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FEEDING BEHAVIOUR OF *EPILACHNA VIGINTIOCTOPUNCTATA* (COLEOPTERA: COCCINELLIDAE) ON *LUFFA AEGYPTIACA*

BY

A. K. SINHA and S. S. KRISHNA

Entomology Laboratory, Department of Zoology, University of Gorakhpur, Gorakhpur (U.P.), India

Observations on adult *Epilachna vigintioctopunctata* Fabr. on *Luffa aegyptiaca* show that these insects prefer flowers in light and leaves and flowers in dark. Probably physical and chemical stimuli, originating from the flowers, guide beetles to them in light. In darkness the insects' comparatively greater preference to leaves and flowers suggests that the attractants and arrestants present in both these parts of the plant are mainly in the form of chemical stimuli bearing equal intensity. These insects prefer to feed on the corolla of the flower of *L. aegyptiaca.* This preference is affected by stimulants in these parts of the plant. The nature and characteristics of these stimuli are unknown.

Several workers have studied various aspects of host selection of different species of *Epilachna* infesting a number of economically useful plants, [Koyama (1950, 1951, 1957); Srivastava (1957); Iwao (1959); Iwao & Machida (1961) and Nayar & Fraenkel (1963)]. Their studies include detailed observations on food selection by different species of *Epilachna* chiefly among solanaceous and cruciferous plants. Very little is known about the mechanism of host selection in these insects on cucurbitaceous crops, many of which are important host plants. Such study is all the more necessary and valuable in India, since the products of these plants form an essential item of food. One of the important features associated with host selection of phytophagous insects is their feeding behaviour on their preferred host (Thorsteinson, 1960; Beck, 1965). Such information with respect to *Epilachna vigintioctopunctata* infesting one of its favourite hosts, a variety of gourd — *Luffa aegyptiaca* — is limited. An attempt has, therefore, been made to study orientation and feeding activity of these insects on their host plant.

MATERIALS AND METHODS

This investigation was restricted to adult *E. vigintioctopunctata* of mixed age and sex groups. The insects were collected from *L. aegyptiaca* cultivated in the vicinity of Gorakhpur University. This cucurbitaceous plant has yellow flowers.

Two different criteria were employed to study the relative preference for different parts of *L. aegyptiaca.* They were (a) comparison of relative efficiency of different sources of food to attract the insects during a given period of time and,

(b) comparison of feeding activity of the insects on different sources of food in a unit time period. Each experiment was adequately replicated and data analysed by methods recommended by Paterson (1939).

To determine the relative preference of various parts of the plant to the beetles, a feeding chamber was made up by inverting a petri dish (diameter 15 cm; height 3 cm) over a white sheet of paper on which were already arranged at equal distances, along its circumference, different parts of the plant freshly plucked from the field. Twenty-five freshly collected insects were released simultaneously at the centre of this feeding chamber. The parts included were a few pieces of stem, leaf, flower-bud, flower, a small-sized whole fruit, fruit without pericarp and pericarp only. Each of these items was placed at one position only within the chamber which was kept at temperatures between 30° and 33°. No attempt was made to renew the plant materials during the observation period since they remained fresh. The number of insects distributed on different parts of the plant was noted at half-hourly intervals for a period of 6 hours. The total number of insects collected on different parts of the plant at the end of 6 hours was recorded and the mean distribution of the insects determined. The experiments were conducted in light and in darkness. Each experiment was repeated four times employing a fresh batch of individuals for every replicate and data were analysed by analysis of variance.

Three different series of experiments were arranged to determine the feeding activity of the insects on various parts of *L. aegyptiaca*, using both freshly collected and 24-hour starved individuals. The general layout of these experiments was similar to that described above.

The first series was designed to measure and compare the feeding activity on a fresh set of the same plant parts selected for study in the previous experiment, and the second series was planned to assay the insects' feeding activity on different components of the flower of *L. aegyptiaca* namely, sepals, petals, stamens, ovary and pedicel. In both series of experiments insects were kept under constant observation for a period of 1 hour and the total number of times each part was fed upon noted so that the mean number of times each test material was ingested could be calculated. In the third series, individual feeding activity of *E. vigintioctopunctata* on different parts of the flower was determined as described by Krishna & Sinha (1969).

RESULTS

The preference of different parts of *L. aegyptiaca* to *E. vigintioctopunctata* in light and in dark are compared in Tables I and II. In light, most beetles were attracted to flowers. Differences in the number of insects on flowers and on any other part of the plant provided in the experiment was significant ($P > 0.01$); differences between numbers on other plant parts were not. In dark, differences in the number of insects settled on flowers and leaves were not statistically significant. However, differences in insect distribution between flowers and that amongst stem

pieces, flower-bud, whole fruit, fruit without pericarp and only pericarp are significant ($P > 0.01$). A similar significant difference was observed between the numbers of these beetles on leaves and on either stem pieces or on pericarp only.

TABLE I

Relative efficiency of different parts of L. aegyptiaca *preferred by* E. vigintioctopunctata *(in light)*

Series	Test Material	Mean distribution of insects at the end of a 6-hour period	Difference from the previous mean	$E_D \times t$
A	Flower	77.25[1]		
B	Whole fruit	31.75	45.50	30.320 at 1% level.
C	Leaf	27.25	4.50	
D	Fruit without pericarp	23.00	4.25	
E	Flower-bud	17.25	5.75	
F	Pericarp of fruit	12.00	5.25	
G	Stem pieces	3.50	8.50	

General Mean: 27.43
Standard error of difference between means (E_D): 10.71
[1] A is significant at 1% level from B, C, D, E, F and G.

TABLE II

Relative efficiency of different parts of L. aegyptiaca *preferred by* E. vigintioctopunctata *(in dark)*

Series	Test Material	Mean distribution of insects at the end of a 6-hour period	Difference from the previous mean	$E_D \times t$
A	Flower	60.50[1]		
C	Leaf	38.00[1]	22.50	32.673 at 1% level.
D	Fruit without pericarp	24.50	13.50	
B	Whole fruit	18.00	6.50	
E	Flower-bud	16.00	2.00	
G	Stem pieces	2.50	13.50	
F	Pericarp of fruit	1.75	0.75	

General Mean: 23.14
Standard error of difference between means (E_D): 11.409
[1] A is significant at 1% level from D, B, E, G and F.
C is significant at 1% level from G and F.

The observations do not show whether the insects are attracted to one part of the plant for feeding or for something else. To ascertain this, the feeding activity of the insects on different parts of the plant was determined.

Comparison of the mean number of times different parts of the plant were fed upon by freshly collected as well as 24-hour starved insects, during an hour's period (Tables III and IV respectively), show that they feed most often on flowers. Differences between the feeding activity on flowers and that on the remaining parts of the plant is significant ($P > 0.01$).

TABLE III

Feeding activity of freshly collected E. vigintioctopunctata *on different parts of* L. aegyptiaca

Series	Test Material	Mean number of times test material is fed upon	Difference from the previous mean	$E_D \times t$
A	Flower	49.75[1]		
D	Fruit without pericarp	6.75	43.00	9.172 at 1% level.
B	Whole fruit	4.75	2.00	
E	Flower-bud	3.50	1.25	
C	Leaf	2.50	1.00	
F	Pericarp of fruit	2.50	0	
G	Stem pieces	1.00	1.50	

General Mean: 10.04
Standard error of difference between means (E_D): 3.24
[1] A is significant at 1% level from D, B, E, C, F and G.

TABLE IV

Feeding activity of 24-hour starved E. vigintioctopunctata *on different parts of* L. aegyptiaca

Series	Test Material	Mean number of times test material is fed upon	Difference from the previous mean	$E_D \times t$
A	Flower	94.25[1]		
E	Flower bud	10.75	83.50	6.794 at 1% level.
B	Whole fruit	6.25	4.50	
D	Fruit without pericarp	5.00	1.25	
C	Leaf	4.50	0.50	
G	Stem pieces	3.25	1.25	
F	Pericarp of fruit	2.25	1.00	

General Mean: 18.107
Standard error of difference between means (E_D): 2.402
[1] A is significant at 1% level from E, B, D, C, G and F.

The feeding activity of both freshly collected and 24-hour starved individuals was studied on different parts of the flower of *L. aegyptiaca*. The results (Tables V and VI respectively) show that the beetles feed mostly on the corolla as against the remaining parts of the flower ($P > 0.01$). Next in order of preference for feeding becomes the calyx.

TABLE V

Feeding activity of freshly collected E. vigintioctopunctata *on different components of flower of* L. aegyptiaca

Series	Test Material	Mean number of times test material is fed upon	Difference from the previous mean	$E_D \times t$
L	Corolla	43.25[1]		
M	Calyx	19.25	24.00	7.072 at 1% level.
N	Gynoecium	9.00	10.25	
O	Androecium	3.00	6.00	
P	Pedicel	1.00	2.00	

General Mean: 15.1
Standard error of difference between means (E_D): 2.4
[1] L is significant at 1% level from M, N, O and P.

TABLE VI

Feeding activity of 24-hour starved E. vigintioctopunctata *on different components of flower of* L. aegyptiaca

Series	Test Material	Mean number of times test material is fed upon	Difference from the previous mean	$E_D \times t$
L	Corolla	61.00[1]		
M	Calyx	34.75	26.25	14.558 at 1% level.
O	Androecium	1.75	33.00	
N	Gynoecium	1.00	0.75	
P	Pedicel	1.00	0	

General Mean: 19.85
Standard error of difference between means (E_D): 4.95
[1] L is significant at 1% level from M, O, N and P.

Thus, the calyx and corolla of *L. aegyptiaca* are the parts mostly fed upon by these coccinellids. Probably a single individual feeds on sepals and petals of the flower, so it would be useful to know how frequently and for how long it feeds on

calyx and corolla when both are available. To ascertain this, a quantitative assessment of the individual feeding activity of both freshly collected and 24-hour starved insects on the two plant parts, specified above, was made. The results, reported elsewhere (Krishna & Sinha, 1969), show that the frequency of feeding of 24-hour starved individuals is greater on the corolla than on the calyx ($P > 0.01$). This is not so with freshly collected individuals. Nevertheless, the total duration of feeding of both freshly collected and 24-hour starved insects is longer on the corolla than on the calyx ($P > 0.01$).

DISCUSSION

These results show that *E. vigintioctopunctata* living on *L. aegyptiaca* prefer different parts of the plant in light and dark. For instance, the insects are mostly attracted to flowers in light; in dark, both leaves and flowers serve as efficient sources of attraction. According to Dethier *et al.* (1960) and Beck (1965) the classes of stimuli involved in positive orientation responses of an insect are designated as attractants. Beck (1965) further states that the nature of these stimuli can be either physical or chemical. Therefore it seems reasonable to explain the differences in the insects' relative preference for different parts of the plant in light and dark as follows: in darkness, the attractants and arrestants contained in both leaves and flowers appear to be mainly in the form of chemical stimuli of equal intensity, attracting these insects to a similar extent to these parts of the plant. In light, the stimuli originating from the flowers, evoking maximum positive responses in these insects, seem to be both physical (probably colour?) and chemical. The intensities of both stimuli jointly influence more strongly and effectively than that of the chemical stimuli alone, operating in dark, to cause the maximum distribution of the insects on this part of the plant.

Considering the feeding activity of *E. vigintioctopunctata* on various parts of *L. aegyptiaca*, it is clear from the results that these insects feed mainly on the flowers, particularly on the corolla. This observation strongly suggests the existence of certain powerful feeding incitants — a class of stimuli which, according to Beck (1965), evoke feeding responses in insects — in petals of the flowers of *L. aegyptiaca*. The fact that these insects continue feeding for greatest length of time on this part of the plant (Krishna & Sinha, 1969) also suggests that the corolla of the flower of *L. aegyptiaca* contains certain unidentified, strong feeding stimulants which are the necessary stimuli for the maintenance of feeding of an insect on its dietary substrate (Beck, 1965). The importance of such stimulants affecting the feeding behaviour of an allied species of this genus (*E. varivestis*) on *Phaseolus* plants has already been shown (Nayar & Fraenkel, 1963).

If this interpretation of the mechanism of attraction is correct, it seems reasonable to conclude that the preference shown by *E. vigintioctopunctata* in its feeding behaviour for the corolla of *L. aegyptiaca* depends on the existence of certain powerful arrestants, incitants and stimulants in this part of the plant.

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RÉSUMÉ

*COMPORTEMENT ALIMENTAIRE D'*EPILACHNA VIGINTIOCTOPUNCTATA *(COLEOPTERA, COCCINELLIDAE) SUR* LUFFA AEGYPTIACA

Cette étude expose les résultats d'observations sur l'orientation et sur le préférendum alimentaire de la coccinelle *Epilachna vigintioctopunctata* Fabr. à l'égard des diverses parties de sa plante hôte: *Luffa aegyptiaca.* Les expériences réalisées sont décrites et les données numériques obtenues ont été soumises au calcul statistique.

Il a été établi que dans des conditions d'obscurité les insectes se portent en nombre presque égal sur les fleurs et sur les feuilles, alors qu'à la lumière, les fleurs sont nettement plus attractives. En ce qui concerne leur alimentation, les insectes préfèrent se nourrir aux dépens de la corolle de la fleur.

Les divers facteurs, chimiques ou visuels, pouvant intervenir dans l'orientation de l'insecte et dans son comportement alimentaire, sont discutés.

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