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BIOLOGY AND FEEDING POTENTIAL OF 7-SPOTTED BEETLE, *COCCINELLA SEPTEMPUNCTATA* (LINNAEUS) ON BERSEEM APHID, *THERIOAPHIS TRIFOLII* (MONELL) IN LABORATORY

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ABSTRACT

The present experiment was carried out on Biology and feeding potential of 7-spotted beetle, *Coccinella septempunctata* L. on berseem aphid, *Therioaphis trifolii* (Monell in the Biological Control Laboratory, Central Cotton Research Institute Sakrand during 2015. For this purpose, adult beetles reared in the laboratory at constant temperature and aphid collected from different crops from vicinity of Central Cotton Research Institute Sakrand were given to lady beetle for feeding. The pre-copulation, copulation and post-copulation periods were recorded as (4.4±0.69),(51.5±4.37) and (4.0±1.05) minutes, respectively. The pre-oviposion, oviposition and post-oviposition periods were averaged as 4.7±0.30, 36.6±4.88 and 5.0±1.69 days, respectively. The female deposited an average of 599.1±109.83 eggs during her life time in 30 days. Egg incubation period was noted 4.0±0.94 days with 90.35% hatching and mortality 17.56%. The larval and pupal durations were 12 and 5.2 days, respectively. The mean pupation rate % was 69.497±9.23 and the larval cannibalism rate was 30.497±9.23. The average number of pupae observed were 20.3 ± 4.47, while the male emergence was 37.47 ± 13.12 %) and the female emergence was 43.98 ± 8.24%). The result showed consumption rate of 1st, 2nd, 3rd and 4th instar larvae of *C. septempunctata* (22.0±4.12, 56.8±5.26, 143.8±5.93 and 289.6±9.65 aphids/day) on *T. trifolii*, respectively. In the same way, consumption rate of adult female (77.41±8.84/day) and male (48.94±6.29 /day) was on *T. trifolii*.

Key words: Biology, Feeding Potential, 7-spotted Ladybird beetle, and Berseem aphid

INTRODUCTION:

Coccinellids also known as ladybird beetles (*Coleoptera Coccinellidae*) are widely known as beneficial insects, because many species prey on aphids (*Rhynchota Aphididae*), scale insects (*Rhynchota Coccoidea*) and other agricultural pests (Honek *et al.,* 2013; Michaud, 2012). For this reason, coccinellids have often been considered for biological control and several species were also introduced in new countries as part of classical control programs (Michaud, 2012). Coccinellid beetles population found in the majority from the start of spring until the cool sets in drop. When cold established outdoor, Coccinellid beetles searched for protected habitats to make the home for hibernate (Mayo, 1998). Coccinellid predators can't hurt /sting, though they most likely make taste unpleasant and make unpleasant smelling odor, maybe by the way of a liquid from joints in the legs, which may assist to defend them. Ladybugs "play dead" during in risk because several predators will not consume an insect that doesn't travel (Fleming, 2000). Many different species of ladybugs have been used as biocontrol agents against the harmful insects. The problem is that a number of the imported coccinellid predators be able to compete with the local coccinellid predators for nourishment and habitation, and may change the inhabitants in many other places. It can decrease coccinellid predator's biodiversity and also can damage local ecosystems. Coccinellid predators, consume aphids and additional destructive pests such as scale insects, which can reduce the pest problems in Agriculture, Horticulture and floriculture farms (CNF, 2000; Marshall, 2000). Coccinellid predators have been broadly used as biocontrol agents for the control of harmful insects for over a century, and the augmentative releases of different ladybird species are well documented and efficient species can be frequently used as of easiness of collection. In the agricultural systems, conservation method for coccinellid predators are significantly emphasized and required for assessment of predator specificity and understanding colonization of new environments, to make best use of their in biological control (Obrycki**,** 1998). The aphidophoguous predatory beetle, *C. septempunctata* L. is one of the efficient predator of barseem aphid and mustard crop aphid, both are the key pests of the barseem, rapeseed and mustard crops. This beetle occupies relatively a amazing

place among the naturally occurring biological control agents of mustard aphid (Mathur, 1983). The scientists have conducted research on the behavior and effectiveness of its predation and biotic factors influencing its population in field and under the laboratory environment with varying results (Singh and Sing, 1986; Verma and Chaudhary, 1975). The *C. septempunctata* beetle prey on other living organisms; the beetles mature and immature stages prey on insects which damage the crops, specially sucking insects pests (Anonymous 1997). The coccinellid predators slay its victim completely and then eat greedily to it (Waldbauer, 1998).

The current research was undertaken for obtaining information on the biology of this predator under local sets of condition. Such information's would be helpful in mass culturing of this predator under laboratory conditions using different rearing food.

MATERIALS AND METHODS

1. Biology: Biology of *Coccinella septempunctata* L. was studies and noted during the period from January to March-2015 in Biological Control Laboratory, Central Cotton Research Institute Sakrand.

1.1 Culture development: Adult beetles of Coccinellid predator *C. septempunctata* were collected from barseem, mustard, maize, cotton, brinjal, okra, nerium, sunflower and other crops from vicinity of Central Cotton Research Institute Sakrand. The collected beetles were kept in the laboratory conditions for rearing purpose in chambered made up of timber cage about (25″× 10″×15″cm). The wall of cages was protected by wire gauze and face of each cage had an operator/observer hole protected by muslin cloth cover to give foodstuffs for predators. The new tender leaves of barseem holding the aphids (prey) were offered daily to the adult predators.

1.2 Development of life cycle

1. Fecundity: 7-spotted coccinellid beetle ten pairs were selected from the reared culture and were kept in separate cage for observing the eggs laid by each pair. The eggs put down mainly on leaves of given host plant and separated every day and kept in paired Petri dishes (9 cm.dia.) containing a filter paper extend over the base of petridishes. The laid quantity of eggs for each female in every Petri dish was calculated under binocular microscope. This method was carried out till the demise of the females. Each trial was kept and ten times was repeated for recording the correct data.

ii. Larval instars: The larval stages period was observed after hatching of eggs, which were kept each larva in Petri dish reared with aphids and repeated 10 times. The data for recording the morphological variations and moulting were observed every day up to last larval instar.

iii. Pupal and adult stages: The 4th instars larva was kept for recording the durations of pupal stages in Petri dishes (9.0×1.5 cm). The period of pupation was recorded twice a daily, awaiting the pupae were ecdyced and the adults come forwarded. The recently come forwarded adults were sexed and male and female pair were kept in Petri dishes and experiment was 10 times repeated. Pairs were supplied 150-250 aphids on fresh leaves of barseem the % appearance of male and female adults, their long life and male and female ratio were observed. The mortality of pupal and adult was noted every day by calculating the deceased pupae and adults.

1.3 Mating behaviour of adult 7-spotted beetle: The newly male and female adults were released in glass bowls (7 cm ×2.5 cm) in couples to confirm the study on mating performance, period of mating, pre-oviposition, oviposition and post oviposition durations. The total number of eggs laid by each females in her whole life, gravidity (incubation), duration of eggs hatching, egg hatching percent and death (mortality) were observed.

2. Feeding potential of 7-spotted beetle in laboratory.

2.1 Larval (grub) instars: The first instar larvae of *C. septempunctata* were moved into Petri dishes (9 cm. dia.) after hatching from eggs, by camel hair brush. For recording the feeding potential of predatory beetle larvae, the aphids were provided 30, 80, 130 and 250, along with the leaves of barseem crop on this trial was repeated five times. The trial was conducted on 1st, 2nd, 3rd and 4th instar larvae. The feeding potential of each larval instar of each predator on aphids was recorded following 24 hrs daily awaiting the larvae entered into next growth stage. The trial was continued until pupation occurred.

2.2 Adults: For observing the feeding potential of newly emerged adults of 7-spotted lady bird beetle collected from pupal culture at random. The adult's male and female coccinellids were kept divide in Petri dishes and trial study was repeated by providing 1920 and 2900 aphids to each adult beetle. The feeding potential of predatory Coccinellid beetle on aphids was noted following 24 hrs daily by calculating the quantity of live hosts. The trial study was carried out repeated five times for recording the accurate data.

3.0 RESULTS

The study was conducted to determine the biology of *Coccinella septempunctata* L. reared on barseem aphid, *Therioaphis trifolii* (MONELL)

under laboratory environment during the investigation period in the 2015. For the biological parameters ten couples of *C. septempunctata* were chosen from the reared couples and kept in split cage for further study**.** The interpretation on the results obtained is given as under.

3.1 Pre-copulation period: Table-1 shows that 7-spotted beetle was noted that the pre-copoulation (talent) period in male *Coccinella septempunctata* was 4.4 ± 0.69 hrs reared on *Therioaphis trifolii*.

3.2 Coopulation period: Table-1 shows that duration of copulation in adult male and female observed direct visually and recorded of *Coccinella septempunctata* was 51.4 ± 3.37 minutes in *Therioaphis trifolii.*

Table 1: Biology and feeding potential of 7-spotted beetle, *C. septempunctata* L. on Berseem aphid, *T. trifolii* in laboratory

Parameters	Values
Adult courtship behaviour	
Pre-copulation (latent) period (hours)	4.4 ± 0.69
Copulation period (minutes)	51.5 ± 4.37
Post-copulation period (minutes)	4.0 ± 1.05
Pre-oviposition period (days)	4.7 ± 0.3
Oviposition period (days)	36.6 ± 4.88
Post-oviposition period (days)	5.0 ± 1.69
Fecundity (per female)	599.1 ±109.83
Egg incubation period (days)	4.0 ± 0.94
Fertility (n=50)	90.32± 6.04
Mortality (n=50)	17.56±14.51
Larval period (days)	
1st instar	3.2 ±0.91
2nd instar	2.5 ± 0.52
3rd instar	2.8 ± 0.78
4th instar	3.5± 0.71
Total larval duration (days)	12.0 ± 1.63
Larval mortality %	
Larval cannibalism % (n=60)	30.49 ± 9.23
Pupal period (days)	
Pupal period	5.2 ± 0.91
Pupation rate	
Pupal % (n=60)	69.49± 9.23
Adult emergence	
Male %	37.47 ± 13.12
Female %	43.98 ± 8.24
Sex ratio	1:1.25± 1:0.45
Adult longevity (days)	
(a) Male	39.2± 3.25
(b) Female	48.1± 3.03

3.3 Post-Copulation period: The post copulation periods was recorded in the male *Coccinella septempunctata* during the trial. During the trial after separation of the genital process, the male stayed for about 4.0 ± 1.05 minutes on the female back in *Therioaphis trifolii* fed adults.

3.4 Pre-oviposion, oviposition and post oviposition periods: The research study on oviposition performance of 7-spotted beetle conducted when the predatory beetle started mating performance and the copulation moment is the period of a one single mating act. Post copulation period is the practice in which time of copulation as lagging between one mating to next mating act. The pre-oviposition period is the initial period before the oviposition time, similarly after that oviposition time is the total period of eggs laid by the female of the beetle and in continuation to post oviposition is the time taken by female when beetle becomes unproductive and period from unproductive condition to passing away time which is considered as post oviposition days. The data shows that pre-copulation time was noted 4.4±0.69 days and 2-6 days in range for ten couples of coccinellid beetle. The copulation time was 51.5±4.37 minutes average of ten couples of Coccinellid beetle, while the post copulation period recorded in the present study was 4.0±1.05days within the range of 3-6 days. whereas data of the oviposition days was recorded that the 7-spotted ladybird beetles of ten couples had average pre-oviposition period 4.7±0.3 days, oviposition period of 36.6±4.88 days, although the post oviposition time of the beetles an average was 5.0±1.69 days with minimum and maximum limits of 2 and 6 days, respectively.

3.5 Fecundity and fertility: The study was conducted to record the fecundity rate of total egg numbers laid by a *C. septempunctata* throughout its life period, whereas the fertility is the procedure of total number of eggs hatched and emerge then come into larval stage. The data results showed that the average eggs laid by beetles were 599.1± 109.83. The fecundity of ten couples of beetles was 433 to 733 eggs in range. The study data indicated that total mean quantity number of fertile eggs of ten couples of 7-spotted beetle pairs was 538.1± 88.71 with the fertility percentage of 90.32±6.04 percent.

3.6 Development period: The study was conducted on the examination of the growth time of *C. septempunctata* was recorded since the egg incubation to adult period to investigate the incubation of egg time, first, second, third and fourth instar larvae times. The pupal stage time was recorded as the insects developed in the larval stages and after that pupal time up to the emergence of adults, the time passed in the middle of time was recorded as the pupal period. The data showed the mean incubation period of the *C. septempunctata* in the laboratory was 4.0±0.94 days , whereas first and second larval instars period was 3.2±0.91 and 2.5±0.52

days and 2-5 and 2-3 days was in range period, respectively.

The data further shows that the third and fourth larval instars mean growth time was as 2.8±0.78 and 3.5±0.71 days and the in the range data was 2-5 and 3-5 days, respectively. Similarly, whole development of larval period was as 12.0±1.63 days and growth period in range was observed 1-14 days. Furthermore, the period of pupal stage was noted mean period as 5.2±0.91 days in the range of 4 to 6 days.

3.7 Pupation rate, larval mortality and cannibalism: The results in the Table 2 show that the mean pupation rate % was 69.497±9.23 in the 4th instar larvae of *C. septempunctata* when it was investigated on *T. trifolii*. The trial data was repeated ten times during the same time. Similarly, larval mortality of larval stage and cannibalism among the larval instars was also recorded in larvae of *C. septempunctata*. The further data shows that 4th instar larvae were reared on *T. trifolii* for observing the cannibalism speed which was 30.497±9.23.

Table 2: Feeding rate and development (days) of *C. septempunctata* reared on *T. trifolii* in laboratory (Mean temp: 27 ± 2°C).

Predator development stage	Duration (days)	Host density (n=5)	Mean aphid consumption (n=5)
First instar	2	40	22.0±4.12
Second instar	2	70	56.8±5.26
Third instar	3	195	143.8±5.93
Fourth instar	4	400	289.6±9.65
Adult male	30	1920	48.94±6.29
Adult female	33	2900	77.41±85.84

3.8 Adult emergence, sex ratio mortality: This parameter of biology for observing the adult emergence and sex ratio mortality, from whole number of pupae emerged adults and percentage was recorded. Furthermore, sex ratio was observed from the total number of pupae which were kept for counting the whole quantity of beetles male and female were separated and sex ratio was counted. Similarly, the mortality was observed from the total number of pupae were kept to record the origin of male and female adult beetles and left over were counted dead and on that base death percentage was noted. The data shows that from the ten couples of *C. septempunctata* mean pupae recorded were 20.3±4.47 whereas the male come out was 8.3±1.94 and percent was 38.50±13.12), similarly, female adults come out was 10.2±2.20 and percent 43.48±8.24). The data shows that the male and female ratio mean was recorded as 1: 1.25 ± 1: 0.45. Similarly, whole adult beetles male and female come out was 81.99±13.37 per adult beetle couple. The mortality observed 4.7±2.16 beetles for each couple indicating mean mortality percent of 17.56±14.51.

3.9 Longevity: The results show the age and longevity of the adult beetles. The longevity was recorded separately of male and female adults of *C. septempunctata*. The age of male 7-spotted ladybird beetles was 39.2±3.25 days and the age of adult female was 48.1±3.03 days on the host. Similarly data was observed on longevity period was significantly greater in case of adult female of 7-spotted ladybird beetles as compared to male adult beetles.

3.10 Feeding potential of *C. septempunctata* reared on barseem aphid, *T. trifolii* in laboratory:

I. Larval instars: In Table-2 the study of feeding potential of the larval instars of *C. septempunctata* showed the extent time of 1st, 2nd, 3rd and 4th larval instar larva was recorded as 2.0, 3.0, 3.0 and 4.0 days when it was tested on barseem aphid, *T. trifolii*. The results further showed the mean feeding efficiency /day/larvae of 1st, 2nd, 3rd and 4th instar was recorded as 22.0±4.12, 56.8±5.26, 143.8±5.93 and 289.6±9.65 days, respectively then 4th larval instars went into the pupae a next development stage of 7-spotted lady bid beetle. Similarly, the percent feeding rate (per larva/day) of 1st, 2nd, 3rd and 4th larval instars was noted as 57.03%, 70.10%, 76.58% and 78.77%. The highest feeding percentage of barseem aphid, *T. trifolii* was observed in 4th larval instars, followed by 3rd, 2nd and 1st larval instars of *C. septempunctata* beetle.

II. Adults: The-Table 2 indicated that duration time of the adults of *C. septempunctata* male and female noted during the feeding on the barseem aphid, *T. trifolii* which was recorded as 30 and 33 days, respectively. During the experiment of feeding efficiency of the adult male was 48.94±6.29 and adult females it was recorded that it consumed 77.41±5.84 aphids/day adult during their development stage in adult age.

4. DISCUSSION

Ecosystem is made up of living and non-living environment. However, non-living environment i.e. ecology directly derive population fluctuations and energy flow by means of different food webs. In the same way, predators pose direct impact on

prey population by consumption (Arshad *et al*., 2015). The recent investigations clearly noticed that the lady beetle reared on aphid (insect) gave significantly the highest results for all the parameters under consideration. Our laboratory investigations are more or less similar or in contradictory to some of the researchers of the past. Gour and Pareek (2003) found that predatory of *C. septempunctata* preferred to prey *L. erysimi* than *Brevicoryne brassicae*. Omker, *et al*., (2003) observed the *C. septempunctata* with highest rapid larval development and greatest daily consumption of barseem aphid at 14.2 days and 45.3 aphids/day. Evans, *et al*., (2004) investigated coccinellid predator used as food on different hosts; for their developmental movement it depend on the most strongly to additional and limited range of host. Kalushkov and Hodek. (2004) reported the efficiency was tested on the 13 different species of aphids (Sternorrhyncha: Aphididae) and then recorded the mainly more plentiful aphidophagous coccinellid *C. septempunctata* L. during the study it was noted that they preferred all the aphids with their development of larval growth, larval death and adult fresh weight. The results of Singh and Singh, (2013) are in conformity with ours that voracity of *C. septempunctata* increased with the age and predate all stages (Jindal and Malik, 2006; Bilashini and Singh, 2009). In our experiments, adults consume more aphids than grubs, such investigations are in consonance with judgment of (Singh *et al*., 1994; Ali and Rizvi, 2007).

The study demonstrated that diet composing aphid as natural host proved excellent for rearing of Coccinellid. Richards and Evans, (1998) feed aphidophagous coccinellid on different kind of hosts with the most preferred prey. The most preferred prey was used to increase the predator culture for experiments except it was not reared the imamture development stages and not also the adult reproduction. Similarly, females reared on the not preferred prey as given only sucrose dissolved in water in 15% solution. Although when it was given with both weevils and sucrose, however, females of both species laid modest numbers of eggs. Further results showed that weevil larvae which were provided as not preferred prey for the lady bird beetles, and that reproduction however can happen in the lack of preferred aphid prey as weevil larvae are collective in the diet with sucrose, another not preferred prey. During present research work the pre copulation periods of the adult was averaged to 9 days, mating lasted on an average 40.65minutes. While the time periods of pre-oviposition, oviposition and post oviposition were averaged to 9.65 days, 10.7 days, and 2.25 days, respectively. The female on an average deposited 78.5 eggs during her lifetime and lived for 24.16 days. Incubation period was 4.2 days and hatching was 32.56% was observed. The larval and pupal durations were 15 and 5.2 days, respectively. More or less in line conclusions have been stated by earlier workers. Singh and Singh (1994) Compilation of a life fecundity table for females of *C. septempunctata* preying on *L. erysimi* revealed that the net reproductive rate and mean length of generation under laboratory and field conditions were 95. 88 and 54.18 and 28.88 and 28. 68 days, respectively. Akram, *et al*., (1996) reported that egg stage of *C. septempunctata* occupied 2. 83 days while the larval instars, 1st, 2nd, 3rd and 4th occupied 2, 1.91, 2and 4 days respectively, making to total of 9.91 days. The pupal stage lasted for 4.66 days and the adults under laboratory conditions survived for 6-8 days. Nirmala, *et al.,* (1996) studied biology and feeding potential of *C. septempunctata* under laboratory conditions on *Brevicoryne brassicae*. The average maximum and minimum temperature during the experimental period was 32.13 and 29.63°C, respectively. The predator was observed to pass through four larval instars. On average, 1st, 2nd, 3rd, and 4th instars lasted for 2.0 ± 0.35, 1.67 ± 0.31, 1033 ± 0.18 and 2.33 ± 0.25 days. The fecundity was recorded as 466.00±1.97 eggs. Hassan, *et al.,* (1999) carried out the studies on the biology of *C. septempunctata*, in the laboratory and under semi-natural conditions and revealed that egg stage occupied 3.69 days; larval period lasted for 13 days and pupal stage extended up to 9.5 days. The duration of development at 20 and was 5 days for the egg, 16 days for the larva, and 7.5 days for the pupa; at 25°C, 3, 10 and 4.5 days for each stage, respectively. Sun and Wan (2000) reported that quality control plays a key role in commercial production. Body weight should be no less than 26.9 mg, emergence should exceed 87.7%, and adult longevity should reach 62.9.

Conclusion:

The results on the biological parameters and consumption rate of *C. septempunctata* on barseem aphid, *T. Trifolii indicated* the average pre-copulation period, pre-copulation, and post copulation periods were recorded respectively. Oviposition periods were less than post oviposition period. The mean fecundity/female was more and hatching parameters were also noted, while the incubation time of eggs was not more than four days and larval instars periods of 1st, 2nd, 3rd, and 4th larval instars were between the twelve days. The pupal periods were not more than six days. The emergence percent was more in female against the male adult. The average feeding rate/day of female was more than

male adult. Whereas 4th and 3rd instars consumed more aphids per day and 2nd and 1st instars consumed less than 4th and 3rd instars. The 4th larval instars were recorded more voracity ability as compared to adults and 3rd, 2nd and 1st larval instars of 7-spotted Coccinellid predator. The longevity of the female adult was more than male adult beetle.

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