis graminum*	Rauf *et al.* (2013)
30±1°C / 60±5%	21.00±0.53	40.50±0.63	124.80±10.15	481.57±11.59	*Schizaphis graminum*	Rauf *et al*. (2013)
21.3±4ºC / 79±9%	20.3	54.3	108.2	232.7	*Macrosiphum. rosae*	This study

larval instar 4.17±0.75 days, the forth larval instar lasts 5.17±0.75 days and pupal period was 5.00±0.63 days. The total larval stage lasted 17.17±1.94 days (Table II).

In this study, *C. septempunctata* larvae from first to last instars were fed with the increasing number of *M. rosea*. Quantities of pests consumed by *C. septempunctata* during its larval instars clearly indicated that number of consumed aphids had increasing trend (Fig. 2). Consequently, the predation efficacy of the *C. septempunctata* was increased with the progress of the larval instars up to the fourth which was the most voracious. This findings are consistent with the results in previous studies (Sattar *et al*., 2008; Mahyoub *et al*., 2013; Rauf *et al*., 2013; Sarmad *et al*., 2015).

Number of aphids consumed by *C. septempunctata* on different larval stages are less in comparison with other studies (Table III). Mahyoub *et al*. (2013) and Rauf *et al*. (2013) reported that the total number of consumed aphids in various conditions was from 484 to 668 individuals, while obtained data showed only a total number of 414 individuals. Only Sattar *et al*. (2008) found out less number of consumed aphids (415.5 individuals) (Table III).

Saleem *et al*. (2014) found out that the number of consumed *M. rosea* by another Coccinellid species *Menochilus sexmaculatus* (Fabr.) under 27±2°C average temperature and 62±5% relative humidity was as follows: The first larval instar of *Menochilus sexmaculatus* consumed 8.4±0.50 individuals of *M. rosae*, the second larval instar 13.6±0.81 individuals, the third larval instar 28.6±1.5 individuals, and the forth larval stage 57.4±4.67 individuals. Comparison of predator efficacy between *M.sexmaculatus* ve *C. septempunctata* on *M. rosea* showed that *C. septempunctata* consumed more aphid than *M. sexmaculatus*. According to our results, fourth larval instar with 5.17±0.75 day period has been found more efficient. However, third larval instar seems to be more appropriate for predator release because after fourth larval instar predator will develop to pupal stage in a short time. Ferran *et al*. (1996) support the predator release in its next-to-last larval instar using *Harmonia axyridis* Pallas as a biological agent to *M. rosae*.

CONCLUSION

In conclusion, the first, second, third and fourth larval instars of *C. septempunctata* consumed 20.3, 54.3, 108.2, and 232.7 *M. rosea*, respectively. Thus, the predation efficacy of the *C. septempunctata* was increased with the progress of the larval instars up to the fourth which was the most voracious.

Statement of conflict of interest

Authors have declared no conflict of interest.

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