

Influence of Host Plants on The Growth and Development of *Cheilomenes Sexmaculata* (Fabricius) (Coleoptera:Coccinellidae) Prey on *Aphis Craccivora* Koch

Rakhshan¹, Md. Equbal Ahmad²

Aphid Systematics & Biocontrol Laboratory, University Department of Zoology, T.M. Bhagalpur University, Bhagalpur-812 007, Bihar

Abstract: Allelochemicals and physical barriers such as wax of leaf surfaces, trichomes, cell wall thickness and lignifications of host plants play important role in unsuitability of prey to predatory lady beetles. Four economically important host plants of family Fabaceae (*Phaseolus sinensis*, *Lablab purpureus*, *Vigna radiata* and *Vigna mungo*) infested by *Aphis craccivora* (Hemiptera: Aphididae) were selected for experiment to observe the growth pattern of one of the most potent predator of aphids, *Cheilomenes sexmaculata* (Fabr.) (Coleoptera: Coccinellidae). The significant variation was observed in the length and width of grubs of each instar stage of predator when preyed on *A. craccivora* on these host plants. The maximum growth of each instars were observed on *P. sinensis* followed by *L. purpureus*, *V. radiata* and *V. mungo*. The highest length ($7.29 \pm 0.15 \text{mm}$) and ($1.32 \pm 0.06 \text{mm}$) in width of 4th instar larvae was recorded on *P. sinensis* than other host plants at $19.45 \pm 0.55^\circ\text{C}$ and $60.85 \pm 1.015\% \text{RH}$. This variation is observed significant by ANOVA test for length ($F_1=28922.7$, $F_2=18.6$; $P<0.05$) and for breadth ($F_1=13504.3$, $F_2=44.1429$; $P<0.05$). Similarly, the developmental period of *C. sexmaculata* was also found to be host plant dependent. The longest developmental period was recorded on *V. mungo* (17.6 ± 0.24 days) and shortest on *P. sinensis* (14.00 ± 0.02 days). This difference is also observed significant between each instars and host plant by analysis of variance test ($F_1=197.667$, $F_2=60.333$; $P<0.05$). It is observed that *P. sinensis* is most suitable host plants for the growth and development of Larvae of *C. sexmaculata*. *V. radiata* and *V. mungo* were the less suitable plants probably due to presence of allelochemicals and trichomes on the leaves which directly affect the searching efficiency of predator.

Keywords: *Aphis craccivora*; *Cheilomenes sexmaculata*; Allelochemicals; Host plants; Growth & Development.

1. Introduction

Coccinellids are the foundation for integrated pest management IPM and core of sustainable agricultural development (Dufour, 2001). They have been found significant role in reducing aphid population (Hzdek, 1973; Agarwala and Chaudhari, 1995; Mari et al., 2005; Olmez Bayhan et al., 2006). Many physiological, ecological and behavioral aspects are governed by interaction with organism from other tropic levels (host plant- prey-predator or parasitoids). Plants insect interaction is a dynamic system. Plants challenged by insects due to changes in compositions and physical properties of cell wall as well as biosynthesis of secondary metabolites (Hopkins and Huner, 2004). Commonly plants produce a large variety of secondary metabolites like phenol, tannins, terpenoids, alkaloids, polyacetylene, fatty acids, steroids, which have an allelopathic effect on the growth and development of the same plant or neighboring plants (Rice, 1992; Khan et. al., 2009; Jayaraman and Ramalingam 2014). Phenolic compounds also function as antimicrobial, antioxidant or chemical toxins in plants and repel would be predators (McCue and Shetty, 2001). Secondary plant substances, allelochemical impacts gave opportunities to better understand interaction of the plant-aphid- ladybeetles tritropic model and demonstrated that successful biological control of pests must integrate the environmental aspects of each tropic level.

2. Material and Methods

The culture of large number of larvae and adult predator of *C. sexmaculata* was established in the laboratory in order to supply aphids reared on different host plants viz., *Phaseolus sinensis*, *Lablab purpureus*, *Vigna mungo* and *Vigna radiata* for the experiment. Fresh aphids were also collected daily with infested leaves of each host plants from experimental field and supplied as food. Mating pairs were collected from the stock culture and beetles were reared on aphids on its host plants in separate beaker (25cmx10cm) at room temperature. The filter paper was placed in the bottom of beaker and top covered by muslin cloth. The eggs laid by these pairs on different host plants were used in experiments. Fresh eggs were collected from stock culture from each host plants. After hatching of eggs, the grubs were transferred individually to another beakers (25cmx10cm) with fresh 100 aphids/predator of mix age with twig/leaves of food plants to avoid cannibalism on different host plants viz., *L. purpureus*, *P. sinensis*, *V. mungo* and *V. radiata*. During post-embryonic developmental period, size of each instar stage was measured. Fresh aphids were provided daily to each larva till the pupation.

3. Results

During the study, *C. sexmaculata* moulted thrice and passes through four larval stages (Plate: 1-4). Significant variation was observed on growth and development of larvae on different host plants at $19.45 \pm 0.55^\circ\text{C}$ and $60.85 \pm 1.015\% \text{RH}$. The maximum length and width of 1st instar larvae were

recorded on *P. sinensis* (1.48±0.11mm; 0.44±0.1mm) and minimum on *V. radiata* (1.38±0.02mm; 0.39±0.02mm). This variation is observed significant by ANOVA test for length and width (F1=28922.7, F2=18.6) (F1=13504.3, F2=44.1429; P<0.05) (Table-1&2). However, the minimum development period of 1st instars was recorded on *P. sinensis* (4.4±0.13 days) and maximum on *V. mungo* (5.4±0.13 days). Similar, results were also observed on 2nd, 3rd and 4th instar stages larvae (Table: 1, 2). Total larval period was recorded minimum on *P. sinensis* (14.00±0.00 days) and maximum on *V. mungo* (17.6±0.24 days) (Table-3). The effect of food plants/ prey quality on larval development of *C. sexmaculata* is observed significant (F1=197.667, F2=60.333; P<0.05).

Table 1: Average length (mm) of grubs of *C. sexmaculata* on *A. craccivora* among host plants (mean ± SE).

Host plants	1 st instar	2 nd instar	3 rd instar	4 th instar
<i>P. sinensis</i>	1.48±0.11	4.29±0.12	5.99±0.19	7.29±0.15
<i>L. purpureus</i>	1.41±0.09	4.24±0.14	5.83±0.12	7.16±0.01
<i>V. radiata</i>	1.40±0.08	4.23±0.11	5.83±0.11	7.16±0.01
<i>V. mungo</i>	1.38±0.02	4.21±0.01	5.77±0.08	7.10±0.12

Table 2: Average breadth (mm) of grubs of *C. sexmaculata* on *A. craccivora* among host plants (mean ± SE).

Host plants	1 st instar	2 nd instar	3 rd instar	4 th instar
<i>P. sinensis</i>	0.44±0.01	0.78±0.03	0.85±0.04	1.32±0.06
<i>L. purpureus</i>	0.41±0.01	0.75±0.04	0.83±0.03	1.29±0.10
<i>V. radiata</i>	0.41±0.01	0.74±0.03	0.82±0.05	1.29±0.03
<i>V. mungo</i>	0.39±0.02	0.74±0.02	0.79±0.04	1.27±0.10

Table 3: Developmental period (in days) of grubs of *C. sexmaculata* on *A. craccivora* (means ± SE).

Host plants	1 st instar	2 nd instar	3 rd instar	4 th instar	Total
<i>P. sinensis</i>	4.4±0.13	3.4±0.24	3.2±0.20	3.00±0.00	14.00±0.00
<i>L. purpureus</i>	4.8± 0.19	3.8±0.19	3.6±0.24	3.2±0.19	15.6±0.24
<i>V. radiata</i>	5.2±0.20	4.2±0.20	3.8±0.20	3.4±0.24	16.6±0.24
<i>V. mungo</i>	5.4±0.13	4.4±0.13	4.2±0.08	3.6±0.13	17.6±0.24



Plate 1: 1st Instar stage of *C. sexmaculata*



Plate 3: 3rd Instar stage of *C. sexmaculata*



Plate 2: 2nd Instar stage of *C. sexmaculata*



Plate 4: 4th Instar stage of *C. sexmaculatas*



Plate 5: Low trichome density on *V. radiata*.



Plate 6: High trichome density on *V. mungo*

4. Discussion

Tank and Korat (2007) reported the average size (length and width) of 1st to 4th instar larvae of *C. sexmaculata* (1.41±0.16mm; 0.42±0.02mm); (4.25±0.18; 0.75±0.17 mm); (5.83±0.29mm; 0.83±0.05 mm) and (7.17±0.20mm; 1.29±0.14mm) respectively when preyed on *A. gossypii* which is supported to present finding. The present investigations are also in conformity with finding of some other authors (Patel 1985, 1998; and Rai et al., 2003; Tank and Korat 2007). Allelochemicals of host plants may influenced larvae survival and development as well as weight of predators (Hodek 1956, Malcolm 1992, Hauge et al., 1998).

However, Lokeshwari et al., (2010) observed less larval period 11-12 days of *M. sexmaculata* /*A. craccivora* on host plant *L. purpureus* at 25±2°C. Devi et al., (2008) also observed that the total larval period of *M. sexmaculata* varied from 7 to 8 days with an average of (7.8±0.45) on *A. gossypii* on brinjal at 25.23°C and average relative humidity 83.71%. This result was lower than the present study. The host plant affect on the developmental period of *C. sexmaculata* was also reported by Rattanapun (2012) on *A. gossypii* on two different host plants. The duration of

larval development varies, when same source of food (*A. gossypii*) was provided on two different host plants. It is clear evidence from earlier works that the host plants play important role on the relative duration of instars of *C. sexmaculata* and found to be substantial and vary with the plant varieties. Pandi et al., (2012) found that grub of *C. sexmaculata* took 8.2±0.58 days during development on *A. craccivora* at 27±1°C and 60±5% RH. However, Nyaanga et al. (2012) reported that the quality of food and environmental factors like temperature, humidity also play an important role on different aspects of the biology of (*Cheilomenes lunata*) coccinellid beetles.

The consensus results indicated strongly that host plant of aphid influence the larval development of *C. sexmaculata*. The Larvae of ladybeetle species when consumed *A. craccivora* feed on *P. sinensis* shows faster development than those consumed aphids from *V. mungo*. Moreover, Larvae of *C. sexmaculata* which reared on *V. radiata* and *V. mungo* showed slow development and high mortality. These results, partially explained by allelochemical compounds of host plants *V. mungo* and *V. radiata* may be toxic to predator which caused slow development and death of larvae of *C. sexmaculata*. Taggar et al. (2014) reported that phloem feeding whitefly induces oxidative stress on *V. mungo* (black gram) and induction of high levels of antioxidative compounds may probably play significant role in host plant defence. Plant antioxidant compound such as phenolics are believed to play an important role in chemical defence against herbivores (Appel, 1993).

Chemical constitutions of host plant are the one of explanation of unsuitability or suitable prey to predator (Omkar and Mishra 2005, Chowdhary et al., 2008). Secondary plants substances allelochemicals such as linamarin acted as defensive compound to reduce ability of herbivore to utilize plant protein, resulting reduced quality of prey decreased the development of predator (Riddick et al., 2011). The better development and survival of *C. sexmaculata* when reared on aphid from *P. sinensis* and *L. purpureus* was likely favourable for suitability of *A. craccivora* to larval growth of *C. sexmaculata*. Generally coccinellids more preferred prey species supported performance of their larvae and adults (essential prey) than poor prey species (alternative prey) (Omkar and Mishra 2005; Cabral et al., 2006; Giorgi et al., 2009).

Larval of *C. sexmaculata* had shows, slow development with minimum body size took longer period minimum on *V. mungo* and *V. radiata*, this may be also due to presence of trichomes on leaves surfaces (Plate:5&6). *V. mungo* have much trichomes than *V. radiata* thus, density of trichomes also affect the searching efficiency of predator which directly affect their development. Thus, due to prolonged searching time less number of aphids were consumed by predator and also developed slowly. Rattanapun (2012) also reported, less consumption of aphids and longer larval development of *C. sexmaculata* which is also similar to present observation. Presence of trichomes on host plants also affects the searching efficiency of predator. Similarly, Southwood (1986) and Werker (2000) reported that the morphological and density of trichomes vary considerably among plant species, Some trichomes have glands that

release secondary metabolites. (terpenes, alkaloids) which can be poison repellent or trap insects (Duffey, 1986). The differences in morphological structures and secondary plant substance composition and utilization by specialist and generalist pests may constitute useful information to designed biological control of aphid pests by predator.

5. Conclusion

In the present study we investigated the effect of host plants on the growth and development of *C. sexmaculata*. As we know that nutritional value, secondary chemistry and morphology of plants can influence both size and developmental period of predator. On the basis of present studies it is concluded that host plants play an important role in the suitability of prey for development of predators. Such type of information is very useful to designing the biological control programme of aphids.

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editorial Board of several journals. He is also serving this university as nodal officer, Public relation officer and UGC Incharge in the university administration.



Rakhshan has completed her M.sc. (Gold Medalist) degree in Zoology (Entomology) from Tilka Manjhi Bhagalpur University. She is doing Ph.D. on biology of aphids and predatory potential of Coccinellids at same University. She was awarded Inspire fellowship from DST, New Delhi for her Ph.D work. She has published two articles and communicated several articles for publication in International and National journals.

Author Profile



Dr. Md. Equbal Ahmad is Asso. Professor, Dept. of Zoology, Tilka Manjhi Bhagalpur University. He has completed his M.Sc. and M.Phil. from A.M.U. Aligarh and did his Ph.D. from DDU, Gorakhpur University. He has more than 25 years of research experience in the field of Toxicology, Bio-ecology and Biosystematics of aphids, their parasitoids and predators. He has received young scientist award by AZRA, Cuttak. He has published more than 30 research articles in reputed journal. He has also completed a major research project of DST. He is a member of