

EVALUATION OF OVIPOSITION-SITE PREFERENCE BEHAVIOR IN PREDATORY BUG *DERAEOCORIS LUTESCENS* SCHILLING (HEMIPTERA: MIRIDAE)

Najme Azimizadeh*, Kamal Ahmadi, Sohrab Imani*,
Hajimohammad Takaloozadeh** and Alimorad Sarafrazi*****

* Department of Entomology, Science and Research Branch, Islamic Azad University, Tehran, IRAN. E-mail: n.azimizadeh@yahoo.com

** Department of Plant Protection, Faculty of Agriculture, Shahid Bahonar University of Kerman, Kerman, IRAN.

*** Department of Insect Taxonomy Research, Iranian Research Institute of Plant Protection, Tehran, IRAN.

[Azimizadeh, N., Ahmadi, K., Imani, S., Takaloozadeh, H. & Sarafrazi, A. 2012. Evaluation of oviposition-site preference behavior in predatory bug *Deraeocoris lutescens* Schilling (Hemiptera: Miridae). *Munis Entomology & Zoology*, 7 (1): 506-515]

ABSTRACT: The present research aimed to study the oviposition site preference of the predatory bug *Deraeocoris lutescens* Schilling (Hemiptera: Miridae) at 25±1°C temperature, relative humidity of 60±10% and a photoperiod of 16:8 h (L:D). The experiments on different plant species were investigated among four groups of plants, six crop plant species, three greenhouse plant species, five orchard plant species and five ornamental plant species. Among different plant species, most oviposition was on broad bean leaves with a total of 41.7±3.7, sweet pepper with 31.1±3.4, grape leaf with 13.9±2.8 and begonia with 39.3±3.0 eggs in each group. In order to determine preference of *D. lutescens* for oviposition, broad bean leaves which infested with different nutritional sources, *Aphis gossypii*, *Aphis fabae*, *Myzus persicae*, eggs of *Sitotroga cerealella*, 10% honey emulsion and 10% honey emulsion + yeast extract were used. Among these leaves as substrates of oviposition, the adult females showed higher preference for leaves infested with *M. persicae* than with other nutritional sources. The preferred site for egg deposition at light and dark area by *D. lutescens* females was tested. The adult females showed significantly higher preference for the leaves as substrates of oviposition in the dark area than in the light area.

KEY WORDS: Predatory bug, *Deraeocoris lutescens*, oviposition site preference, plant species, nutritional sources.

Primarily through the study of many insects, it has become clear that oviposition behaviour, and choice of oviposition sites in particular, can increase the performance and survival of insect progeny. Such oviposition behavior is largely driven by variation in the environment. Choice of oviposition sites and dispersion of eggs by adult insects can vary among host species, among individuals within a host population, and within an individual of a particular host population.

A positive correlation between female preference for oviposition sites and offspring performance was detected in many studies, primarily for herbivorous insects (Craig et al., 1989; Craig et al., 2000; Craig & Ohgushi, 2002; Jaenike, 1978; Kanno & Harris, 2002; Scheirs et al., 2000; Stein & Price, 1995; Thompson, 1988). Females of the gall aphid *Pemphigus betae* indeed maximise their overall fitness; stem mothers prefer to establish galls at sites on the leaves that support more offspring (Whitham, 1978, 1980). Determinants of oviposition choice by phytophagous insects include allelochemicals, quantity and/or quality of resources, plant morphology and natural enemies (Thompson & Pellmyr, 1991). Such factors can lead to variation in performance and survival of insect progeny for eggs deposited in different locations (Craig et al., 1989; Mayhew, 1997;

Rausher, 1979; Resetarits, 1996; Simberloff & Stiling, 1987; Stamps & Linit, 2002). Because variation in oviposition behaviour can be genetic and heritable (Jaenike, 1990; Jaenike & Holt, 1991; Thompson & Pellmyr, 1991), natural selection may favour the choice of oviposition sites that facilitate growth and survival of offspring.

Moreover, oviposition site selection by predatory bugs to be correlated positively with offspring performance at the substrate of oviposition. This is supported by the significantly higher hatching success of eggs deposited at the preferred vein origin site as compared with those deposited on other parts of the leaf (Groenteman et al., 2006). When selecting an oviposition site, omnivores are expected to respond to both prey availability and, even more strongly, to plant traits that affect both females and their offspring (Groenteman et al., 2006). The relation between omnivore oviposition preference and offspring performance was tested on two spatial scales, between plants of different nutritional value, and between areas within a leaf (Groenteman et al., 2006). Some predators deposit their eggs where prey is concentrated (Hagen et al., 1999). Others oviposit away from prey (Schellhorn & Andow, 1999), possibly relying on the high mobility of the hatching young. However, a rigorous exploration of the relationship between offspring mobility and oviposition strategy in predators has not yet been attempted. Even less is known about the oviposition preference–offspring performance relationship in omnivorous insects that feed on both prey and plant food sources (Coll, 1996). Omnivory is widespread in nature, and may be exhibited by most consumers during at least one of their life stages (Coll & Guershon, 2002; Pimm & Lawton, 1978; Whitman et al., 1994). These consumers are therefore expected to respond to both plant characteristics and prey availability when choosing an oviposition site.

Deraeocoris lutescens Schilling (Hemiptera: Miridae) is a predatory bug found commonly on a wide variety of plants across Middle East and Europe, that feeds on a wide range of arthropod pests such as aphids, small caterpillars, mites and insect eggs (Lamine et al., 2005). Females insert their eggs in leaf tissue. The females' choice of oviposition site is important for the subsequent distribution of nymphs on prey's host plants. Oviposition behaviour of many insects has been investigated by others on anthocorids (Armer et al., 1998; Evans, 1976; Groenteman et al., 2006; Sigsgaard, 2004; Thompson & Pellmyr, 1991). Oviposition behaviour of this predator and others of the genus *Deraeocoris* is not well known. This research investigates the acceptability and preferences of a range of plants for oviposition by the predatory bug *D. lutescens* in the laboratory. Moreover, we examined oviposition preference on the same plant with different nutritional sources and places of light and dark on the leaves.

MATERIAL AND METHODS

Insect rearing

The stock cultures of *Aphis fabae* Scopoli on broad bean, *Aphis gossypii* Glover on cotton and *Myzus persicae* (Sulzer) on cabbage plants were established with individuals obtained from stock cultures available at the Shahid Bahonar University of Kerman. For obtaining of individuals in the desired age, aphid species was kept in a climatically controlled chamber at $25\pm 1^\circ\text{C}$ temperature, relative humidity of $60\pm 10\%$ and a photoperiod of 16:8 h (L:D) on broad bean leaves in the round plastic Petri dishes (6 cm diameter) that were filled with 2 cm-thick-layer of 0.7% agar gel.

The predatory bug, *D. lutescens* were originally obtained from the experimental teaching garden of Shahid Bahonar University of Kerman, Iran. This species was identified by department of insect taxonomy research, Iranian research institute of plant protection, Tehran, Iran. The predatory bugs were reared on freshly excised broad bean leaf discs 5 cm in diameter (as substrate of oviposition) which were placed in the abovementioned round Petri dishes. Broad bean leaves were infested with more than 40 nymphs of aphids mentioned above as prey. The cages were held in a controlled climate and adults were transferred to new cages every two days. Broad bean leaves with eggs were incubated until egg hatching. These leaves and first nymphs were placed into new Plexiglas cages (7.5 × 15 × 4.5 cm), with a mesh-covered hole in the lid, to start the pre-imaginal rearing. Food and water were supplied up to adult emergence.

Experimental conditions

The preference oviposition of *D. lutescens* was determined by multiple-choice experiments in a Plexiglas cages (21×12×9 cm), with three mesh-covered holes in the lid in a climatically controlled chamber at 25±1°C temperature, relative humidity of 60±10% and a photoperiod of 16:8 h (L:D).

Preference to different substrates

The oviposition preference by *D. lutescens* on different plant species was investigated among four groups of plants. During each experiment, leaf discs (5 cm in diameter) of six crop plant species (bean, potato, broad bean, sugar beet, tobacco and cabbage), three greenhouse plant species (cucumber, tomato and sweet pepper), five orchard plant species (grape, walnut, cherry, peach and pear) and five ornamental plant species (geranium, coleus, Begonia, Stonecrop and giant dumb cane) were placed upside down onto, the round Petri dishes 6 cm in diameter were partially filled with 2 cm thick layer of 0.7% Agar gel. The round plastic Petri dishes containing different leaves of each group were randomly positioned in the abovementioned Plexiglas cages during a trial. The adult females and males of *D. lutescens* (1-day-old) were transferred for 7 days into the Plexiglas cages, containing leaves of different plant species of each group infested with eggs of *Sitotroga cerealella* (Olivier) (Lepidoptera: Gelechiidae) as food. This step was necessary in order to reduce the possibility that *D. lutescens* might get adapted to a certain plant species and to give the adult females and males the chance to mate. After 8 days, three mated females were transferred together into another Plexiglas cage with different leaves and offered eggs of *S. cerealella* as food. The oviposition substrates were daily replaced by new ones and the numbers of laid eggs on the leaves were recorded. A trial lasted seven days from 9th till 15th days of longevity and replicated 12 times.

Preference to different nutritional sources

In order to determine preference of *D. lutescens* for oviposition on broad bean leaves, which infested with different nutritional sources, six freshly excised broad bean leaf discs (5 cm diameter) placed in the abovementioned round plastic Petri dishes were used. The round plastic Petri dishes containing *A. gossypii* (3-4-days-old), *M. persicae* (3-4-days-old), *A. fabae* (3-4-days-old), 10% honey emulsion, 10% honey emulsion + yeast extract and eggs of *S. cerealella* on broad bean leaves were randomly positioned in the Plexiglas cages. Three *D. lutescens* females (mated, 9-days-old) were kept together in each Plexiglas cage. After that, the females were transferred to another Plexiglas cage containing new leaves every 24 hours. The leaves in the old Plexiglas cage were checked under a binocular for

recording of the eggs. The experiment was continued for one week and replicated 12 times.

Preference to light and dark area

The preferred site for egg deposition by *D. lutescens* females at different light and dark area was tested in the laboratory. In order to prepare the dark and light area in each Plexiglas cage, half part of each Plexiglas cages mentioned above was covered with black watercolour from all sides. For each Plexiglas cage, four freshly excised broad bean leaf discs (5 cm diameter) placed in the round plastic Petri dishes (6 cm diameter) without lids were used. Leaf discs infested with eggs of *S. cerealella* as food were placed in the opposite corners of each Plexiglas cages. Three mated females of the predatory bug (9-days-old) were confined simultaneously in the Plexiglas cages for 24 hours. After that, the females transferred together into another Plexiglas cage, similar to the one described above, and the number of laid eggs into each leaf was recorded. The experiment was continued for 7 days and replicated 12 times.

Statistical analysis

For statistical comparison among several means, all the data from the laboratory studies on egg laying of the predatory bug were subjected to a one-way analysis of variance (ANOVA) followed by a Tukey Test (StatPlus 4.9, 2007).

RESULTS

Egg-laying preferences of *D. lutescens* on greenhouse plants

The daily and total number of eggs laid by three *D. lutescens* females from the 9th till the 15th days of longevity on three species of greenhouse plants, cucumber (*Cucumis sativus*), tomato (*Lycopersicon esculentum*) and sweet pepper (*Capsicum annuum*) with eggs of *S. cerealella* as food at $25\pm 1^\circ\text{C}$ are summarized in Table 1. The predatory bug was not able to lay eggs on greenhouse plant species used in the experiment equally.

The adult females showed most oviposition preference on Sweet pepper leaves with a total of 31.1 ± 3.4 eggs and least oviposition preference on Cucumber with 7.1 ± 1.5 eggs. However, among the three greenhouse plant species used, Sweet pepper had significantly the highest counts of the predator eggs ($P < 0.01$).

Egg-laying preferences of *D. lutescens* on crop plants

The Broad bean leaves with a total of 41.7 ± 3.7 eggs showed significantly ($P < 0.05$) the highest number of *D. lutescens* eggs among the crop plant species. No clear tendency in oviposition substrate preference of the predator females was to be distinguished among the other crop plant species that are showed in Table 2.

Egg-laying preferences of *D. lutescens* on orchard plants

Among five species of orchard plant, pear, walnut and peach leaves were not as a suitable substrate for oviposition. Although among these leaves, cherry leaves (with a total of 1.0 ± 0.5 eggs) were observed significant difference in total eggs laid by the predator. But the adult females showed significantly higher oviposition preference for grape leaves (with a total of 13.9 ± 2.8 eggs) than other orchard plant species ($P < 0.005$) (Table 3).

Egg-laying preferences of *D. lutescens* on ornamental plants

Begonia leaves with a total of 39.3 ± 3.0 eggs showed significantly ($P < 0.005$) the highest number of *D. lutescens* eggs among the ornamental plant species (except geranium) were used (Table 4).

Among stonecrop, giant dumb cane and coleus leaves as substrate of oviposition, no significant difference in egg-laying preferences was observed ($P < 0.01$). No clear tendency in oviposition preference of the predator females was to be observed between coleus and geranium ($P < 0.005$).

Oviposition preference of *D. lutescens* to different nutritional sources

Table 5 represents the daily and total number of eggs laid by three *D. lutescens* females on the leaves from the 9th to 15th days of longevity. Among these leaves as substrates of oviposition, the adult females showed higher preference for leaves infested with *M. persicae* than with other nutritional sources with a total of 27.2 ± 1.6 eggs ($P < 0.05$). Except *M. persicae* treatment, no significant tendency in oviposition substrate preference of the predator females was to be distinguished among the nutritional sources ($P < 0.01$).

Egg-laying preferences of *D. lutescens* to light and dark area

Fig.1 shows the daily and total number of eggs laid by three *D. lutescens* females from the 9th till the 15th days of longevity on broad bean leaves at light and dark area with eggs of *S. cerealella* as food at $25 \pm 1^\circ\text{C}$. The adult females showed significantly higher preference for the leaves as substrates of oviposition in the dark area with a total of 102.2 ± 3.5 eggs than in the light area with a total of 18.5 ± 2.0 eggs ($P < 0.005$).

DISCUSSION

Oviposition preference is a way of maternal investing; the females spend time and energy in such activity, which may result or not in providing the offspring development (Krainacker et al., 1987). The oviposition site preference of *D. lutescens* on Greenhouse, crop, ornamental plants is higher than orchard plants. The current study showed that the predator bug between plant groups has distinctive preference for different species. It dependent to physical and chemical structure of leaves, so oviposition-preference patterns of *D. lutescens* are supposed to correspond to host suitability for egg hatching and offspring development because females are assumed to maximize their fitness by oviposition on high-quality hosts. The major hypothesis of the evolution of oviposition behavior is that the females would choose species of plants that could maximize offspring survival and growth (Thompson & Pellmyr, 1991). The predators and their herbivorous prey may respond in similar ways to variations in plant quality, resulting in a spatial or temporal overlap in their distributions (Groenteman et al., 2006). *Anthocoris confusus* Reuter (Hemiptera: Anthocoridae) females insert their rostrum into plant tissue to determine the suitability of the plant for oviposition (Evans, 1976). Moreover, *Orius insidiosus* (say) (Hemiptera: Anthocoridae) can obtain water from the xylem, and may ingest small amount of starches, sugars and amino acids from the mesophyll of plants (Armer et al., 1998). Both moisture and nutrient levels could be detected by the females. Therefore, the females of the predator could detect both moisture and nutrient levels. The females select oviposition sites that maximize the hatch rate of deposited eggs rather than to optimize nymph performance may be related to the high mobility of the neonates and their ability to search for food away from

the egg-hatching site. A similar oviposition strategy is probably exhibited by at least some of the predators that were found to lay egg near prey aggregations (Groenteman et al., 2006). Microhabitat selection for oviposition by *Anthocoris nemorum* is affected by plant quality and prey availability as well as exudates from prey (Sigsgaard, 2005). The abilities of *D. lutescens* females to distinguish between different nutritional sources and preferentially deposit their eggs into leaves with *A. gossypii*, *M. persicae* and eggs of *S. cerealella* appears to be correlated with nymphal development success. The predators may therefore respond primarily to variations in food or prey quality, which may be a better predictor of nymph performance. In choice oviposition experiments by *Anthocoris nemoralis* and *A. nemorum*, honeydew-treated pear leaves attracted more oviposition than honeydew free leaves (Sigsgaard, 2005). The predators rely on a nitrogen-rich prey diet, and oviposition of females may therefore respond to prey availability. In many cases, however, prey availability varies greatly in space and time, making it difficult for oviposition of females to predict prey availability for their offspring (Groenteman et al., 2006).

Detectable cues to assess microhabitat quality are a selective advantage for oviposition of females (Meyling & Pell, 2006). There was no evidence for photo-preference of *D. lutescens* studied between light and dark areas within the habitat. This result suggests that the dark area is a significant predictor of oviposition site selection by *D. lutescens* females.

Several recent studies have illustrated that habitat selection may commonly reflect a combination of direct effects on adult females and indirect fitness effects via future offspring performance (Doumbia et al., 1998; Groenteman et al. 2006; Krainacker et al., 1987; Thompson & Pellmyr, 1991). According to these results, the choice for oviposition sites by *D. lutescens* females is influenced by different factors of mentioned above. The preference of this predator to oviposit on different plant species and with different nutrition source is one of the major factors in determining its ability to successfully control the pests of these plants.

LITERATURE CITED

- Armer, C. A., Wiedeenmann, R. N. & Bush, D. R.** 1998. Plant feeding site selection on soybean by the facultatively phytophagous predator *Orius insidiosus*. *Entomologia Experimentalis et Applicata*, 86: 109–118.
- Coll, M.** 1996. Feeding and ovipositing on plants by an omnivorous insect predator. *Oecologia*, 105: 214–220.
- Coll, M. & Guershon, M.** 2002. Omnivory in terrestrial arthropods: mixing plant and prey diets. *Annual Review of Entomology*, 47: 267–297.
- Craig, T. P. & Ohgushi, T.** 2002. Preference and performance are correlated in the spittlebug *Aphrophora pectoralis* on four species of willow. *Ecological Entomology*, 27: 529–540.
- Craig, T. P., Itami, J. K. & Price, P. W.** 1989. A strong relationship between oviposition preference and larval performance in a shoot-galling sawfly. *Ecology*, 70: 1691–1699.
- Craig, T. P., Itami, J. K., Shantz C., Abrahamson, W. G., Horner, J. D. & Craig, J. V.** 2000. The influence of host plant variation and intraspecific competition on oviposition preference and offspring performance in the host races of *Eurosta solidaginis*. *Ecological Entomology*, 25: 7–18.
- Doumbia, M., Hemptinne, J. L. & Dixon, A. F. G.** 1998. Assessment of patch quality by ladybirds: role of larval tracks. *Oecologia*, 113: 197–202.
- Evans, H. F.** 1976. The effect of prey (*Aulacorthum circumflexus*) density and host plant [broadbeans] characteristics on oviposition and fertility in *Anthocoris confusus* (Reuter). *Ecological Entomology*, 1: 157–161.

- Groenteman, R., Guershon, M & Coll, M.** 2006. Effects of leaf nitrogen content on oviposition site selection, offspring performance, and intraspecific interactions in an omnivorous bug. *Ecological Entomology*, 31: 155–161.
- Hagen, K. S., Mills, N. J., Gordh, J. A. & McMurtry, J. A.** 1999. Terrestrial arthropod predators of insect and mite pests. In Bellows, T.S. & Fisher, T. W. (Eds.), *Handbook of Biological Control*. Academic Press, San Diego, California, pp. 383–503.
- Jaenike, J.** 1978. On optimal oviposition behaviour in phytophagous insects. *Theoretical Population Biology*, 14: 350–356.
- Jaenike, J.** 1990. Host specialization in phytophagous insects. *Annual Review of Ecology and Systematics*, 21: 243–273.
- Jaenike, J. & Holt, R. D.** 1991. Genetic variation for habitat preference: evidence and explanations. *American Naturalist*, 137: 67–90.
- Kanno, H. & Harris, M. O.** 2002. Avoidance of occupied hosts by the Hessian fly: oviposition behaviour and consequences for larval survival. *Ecological Entomology*, 27: 177–188.
- Krainacker, D. A., Carey, J. R. & Vargas, R. J.** 1987. Effect of larval host on life history traits of the mediterranean fruit fly, *Ceratitis capitata*. *Oecologia*, 73: 583–590.
- Lamine, K., Lambin, M. & Alauzet, C.** 2005. Effect of starvation on the searching path of the predatory bug *Deraeocoris lutescens*. *BioControl*, 50 (5): 717–727.
- Mayhew, P. J.** 1997. Adaptive patterns of host-plant selection by phytophagous insects. *Oikos*, 79: 417–428.
- Meyling, N. V. & Pell, J. K.** 2006. Detection and avoidance of an entomopathogenic fungus by a generalist insect predator. *Ecological Entomology*, 31 (2): 162–171.
- Pimm, S. L. & Lawton, J. H.** 1978. On feeding on more than one trophic level. *Nature*, 275: 542–544.
- Rausher, M. D.** 1979. Larval habitat suitability and oviposition preference in three related butterflies. *Ecology*, 60: 503–511.
- Resetarits, W. J.** 1996. Oviposition site choice and life history evolution. *American Zoologist*, 36: 205–215.
- Scheirs, J., De Bruyn, L. & Verhagen, R.** 2000. Optimization of adult performance determines host choice in a grass miner. *Proceedings of the Royal Society of London, Series B*, 267: 2065–2069.
- Schellhorn, N. A. & Andow, D. A.** 1999. Cannibalism and interspecific predation: role of oviposition behaviour. *Ecological Applications*, 9: 418–428.
- Sigsgaard, L.** 2004. Oviposition preference of *Anthocoris nemorum* and *A. nemoralis* for apple and pear. *Entomologia Experimentalis et Applicata*, 111: 215–223.
- Sigsgaard, L.** 2005. Oviposition preference of *Anthocoris nemoralis* and *A. nemorum* (Heteroptera: Anthocoridae) on pear leaves affected by leaf damage, honeydew and prey. *Biocontrol Science and Technology*, 15 (2): 139–151.
- Simberloff, D. & Stiling, P.** 1987. Larval dispersion and survivorship in a leaf-mining moth. *Ecology*, 68: 1647–1657.
- Stamps, W. T. & Linit, M. J.** 2002. Oviposition choice by the black walnut curculio (Coleoptera: Curculionidae): a ten-year study. *Environmental Entomology*, 31: 281–284.
- Stein, S. J. & Price, P. W.** 1995. Relative effects of plants resistance and natural enemies by plant developmental age on sawfly (Hymenoptera: Tenthredinidae) preference and performance. *Environmental Entomology*, 24: 909–916.
- Thompson, J. N.** 1988. Evolutionary ecology of the relationship between oviposition preference and performance of offspring in phytophagous insects. *Entomologia experimentalis et applicata*, 47: 3–14.

Thompson, J. N. & Pellmyr, O. 1991. Evolution of oviposition behaviour and host preference in Lepidoptera. Annual Review of Entomology, 36: 65–89.

Whitham, T. G. 1978. Habitat selection by Pemphigus aphids in response to resource limitation and competition. Ecology, 59: 1164–1176.

Whitham, T. G. 1980. The theory of habitat selection: examined and extended using Pemphigus aphids. American Naturalist, 115: 449–466.

Whitman, D. W., Blum, M. S. & Slansky, F. J. 1994. Carnivory in phytophagous insects. In: Ananthakrishnan, T. N. (Eds.), Functional Dynamics of Phytophagous Insects. Science Publishers, New Hampshire, pp. 161–205.

Table 1. Mean daily and total number of eggs laid by tree *Deraeocoris lutescens* females on different leaf of greenhouse plant species by feeding on eggs of *Sitotroga cerealella* as prey for seven days from 9th till 15th days of longevity at 25±1°C.

Host plant	n	Mean number of laid eggs on the day							
		9 th	10 th	11 th	12 th	13 th	14 th	15 th	Total
Cucumber	12	0.9±0.3	1.2±0.8	0.6±0.3	0.3±0.2	1.6±0.8	1.2±0.8	1.3±0.5	7.1±1.5 a
Tomato	12	3.7±1.4	1.7±0.8	2.2±1.1	2.7±1.5	4.0±1.1	3.5±1.6	1.4±0.5	19.3±3.3 b
Sweet pepper	12	8.1±2.7	4.9±1.8	6.9±1.9	2.7±1.0	4.2±1.3	2.3±1.1	2.0±0.6	31.1±3.4 c

Table 2. Mean daily and total number of eggs laid by tree *Deraeocoris lutescens* females on different leaf of crop plant species by feeding on eggs of *Sitotroga cerealella* as prey for seven days from 9th till 15th days of longevity at 25±1°C.

Host plant	n	Mean number of laid eggs on the day							
		9 th	10 th	11 th	12 th	13 th	14 th	15 th	Total
Bean	12	3.3±1.6	0.4±0.3	1.1±0.9	1.1±0.7	1.1±0.9	0.6±0.3	0.0±0.0	8.2±2.3 a
Tobacco	12	1.5±1.0	0.9±0.5	2.5±1.3	1.2±0.9	0.3±0.2	0.2±0.2	0.0±0.0	6.7±2.2 a
Cabbage	12	1.2±0.7	1.5±1.0	0.5±0.5	0.2±0.2	0.2±0.2	0.4±0.3	0.1±0.1	4.2±1.1 a
Broad bean	12	5.8±2.2	8.8±1.8	6.6±1.8	3.2±1.5	8.2±2.1	5.8±2.0	3.2±1.2	41.7±3.7 b
Sugar beet	12	2.2±1.0	2.9±1.0	1.2±0.8	2.0±1.0	1.7±0.6	1.0±0.7	0.2±0.1	11.2±1.7 a
Potato	12	1.0±0.7	2.7±1.2	4.3±1.4	2.6±1.1	0.9±0.7	1.2±0.5	0.1±0.1	12.6±2.5 a

Table 3. Mean daily and total number of eggs laid by tree *Deraeocoris lutescens* females on different leaf of orchard plant species by feeding on eggs of *Sitotroga cerealella* as prey for seven days from 9th till 15th days of longevity at 25±1°C.

Host plant	n	Mean number of laid eggs on the day							Total
		9 th	10 th	11 th	12 th	13 th	14 th	15 th	
Cherry	12	0.2±0.2	0.2±0.2	0.0±0.0	0.0±0.0	0.2±0.2	0.2±0.1	0.0±0.0	1.0±0.5 b
Pear	12	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0 a
Grape	12	2.2±1.5	4.0±1.5	2.2±1.4	1.6±1.0	1.7±0.9	0.6±0.3	0.3±0.2	13.9±2.8 c
Walnut	12	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0 a
Peach	12	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0 a

Table 4. Mean daily and total number of eggs laid by tree *Deraeocoris lutescens* females on different leaf of ornamental plant species by feeding on eggs of *Sitotroga cerealella* as prey for seven days from 9th till 15th days of longevity at 25±1°C.

Host plant	n	Mean number of laid eggs on the day							Total
		9 th	10 th	11 th	12 th	13 th	14 th	15 th	
Begonia	12	3.6±1.5	8.4±1.7	7.2±1.8	6.4±2.9	4.7±1.3	5.7±1.0	3.2±0.7	39.3±3.0 c
Geranium	12	2.2±1.0	5.4±2.2	2.2±0.9	5.7±1.4	5.4±1.8	5.2±2.0	5.2±2.0	33.2±4.2 bc
Stonecrop	12	0.0±0.0	0.0±0.0	0.2±0.2	0.4±0.4	0.1±0.1	0.0±0.0	0.0±0.0	0.7±0.6 a
Giant Dumb Cane	12	0.2±0.1	0.8±0.6	0.8±0.7	0.0±0.0	1.2±0.7	1.1±0.8	0.7±0.6	4.8±1.9 a
Coleus	12	0.7±0.3	0.9±0.7	1.4±1.1	3.3±1.6	2.3±1.3	1.5±0.7	0.7±0.2	10.9±2.0 ab

Table 5. Mean daily and total number of eggs laid by three *Deraeocoris lutescens* females on broad bean leaves infested with different nutritional source portions for seven days from 9th till 15th days of longevity at 25 ±1°C.

Nutritional source	n	Mean number of laid eggs on the day							Total
		9 th	10 th	11 th	12 th	13 th	14 th	15 th	
<i>M. persicae</i>	12	6.2±2.2	6.2±2.0	6.5±2.4	2.1±1.1	2.1±1.4	3.2±1.1	0.7±0.5	27.2±1.6 b
<i>A. fabae</i>	12	0.6±0.5	2.7±1.2	0.6±0.6	1.0±0.9	1.6±0.9	3.7±1.5	1.3±1.1	11.6±2.6 a
<i>A. gossypii</i>	12	3.2±1.3	1.0±0.8	0.6±0.6	6.7±3.4	5.7±2.6	0.4±0.3	1.7±0.7	19.3±5.0 ab
<i>Sitotroga cerealella</i> (egg)	12	1.2±1.2	3.9±1.9	1.3±1.1	2.0±1.0	4.2±1.6	1.1±0.7	5.9±2.6	19.3±3.3 ab
10% Honey emulsion	12	0.0±0.0	2.0±1.4	0.8±0.4	0.9±0.6	2.3±1.4	1.4±0.7	1.4±0.6	8.9±2.4 a
10% Honey emulsion +yeast extract	12	1.2±1.2	5.6±3.0	0.9±0.5	0.7±0.4	1.7±1.0	1.3±0.8	1.0±1.0	12.6±3.9 a

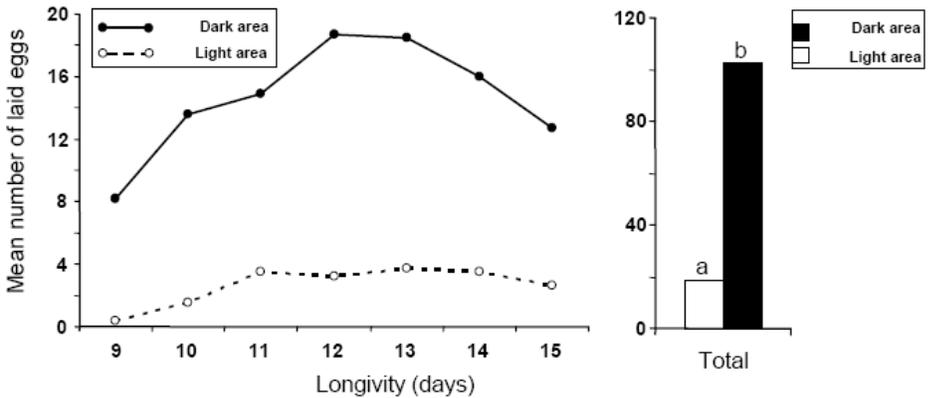


Figure 1. Mean daily and total number of eggs laid by three *Deraeocoris lutescens* females on broad bean leaves with eggs of *Sitotroga cerealella* as prey at light and dark area for 7 days from 9th till 15th days of longevity at 25±1°C temperature and 16:8h (L:D) photoperiod.