

# HOST BIOLOGY INTERACTIONS OF EPILACHNA VIGINTIOCTOPUNCTATA FABR

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## ABSTRACT

The Studies conducted during 2008 and 2009 at Sher-e-Kashmir University of Agricultural Sciences and Technology, Chatha, Jammu revealed that 16 cultivated and 3 wild plants growing in the vicinity of the brinjal and bitter gourd crop fields offer shelter to the pest and maintain its population throughout the year. Effect of eight major host plants on all the biological parameters of the test insect included in the study revealed that grub and pupal development, survival, longevity and fecundity of *Epilachna vigintioctopunctata* (F.) (Coleoptera: Coccinellidae) adults on given host plants under laboratory conditions (29 ± 1°C, 60-70% RH) differ significantly. In a choice test *E. vigintioctopunctata* females oviposited most on *Solanum nigrum* (286.80 ± 19.86 eggs), least on *Luffa acutangula* (164.90 ± 26.24 eggs). The incubation period was shortest on *S. nigrum* (3.25 ± 0.97 days) and longest on *Datura Stromanium* (5.40 ± 0.75 days) whereas per cent egg hatchability was highest on *Solanum tuberosum* (91.75 ± 3.73 %) and lowest on *L. acutangula* (82.00 ± 5.94%). *E. vigintioctopunctata* grubs developed differently on eight host plants, shortest on *S. nigrum* (13.25 ± 1.12 days) and longest on *D. stromonium* (21.55 ± 1.70 days) and survived best on *S. nigrum* and *P. minima* (92.00 ± 1.22 and 91.25 ± 0.88%) and worst on *L. acutangula* (45.25 ± 2.45%). More females than males were found among emerged adults and females lived longer than males. Pupal development was shortest on *S. nigrum* (3.85 ± 0.67 days) and longest in *M. charantia* (6.10 ± 0.72 days), wherein, adult emergence rate was highest on *S. nigrum* (94.25 ± 0.98%) and lowest on *L. acutangula* (53.25 ± 2.18%). Further on the basis of growth index, fecundity, survival and adult emergence, *S. nigrum* and *P. minima* were recorded to be the most suitable host plants followed by *S. melongena*, *S. tuberosum*, *S. esculentum*, *M. charantia* and *D. stromonium*. *L. acutangula* was the least preferred host plant by the test insect for overall growth and development.

## INTRODUCTION

The beetles belonging to the Epilachninae, constitute one sixth of the known species of the coccinellidae. The genus *Epilachna* has nearly 500 phytophagous species, and is widely distributed in South East Asia, Australia, Sri Lanka, East Indies, Malaya, America, Siberia, China and India. In India, the beetle is present in higher hills and in plains of Jammu and Kashmir, Punjab, Himachal Pradesh, Uttar Pradesh, Karnataka and Bengal and also in the plains (Shankar *et al.*, 2010). *E. vigintioctopunctata* is one of a group of closely related herbivorous ladybird beetles that have diversified greatly in external morphology and host plant use in and around Indian sub-continent. It is a polyphagous plant feeder and destructive pest of many cultivated and wild crops belonging to solanaceae, cucurbitaceae, fabaceae, convulvulaceae and malvaceae family such as brinjal, tomato, potato, tobacco, melon, cucumber, gourds and pumpkin in Jammu and Kashmir and in other parts of India (Ahmad *et al.*, 2001; Rath, 2005). It has also been reported on some medicinal plants like *Datura stromonium* L., *D. metel* L., *D. innoxia* Mill., *Solanum aviculare* Forst., *S. nigrum* L., *Withania somnifera* Dunal., *Physalis minima* L., wild species of *Amaranthus caudatus* L. (Wilson, 1989). Ganga and Chetty (1982) recorded that many other naturally occurring solanaceous plants (*Solanum nigrum*, *S. torvum*, *S. esculentum*, *Physalis minima* and *Datura*

*fastuosa*) act as a reservoir for maintaining the population of *E. vigintioctopunctata* throughout the year.

To better understand *E. vigintioctopunctata*/crop-plant interactions it is necessary to determine the role of wild hosts on grub and adult biology, the effect of grub to adult host-switches on adult biology, polyphagy/host plant sequences and specific feeding habits. All of the above factors are critical components of *E. vigintioctopunctata* nutritional ecology, bionomics and management. The increasing pest status and abundance of hadda beetle on brinjal and bitter gourd in J&K state has raised a number of questions regarding the factors responsible for its development, its natural enemy complex and management under natural conditions. The objectives of the current study were to catalogue the host plant complex of *E. vigintioctopunctata* and to delineate and quantify their role on the pest biology under Jammu conditions.

## MATERIALS AND METHODS

The investigations on host biology interactions of the pest were carried out using eight host plants including cultivated and wild species *viz.*, Bitter gourd (*Momordica charantia*), Brinjal (*Solanum melongena*), Makoi (*S. nigrum*), *Datura* (*Datura stromonium*), Tomato (*S. esculentum*), Potato (*S. tuberosum*), Rasp berry (*Physalis minima*) and Ridge gourd (*Luffa acutangula*). These plants were selected because among

them are the economically important and primary host plants of *E. vigintioctopunctata* in Jammu region. These eight host plant species were singly planted in pots (19 × 17 × 12cm) in a green house at Sher-e-Kashmir University of Agricultural Sciences and Technology at Chatha, Jammu, India and were maintained insecticide free. The plants were used when they had 4-5 true leaves. All the stages of the pest were recorded on each host during investigations.

#### Developmental parameters

The studies on duration of different developmental stages of the pest were carried out *in vitro* at 29 ± 1°C and relative humidity of 60 ± 10 per cent. Initial culture of the test insect was collected from field and raised in the laboratory on potted host plants species under study. 20 specimens replicated five times of each life stage of the beetle were collected and confined to Petri dishes (10cm diameter). Observations were recorded on time period consumed for completion of each stage. Fresh leaves of the respective host plants were provided daily as food after cleaning the Petri dishes.

#### Biological parameters

For these experiments 20 specimens of freshly laid eggs, newly emerged grubs, pupae, male and female adults having five replications were kept separately for all the host plant species. The specimens were observed daily and data on fecundity, per cent hatchability of eggs, per cent grubs survival and per cent adult emergence was recorded separately for each host plant.

#### Growth index

Growth index of the test insect on each plant species was computed as per the formula given by Singh and Rapusas (1986).

$$\text{Growth index} = \frac{\text{Percentage of grubs developed into adults}}{\text{Mean growth period of grubs in days}}$$

#### Sex ratio

Ten numbers of first instar grubs were kept separately on fresh leaf cuttings of test plant species which constituted on replication. Five replications were kept to study the sex ratio. The dried leaves of respective host plants were replaced by corresponding fresh leaves. The grubs were maintained till the adult stage, after that numbers of males and females were recorded. The ratio of male: female adults were expressed in numerical for statistical analysis. Thus, the effect of different host plants on the growth and development of the test insect was calculated by statistical analysis of data recorded on fecundity, per cent hatchability, incubation period, grub period, per cent grub survival, pupal period, per cent adult emergence, total life cycle, male longevity, female longevity and growth index using one way ANNOVA (Tukey's-b,  $P < 0.05$ ), Maurice *et al.* (2012).

## RESULTS AND DISCUSSION

Field observations conducted during 2008 and 2009 revealed that the pest (*E. vigintioctopunctata*) was invariably found on cultivated as well as on wild host plants acting as a pest reservoir. These plants offer shelter to the pest and maintain its population throughout the year. The present findings are in

agreement with those of (Ahmad *et al.*, 2001., Rath, 2005) who recorded many cultivated and wild crops belonging to solanaceae, cucurbitaceae, fabaceae, convulvulaceae and malvaceae families as host plants such as brinjal, tomato, tobacco, melon, cucumber, gourds, pumpkin and potato have been attacked by *E. vigintioctopunctata*. Similar findings have also been reported on some medicinal plants like *Datura stromonium*, *D. metel*, *D. innoxia*, *Solanum aviculare*, *S. nigrum*, *Withania sominifera*, *Physalis minima* and wild species of *Amaranthus caudatus* (Rajagopal and Trivedi, 1989).

The fate of the phytophagous offspring of insects is correlated strongly with oviposition on a suitable host plant because larvae usually are limited in mobility. Choice behavior of female insects can be affected by numerous parameters. Factors determining oviposition choice include quantity and/or quality of resources, plant morphology, natural enemies, inter- or intraspecific competition, and allelochemicals (Ballhorn and Lieberei, 2006). The data presented in Fig. 1 revealed that the host biology relation of *E. vigintioctopunctata* varies when reared on different host plants. The average fecundity of *E. vigintioctopunctata* on different hosts differ significantly ( $F = 68.390$ ,  $P = 0.001$ ) in the descending order of host preference of the hadda beetle *S. nigrum* (286.80 ± 19.86), *P. minima* (281.15 ± 23.27), *S. tuberosum* (261.25 ± 22.06) and *S. melongena* (235.60 ± 24.74) which promote a higher egg laying in comparison to *D. stromonium* (221.15 ± 18.65), *M. charantia* (211.80 ± 16.29) and *L. acutangula* (164.90 ± 26.24). The present findings are in conformity with Dhamdhare *et al.* (1990) who also reported the fecundity of female reared on makoi was the highest (603) followed by brinjal (486), tomato (355) and was lowest on datura (297). Similarly, Ramzan *et al.* (1990) also recorded highest fecundity on *S. nigrum* followed by brinjal and potato. The incubation period of eggs varied significantly ( $F = 20.131$ ,  $P = 0.0001$ ) on the host plants and ranged from 3.25 ± 0.97 days (*S. nigrum*) to 5.40 ± 0.75 days (*D. stromonium*). Similar results have been obtained by Dhamdhare *et al.* (1990) who reported that the average incubation period of eggs was shortest on brinjal (4.00 days) followed by makoi (4.04 days), tomato (4.13 days) and datura (5.20 days). Further Ramzan *et al.* (1990) also reported incubation period of 4.30 days on makoi followed by potato (3.50 days) and brinjal (3.60 days). Per cent egg hatchability differed significantly ( $F = 9.324$ ,  $P = 0.0001$ ) and highest was observed in case of *S. tuberosum* (91.75 ± 3.73 per cent) followed by *S. nigrum* (91.25 ± 3.93), *S. melongena* (90.50 ± 4.26), *P. minima* (89.25 ± 4.94), *L. esculentum* (88.25 ± 5.20), *M. charantia* (87.25 ± 5.25), *D. stromonium* (85.25 ± 4.99 per cent) and lowest on *L. acutangula* (82.00 ± 5.94).

The grub period also varied significantly ( $F = 100.642$ ,  $P = 0.0001$ ) and was recorded longest on *D. stromonium* (21.55 ± 1.70 days) followed by *M. charantia* (17.80 ± 1.06), *L. esculentum* (16.60 ± 1.27), *L. acutangula* (16.15 ± 1.35 days), *S. tuberosum* (15.10 ± 1.37), *S. melongena* (14.10 ± 1.02) and *P. minima* (13.70 ± 1.22 days). Shortest grub duration was observed on *S. nigrum* (13.25 ± 1.12 days). The present findings are in conformity with Thomas *et al.* (1969) who also observed that the average duration of grub period was 13 days on *Physalis maxima*, 13.41 days on *Datura stromonium*, 14.11 days on tomato and 16.35 days on brinjal.

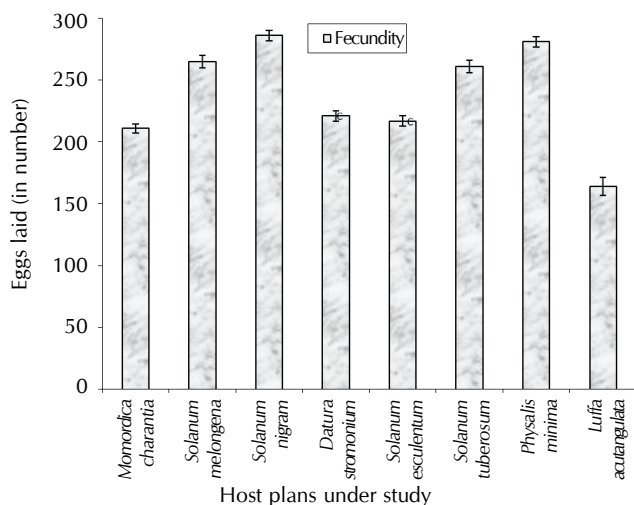


Figure 1: Effects of host plants on fecundity of hadda beetle

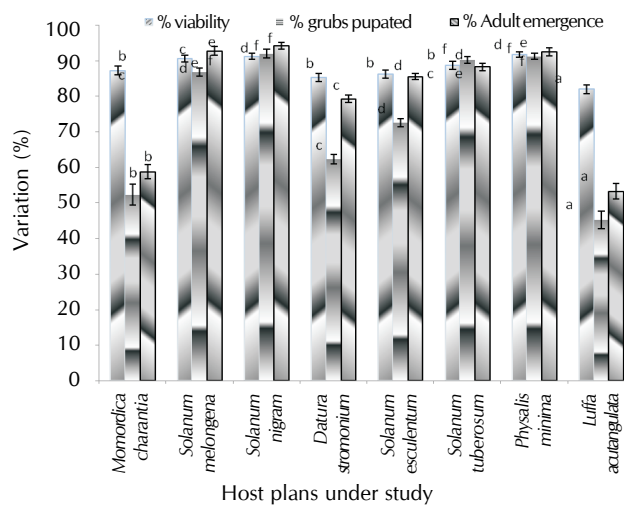


Figure 2: Effects of host plants on per cent survival of hadda beetle life stages

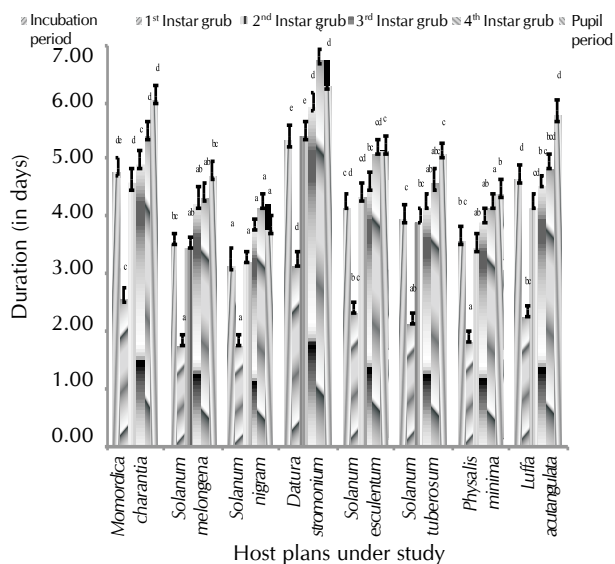


Figure 3: Effect of host plants of developmental parameters of Hadda beetle

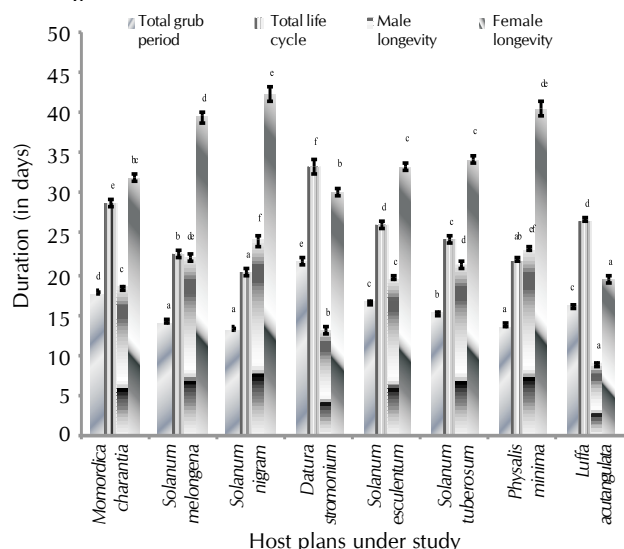


Figure 4: Effect of host plants on duration of Hadda beetle's vital life stages

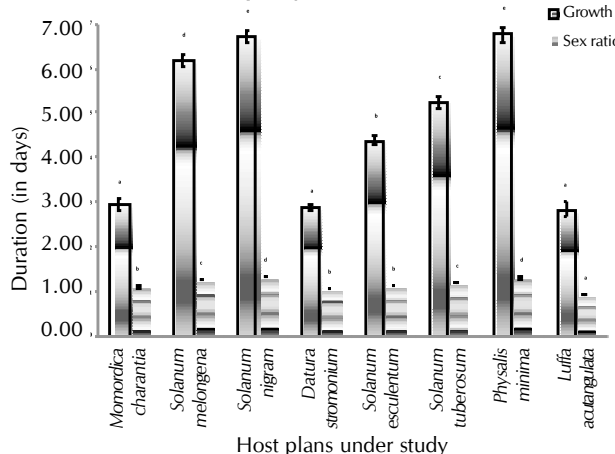


Figure 5: Effect of host plants on growth index and sex ratio of Hadda beetle

\*Within each bar, different letters indicate significant differences (Tukey's-b, P < 0.05)

Pandey and Shankar (1975) also reported that the average grub period was 12.0 days on brinjal, 13.50 days on potato, 15.50 days on tomato and 17.00 days on ridge gourd. Similarly, Ramzan *et al.* (1990) recorded grub duration of 11.3 days on makoi, 12.00 days on potato and 14.70 days on brinjal. Earlier workers reported the shortest grub period on raspberry *Physalis minima* (Thomas *et al.*, 1969), makoi (Ramzan *et al.*, 1990) and potato (Patel and Purohit, 2000) and longest on brinjal (Ramzan *et al.*, 1990), bhatkatai (Sahu and Rawat, 1969), datura (Dhamdhare *et al.*, 1990) and tomato (Patel and Purohit, 2000). Our findings are in conformity with Dhamdhare *et al.* (1990) who reported that the development of the grub was quickest on brinjal (12.56 days) followed by tomato (16.20 days), makoi (14.85 days) and longest on datura (22.70 days). Patel and Purohit (2000) recorded grub duration of 15.60 days on brinjal and 15.95 days on tomato. The grub period of *E. dodecastigma* was recorded to be  $9.75 \pm 0.80$  days on brinjal (Khan, 1997),  $11.20 \pm 1.90$  days on ridge gourd (Rahman, 2002) and 9-17 days on bitter gourd



**Figure 6: A. Laboratory studies on the host biology relationship on brinjal and bitter gourd.**

(Shanmugapriyan and Kingsly, 2003). Rahman *et al.* (2009) also reported that grub period of *E. dodecastigma* was highest on brinjal ( $29.88 \pm 0.78$  days) and lowest on bitter gourd ( $20.86 \pm 0.83$  days) and ridge gourd ( $17.40 \pm 1.02$  days). These findings indicated that there were considerable variations in grub period and such variation might be due to the experimental time and location, suitability of host plants as food and variability in food value.

There was significant difference in pupal period ( $27.149$ ,  $P = 0.0001$ ) which was recorded shortest on *S. nigrum* ( $3.85 \pm 0.67$  days) followed by *P. minima* ( $4.50 \pm 0.83$  days), *S. melongena* ( $4.80 \pm 0.70$ ), *S. tuberosum* ( $5.15 \pm 0.67$ ), *L. esculentum* ( $5.25 \pm 0.64$ ), *L. acutangula* ( $5.85 \pm 0.88$ ) and *M. charantia* ( $6.10 \pm 0.72$  days). The longest pupal period was recorded on *D. stromonium* ( $6.40 \pm 0.94$  days). Our results are in conformity with Thomas *et al.* (1969) who recorded the average duration of pupal period for 5.00 days on tomato, 5.16 days on datura, 5.38 days on husk tomato and 5.59 days on tomato. Ramzan *et al.* (1990) recorded pupal duration of 4.30 days on makoi, 4.70 days on potato and 5.50 days on brinjal. Dhamdhare *et al.* (1990) also reported the shortest pupal duration on makoi (4.10 days) followed by brinjal (4.50 days), tomato (5.51 days) and datura (6.06 days). Patel and Purohit (2000) recorded pupal duration of 4.10 days on brinjal and 4.30 days on tomato. Ueno *et al.* (2001) also reported that grub period of *E. vigintioctopunctata* reared on *S. tuberosum* ( $21.30 \pm 0.15$  days) was shortest than those reared on *Schizopepon bryoniaefolius* ( $23.20 \pm 0.50$  days). It was reported that the pupal period of *E. dodecastigma*  $5.63 \pm 0.26$  days (Moniruzzaman, 1999) on brinjal, 4-9 days (Shanmugapriyan and Kingsly, 2003),  $5.70 \pm 0.20$  days (Hossain *et al.*, 2008) on bitter gourd. Rahman *et al.* (2009) also observed lowest pupal period on brinjal ( $4.50 \pm 0.71$  days) and highest on bitter gourd ( $6.14 \pm 0.64$  days) and ridge gourd ( $6.00 \pm 0.63$  days).

On the basis of growth index, *P. minima* was found to be the most suitable host plant having highest growth index ( $6.76 \pm 0.67$ ) followed by *S. nigrum* ( $6.70 \pm 0.61$ ), *S. melongena* ( $6.19 \pm 0.61$ ), *S. tuberosum* ( $5.26 \pm 0.63$ ), *L. esculentum* ( $4.39 \pm 0.45$ ), *M. charantia* ( $2.93 \pm 0.69$ ) and *D. stromonium* ( $2.90 \pm 0.33$ ). *L. acutangula* was recorded as the least suitable

host plant having lowest growth index ( $2.82 \pm 0.76$ ). Thomas *et al.* (1969) reported husk tomato (*Physalis minima*) as the best host plant followed by *S. insanum*, *Datura stromonium*, brinjal and tomato. While as Dhamdhare *et al.* (1990) reported brinjal as the most suitable host plant followed by tomato, makoi, bhatkatai, tomato and raspberry, these studies support our results.

The longevity of hadda beetles' male and female adults reared on different host plants differed significantly ( $F = 178.129$ ,  $132.864$ ;  $P = 0.0001$ ,  $0.0001$ ) and ranged from ( $8.85 \pm 1.31$  days) on *M. charantia* to ( $24.15 \pm 2.43$  days) on *S. nigrum* and ( $19.4 \pm 1.50$  days) on *M. charantia* to ( $42.15 \pm 2.60$  days) on *S. nigrum*, respectively. The female beetles lived longer than their male counter parts in all the cases. In earlier studies also, similar longevities of adult beetles were reported  $32.63 \pm 2.39$  days (Moniruzzaman, 1999) on brinjal,  $21.50 \pm 1.58$  days on ridge gourd (Rahman, 2002) and  $27.01 \pm 1.58$  days on bitter gourd (Rahman, 2002). Pandey and Shankar (1975) recorded male and female longevity for 29.00 and 36.00 days on ridge gourd, 30.00 and 38.00 days on tomato, 31.00 and 40.00 days on potato and 37.00 and 44.00 days on brinjal. Dhamdhare *et al.* (1990) also recorded the male and female longevity of 29.00 and 34.00 days on datura,



**B. Host range of *Epilachna vigintioctopunctata***

34.00 and 46.00 days on brinjal, 37.00 and 48.00 days on tomato and 37.00 and 57.00 days on makoi. Male and female longevity of 18.00 and 27.30, 20.20 and 26.30 days on datura and tomato, respectively, was reported by Ramzan *et al.* (1990). Patel and Purohit (2000) recorded male and female longevity of 34.00 and 46.15, 37.00 and 48.00 days on brinjal and tomato, respectively. Our results are also in conformity with Rahman *et al.* (2009) who reported that the longevity of adult beetles of *E. dodecastigma* on ridge gourd, bitter gourd and brinjal were  $26.00 \pm 1.67$ ,  $25.28 \pm 1.39$  and  $37.75 \pm 0.83$  days, respectively.

The average life cycle duration in descending order was on *D. stromonium* ( $33.25 \pm 3.17$  days), *M. charantia* ( $28.75 \pm 1.59$ ), *L. acutangula* ( $26.75 \pm 2.12$ ), *L. esculentum* ( $26.10 \pm 1.86$ ), *S. tuberosum* ( $24.30 \pm 1.95$ ), *S. melongena* ( $22.5 \pm 1.91$ ) and *P. minima* ( $21.85 \pm 2.83$  days). Similar studies have also been conducted by Ganga and Chetty (1982) who observed that on *S. nigrum*, *S. torvum*, *D. fastuosa*, *S. melongena* and *L. esculentum* the duration of life cycle was progressively longer and on *P. minima* it was very much shortened. These results are in line with the findings of Dhamdhare *et al.* (1990) who also reported the average life cycle of *E. vigintioctopunctata* was shortest on brinjal (21.06 days) followed by tomato (21.79 days), makoi (24.99 days), bhatkatai (26.77 days), raspberry (29.20 days) and was longest on datura (33.96 days). Ramzan *et al.* (1990) also recorded the developmental behaviour and seasonal abundance of *E. vigintioctopunctata* on various solanaceous food plants and found that coccinellid completed its life cycle most quickly on *S. nigrum* (22.4 days) and the highest numbers of the pest were found on *S. xanthocarpum*, reaching a maximum of 526.3/10 plants in March.

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