Pest Management in Horticultural Ecosystems
Vol. 28, No.2 pp 58-63 (2022)
DOI Number: 10.5958/0974-4541.2022.00039.X

Preference of pumpkin beetles, *Aulacophora* spp. (Coleoptera: Chrysomelidae) to different cucurbitaceous hosts

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ABSTRACT: Preference for two species of pumpkin beetles, *i.e. Aulacophora foveicollis* (Lucas) and *Aulacophora intermedia* (Jacoby) (Galerucidae: Coleoptera) towards six cucurbitaceous hosts were evaluated at the Department of Entomology, Faculty of Agriculture, Annamalai University, Tamil Nadu, India. In the field evaluation, the population of *A. foveicollis* was the highest in pumpkin (12.83 adults/ plant) and least in snake gourd (0.61 adults/ plant). However, the population of *A. intermedia* was the maximum in bottle gourd (11.89 adults/ plant) and was least in bitter gourd (5.17 adults/ plant). In the laboratory free choice test, *A. foveicollis* preferred pumpkin, while *A. intermedia* preferred ridge gourd. Bitter gourd was the least preferred by both species. A similar preference pattern was observed in the confinement test also. Orientation assay using an olfactometer revealed that preference towards different hosts by *A. foveicollis* was bottle gourd> pumpkin >ridge gourd, cucumber >snake gourd > bitter gourd, and that of *A. intermedia* was ridge gourd > bottle gourd > pumpkin > cucumber > snake gourd > bitter gourd. The maximum number of trichomes recorded on the bottle gourd was followed by the snake gourd, whereas less trichome density was recorded on the cucumber. Trichome density had a significant positive correlation with *the A. intermedia* population and a non-significant negative correlation with *A. foveicollis*.

Keywords: *Aulacophora foveicollis*, *A. intermedia*, Host preference, cucurbits

INTRODUCTION

Red pumpkin beetles are predominant pests of cucurbitaceous vegetables (Raman and Annadurai, 1985). Three species of red pumpkin beetles, *viz*., *Aulacophora foveicollis*, *A. cincta*, and *A. intermedia* (Galerucidae: Coleoptera), inflict severe damage from the seedling to maturity stage. The adults of *A. foveicollis* are red-coloured, while *A. cincta* are grey with black having a glistening yellow-red border, and *A. intermedia* are blue in colour. The female can lay 150-300 numbers of eggs. The grubs feed on the roots portion, and adults feed on leaves and flowers, and the resultant damage range extends from 35% to 75% (Saljoqi and Khan, 2007). The response of *Aulacophora* spp on the cucurbitaceous hosts differs, and it can be exploited for the behavioural management of the beetle. Hence, the preference of two species of red pumpkin beetles *viz., Aulacophora foveicollis* (Lucas) and *Aulacophora intermedia* (Jacoby) towards six cucurbitaceous hosts were evaluated under laboratory and field conditions.

MATERIALS AND METHODS

In situ preference of pumpkin beetles

The field evaluation was carried out at the Department of Entomology, Faculty of Agriculture, Annamalai University, Tamil Nadu, India. The seeds of cucurbitaceous vegetables *viz*., pumpkin (*Cucurbita maxima* Linn.), bottle gourd (*Lagenaria siceraria* (Molina) Standl.), ridge gourd (*Luffa acutangula* Linn.), snake gourd (*Trichosanthes cucumerina* Linn.), bitter gourd (*Momordica charantia* Linn.) and cucumber (*Cucumis sativus* Linn.) were procured from commercial seed stores and local farmers. The field experiments were laid out in a Randomized Block Design in a plot size of 2.5m×2.5m, and three such replicated plots were maintained. Regular agronomic practices were followed. To evaluate the preference of red pumpkin beetles towards different cucurbitaceous crops, the population of beetles was recorded between 6 am and 8 am when the feeding activity is more. The number of adult beetles on the leaves, flowers, and stems of three plants were counted at 15, 30, 45, 60, 75, and 90 days after sowing, and the data were pooled together.

Mass culturing of pumpkin beetles

For the laboratory experiments, a homogenous population of red pumpkin beetle cultured on the pumpkin was used. Plants were raised in cement pots (50 cm × 30 cm × 30 cm) and caged using a 1.5m × 1.5m × 2m sized net cage. Two species of red pumpkin beetles, *A. foveicollis* and *A. intermedia* were collected from the experiment field and released into separate cages. Periodically fresh plants were placed inside the

Table 1. Field incidence of *Aulacophora foveicollis* on different cucurbits

Host	Number of adult / plant						Mean
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	
Pumpkin	1.33 (1.52)^{b}	6.00 (2.64)^{c}	17.67 (4.31)^{d}	22.67 (4.86)^{f}	16.33 (4.16)^{e}	13.00 (3.73)^{c}	**12.83**
Bitter gourd	0.00 (1.00)^{a}	1.33 (1.52)^{a}	2.67 (1.91)^{a}	5.33 (2.51)^{c}	1.67 (1.62)^{b}	1.33 (1.52)^{b}	**2.06**
Bottle gourd	1.00 (1.41)^{b}	4.33 (2.30)^{b}	5.33 (2.51)^{b}	11.33 (3.51)^{d}	13.67 (3.82)^{d}	0.00 (1.00)^{a}	**5.94**
Ridge gourd	1.67 (1.62)^{bc}	4.67 (2.37)^{bc}	5.33 (2.51)^{b}	3.00 (1.97)^{b}	1.33 (1.52)^{b}	0.33 (1.13)^{ab}	**2.72**
Snake gourd	0.00 (1.00)^{a}	1.33 (1.52)^{a}	2.33 (1.82)^{a}	0.00 (1.00)^{a}	0.00 (1.00)^{a}	0.00 (1.00)^{a}	**0.61**
Cucumber	2.33 (1.82)^{c}	6.00 (2.64)^{c}	13.33 (3.78)^{c}	15.67 (4.08)^{e}	7.00 (2.82)^{c}	0.33 (1.13)^{ab}	**7.44**
S.Ed.	**0.10**	**0.14**	**0.11**	**0.12**	**0.09**	**0.18**	
C.D. (p=0.05)	**0.24**	**0.32**	**0.25**	**0.27**	**0.21**	**0.42**	

*****Mean of three replications. Values in parenthesis are square root transformed. Value with different alphabets differs significantly.

Table 2. Field incidence of *Aulacophora intermedia* on different cucurbits

Host	Number of adult / plant						Mean
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	
Pumpkin	1.33 (1.52)^{a}	4.67 (2.37)^{bcd}	13.67 (3.82)^{c}	16.33 (4.16)^{de}	7.67 (2.94)^{b}	0.67 (1.27)^{a}	**7.39**
Bitter gourd	1.33 (1.52)^{a}	4.33 (2.30)^{bc}	5.33 (2.51)^{a}	7.67 (2.94)^{a}	12.33 (3.64)^{c}	0 (1.00)^{a}	**5.17**
Bottle gourd	3.33 (2.07)^{b}	5.33 (2.50)^{cd}	8.33 (3.05)^{b}	17.67 (4.31)^{e}	21.67 (4.76)^{d}	15 (3.99)^{d}	**11.89**
Ridge gourd	6.67 (2.76)^{c}	12.33 (3.65)^{d}	7.67 (2.94)^{b}	11.67 (3.55)^{c}	5.67 (2.57)^{a}	0.33 (1.13)^{a}	**7.39**
Snake gourd	2.33 (1.82)^{b}	1.33 (1.52)^{a}	7.33 (2.88)^{b}	15.67 (4.08)^{d}	19.67 (4.54)^{d}	8.33 (3.05)^{c}	**9.11**
Cucumber	2.67 (1.91)^{b}	3.67 (2.15)^{b}	7.67 (2.94)^{b}	10.33 (3.36)^{b}	8.33 (3.05)^{b}	2.33 (1.82)^{b}	**5.83**
S.Ed.	**0.11**	**0.15**	**0.11**	**0.07**	**0.10**	**0.15**	
C.D. (p=0.05)	**0.25**	**0.33**	**0.24**	**0.16**	**0.22**	**0.33**	

Mean of three replications. Values in parenthesis are square root transformed. Value with different alphabets differs significantly

cages, and the test insects were allowed to multiply within the cage and used for laboratory experiments.

In vivo feeding preference of pumpkin beetles towards selected hosts by free choice

The preference of pumpkin beetles towards various hosts was evaluated under a completely randomized design under laboratory conditions of 28±20C and 90 per cent relative humidity. Fresh and insect damage-free leaves of the six cucurbit hosts were collected from the experimental field. Leaf discs (3.7 cm2) were excised from the respective hosts and were placed at equidistance on a moist filter paper inside plastic Petri plates (20 cm dia). Overnight pre-starved adult beetle was released inside @ one per Petri plate. Three replications were maintained for both species of red pumpkin beetles. Leaf area fed was calculated using graph sheets at 12, 24, and 48 hrs after the adult release.

***In vivo* feeding preference of pumpkin beetles towards selected hosts under confinement**

Leaf discs of 3.7 cm^2 excised from the six cucurbit hosts were individually placed on filter paper inside plastic Petri plates (9 cm diameter). One overnight pre-starved adult beetle was confined to feed on the leaf discs. Three replications were maintained for each host and both species of red pumpkin beetle. Leaf area fed was calculated using graph sheets at 12, 24, and 48 hrs after the adult release.

***In vivo* evaluation of orientation of pumpkin beetles towards selected hosts**

The olfactory preference of *A. foveicollis* and *A. intermedia* towards different hosts was evaluated using an olfactometer (Mascot Enterprises, Coimbatore, India). Finely chopped leaves of selected host plants were kept in different hands of an olfactometer @ three hosts at a time. The evaluation was done for all six hosts by replacing the hosts. Twenty-five beetles pre-starved overnight were released at the centre of the olfactometer per set. The central chamber was vacuumed, and mild air was sent through the opening of the hands. Beetles were also replaced when the hosts were replaced in the hands. The number of insects oriented towards the different hosts was recorded. Each experiment was repeated thrice. The orientation of red pumpkin beetles towards other hosts was calculated in percentage.

Estimation of diversity and density of trichomes on selected cucurbit hosts

To identify the reasons for the preference for red pumpkin beetle, the density and types of trichomes present in the abaxial and adaxial leaf surfaces and petioles of the selected hosts were estimated based on micromorphology description for cucurbits given by Ali and Al-Hemaid (2011). One square centimetre section was cut from the leaves of specified hosts. The sectioned samples were observed under a compound microscope (10 X magnification). The number of trichomes and types of trichomes was counted and expressed as trichome density per square centimetre area.

Statistical analysis

The data obtained from the field and laboratory evaluation were analyzed statistically as per the methods described by Panse and Sukhatme (1978).

RESULTS AND DISCUSSION

Incidence of *A. foveicollis* and *A. intermedia* on selected hosts

The field incidence of red pumpkin beetles was noticed in all the test hosts. At 15 DAS, the maximum population of *A. foveicollis* was recorded on cucumber, followed by ridge gourd, pumpkin, and bottle gourd, as against no population on the bitter gourd and snake gourd. Similarly, a higher preference for red pumpkin beetles towards cucumber was observed by Mahmood *et al*. (2005), Khan (2015), and Laila *et al.* (2015). The mean data shows that the maximum population of beetles was observed on pumpkins, followed by cucumber. Significant variation in the beetle population was observed during various days of observation. The hierarchy of preference towards other hosts was cucumber > bottle gourd>ridge gourd >bitter gourd (Table 1). Hassan *et al*. (2012) reported that bitter gourd was less preferred in all the stages.

Host preference of *A. intermedia* varied significantly among the different days of observation. In the early stages of crop growth, ridge gourd was highly preferred, whereas, in the later stages, bottle gourd was the most preferred. The highest mean population of *A. intermedia* was recorded on bottle gourd, and the lowest was on bitter gourd. The order of preference of *A. intermedia* towards other hosts was snake gourd > pumpkin >ridge gourd > cucumber. Similar observations were recorded by Vandana *et al*. (2001), Roy and Pande, 1990 and Mehta and Sandhu (1992).

***In vivo* feeding preference of pumpkin beetles to selected hosts**

In a free choice test, cucumber was the most preferred host by *A. foveicollis*, followed by pumpkin, bottle gourd, snake gourd, and ridge gourd and no leaf area consumption was recorded on bitter gourd. Similarly, in earlier studies,

Table 3. Leaf area consumption of red pumpkin beetles

Host	Leaf area consumption (Sq.cm) free-choice test						Leaf area consumption (Sq.cm) no-choice test					
	A. foveicollis			*A. intermedia*			*A. foveicollis*			*A. intermedia*		
	12 HRS	24 HRS	48 HRS	12 HRS	24 HRS	48 HRS	12 HRS	24 HRS	48 HRS	12 HRS	24 HRS	48 HRS
Pumpkin	0.27 (1.12)^{a}	0.51 (1.22)^{b}	0.97 (1.39)^{b}	0.06 (1.03)^{bc}	0.1 (1.04)^{b}	0.17 (1.08)^{b}	0.06 (1.03)^{b}	0.11 (1.05)^{a}	0.23 (1.10)^{b}	0.39 (1.18)^{c}	0.77 (1.33)^{d}	1.18 (1.47)^{b}
Bitter gourd	0 (1.00)^{a}	0 (1.00)^{a}	0 (1.00)^{a}	0 (1.00)^{a}	0 (1.00)^{a}	0 (1.00)^{a}	0.01 (1.00)^{a}	0.08 (1.04)^{a}	0.17 (1.08)^{ab}	0.01 (1.00)^{a}	0.03 (1.01)^{a}	0.06 (1.03)^{a}
Bottle gourd	0.09 (1.04)^{a}	0.16 (1.07)^{ab}	0.31 (1.14)^{a}	0 (1.00)^{a}	0 (1.00)^{a}	0 (1.00)^{a}	0.03 (1.01)^{a}	0.16 (1.07)^{a}	0.21 (1.09)^{ab}	0.02 (1.01)^{a}	0.07 (1.03)^{a}	0.14 (1.06)^{a}
Ridge gourd	0.02 (1.01)^{a}	0.06 (1.02)^{a}	0.13 (1.06)^{a}	0.3 (1.14)^{a}	0.51 (1.22)^{d}	0.98 (1.40)^{c}	0.28 (1.13)^{c}	0.55 (1.24)^{b}	0.88 (1.37)^{c}	0.26 (1.12)^{b}	0.39 (1.18)^{b}	0.98 (1.40)^{b}
Snake gourd	0 (1.00)^{b}	0.03 (1.01)^{a}	0.25 (1.11)^{a}	0.08 (1.04)^{c}	0.18 (1.08)^{c}	0.26 (1.12)^{b}	0.05 (1.02)^{a}	0.11 (1.05)^{a}	0.14 (1.06)^{a}	0.02 (1.01)^{a}	0.05 (1.02)^{a}	0.07 (1.03)^{a}
Cucumber	0.5 (1.44)	1.67 (1.62)^{c}	2.8 (1.94)^{c}	0.02 (1.01)^{ab}	0.03 (1.01)^{ab}	0.07 (1.03)^{a}	0.73 (1.31)^{d}	1.46 (1.50)^{c}	1.84 (1.68)^{d}	1.1 (1.45)^{d}	2.03 (1.74)^{d}	2.4 (1.84)^{c}
SE(d)	**0.08**	**0.08**	**0.08**	**0.01**	**0.02**	**0.02**	**0.01**	**0.03**	**0.02**	**0.02**	**0.04**	**0.04**
C.D.	**0.19**	**0.18**	**0.18**	**0.02**	**0.03**	**0.05**	**0.02**	**0.05**	**0.03**	**0.04**	**0.08**	**0.08**

*Mean of three replications. Values in parenthesis are square root transformed. Value with different alphabets differs significantly.

Table 6. Correlation between Red Pumpkin beetles and trichome density of leaves (Pearson correlation)

	Trichome density
A.fovicollis	
Population	-0.002^{NS}
Feeding preference	-0.563^{NS}
A.intermedia	
Population	0.943**
Feeding preference	0.076^{NS}

NS- Non-significant
*- Significant at 0.05 % level of probability
**-Significant at 0.05 % level of probability

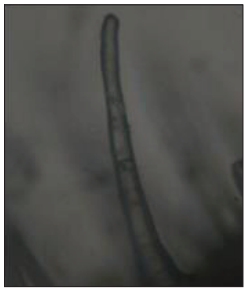
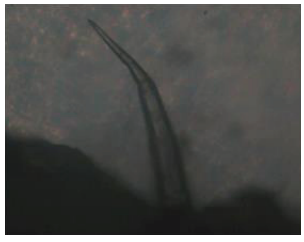


Plate. A. Trichomes of Bottle gourd

Plate. B. Trichomes of Snake gourd



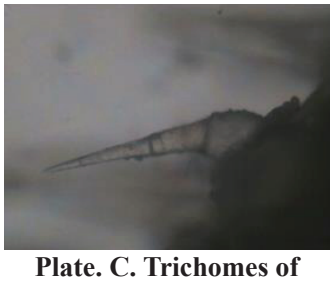
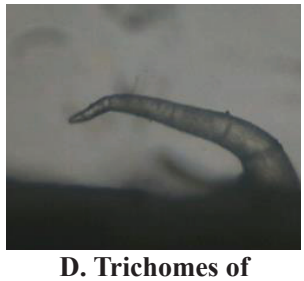


Plate. C. Trichomes of Pumpkin Plate.



D. Trichomes of Ridge gourd

Plate. E. Trichomes of Bitter gourd

Plate. F. Trichomes of Cucumber

cucumber was the most preferred and bitter gourd was the least preferred host of *A. foveicollis* (Khan *et al.,* 2011 and Khan *et al.,*2012). *A. intermedia* registered the maximum consumption of ridge gourd followed by snake gourd, pumpkin, and cucumber; there was no feeding on the bitter gourd and bottle gourd (Table 3). In the confinement test, the maximum leaf consumption by *A. foveicollis* was on cucumber *A. intermedia* fed the maximum on pumpkins which is a deviation from the free choice test (Table 3).

Orientation of pumpkin beetles towards selected hosts

In the orientation assay, the maximum number of *A. foveicollis* oriented towards the bottle gourd, followed by pumpkin, ridge gourd, cucumber, and snake gourd. In contrast, the orientation of *A. intermedia* was the maximum towards the ridge gourd. Orientation of both species was the minimum towards snake gourd and little gourd (Table 4).

Density and diversity of trichomes on the selected host plants and its impact on the preference of *A. foveicollis* and *A. intermedia*

Three types of trichomes, *viz.,* Type-I (thin-walled, irregular shape and flattened disc at base), Type-II (Curved pointed apical cell) and Type-III (short, thick-walled, swollen at the base and pointed tip) as described by Ali and Al-Hemaid, (2011) were observed on the selected hosts. Various types of trichomes were observed in test hosts *viz.,* bottle gourd (Types-I) (Plate A), snake gourd (Type-I, II & III) (Plate B), pumpkin (2 types) (Plate C), ridge gourd (1 type) (Plate D), bitter gourd (3 types) (Plate E) and cucumber (1 type) (Plate F) (Table.5). The highest number of trichomes, irrespective of types was observed in bottle gourd leaves followed by snake gourd and the lowest number of trichomes was observed on cucumber (Table 5). There is no significant effect of trichome density present in the host plants against *A. foveicollis* on population and feeding preference but a significant positive effect on *the A. intermedia* population (Table 6). Dalin *et al*. (2008) reported that trichome density in various plants was suggested as the probable source of resistance against many soft-bodied insects. In the case of red pumpkin beetles, hard-bodied, coleopteran pests were not affected by trichomes in the selected test hosts.

CONCLUSION

Among the host plants, Pumpkin was the most preferred host of *A. foveicollis,* whereas bottle gourd was the most preferred host of *A. intermedia* in both field and laboratory conditions. No significant effect was observed between red pumpkin beetle preference and trichomes density.

ACKNOWLEDGEMENT

The authors thank the authorities of Annamalai University for providing necessary facilities to conduct the experiment.

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MS Received: 05 December 2022
MS Accepted : 29 December 2022