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Role of artificial foods, honey and sucrose as kairomones to the predatory mirid bug, *Cyrtorhinus lividipennis* Reuter

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Abstract: Honey and sucrose were tested for their role as kairomones and food materials to the predatory mirid bug, *Cyrtorhinus lividipennis* Reuter in the laboratory and greenhouse. Honey and sucrose at 10, 25, 50 and 100 per cent concentrations were found to be attractive to the mirid bugs. Honey was comparatively more attractive than sucrose. Honey and sucrose at different concentrations did not show significant differences in attracting mirid bugs and supported the survival of mirid bugs for 7-9 days compared to rice plants which supported for only 5 days.

Key words: Artificial foods, Cyrtorhinus lividipennis, honey, sucrose, kairomones, Nilaparvata lugens.

Introduction

Predatory mirid bug, *Cyrtorhinus lividipennis* Reuter feeds on eggs and early instar nymphs of leafhopper and planthopper pests of rice particularly those of brown planthopper (BPH), *Nilaparvata lugens* (Stal) (Pophaly *et al.*, 1978). It is one of the important natural enemies affecting the population build up of these hoppers. Asynchrony in the initial appearance of the predator with reference to the pest appears to be the main limitation for a complete expression of the biocontrol potential of the mirid bug in nature. Thus strategic augmentation of the mirid bug has been proposed to be the main biocontrol tactic in hopper pest management.

The goal of conservation in biological control is to enhance conditions for natural enemy survival and reproduction relative to pests so that pest population growth rates are lowered and pest densities reduced over time. One of the techniques is to apply artificial foods to crops to provide food and to concentrate natural enemies in the field. Artificial foods like sucrose and honey solution applied to crop foliage served as a food material in meeting the nutritional needs for self maintenance in adult parasitoids and predators of crop pests (Ewert and Chiang, 1966; Schiefelbein and Chiang, 1966; Ben Saad and Bishop, 1976 a and b) and these natural enemies were concentrated in large numbers in the fields applied with these artificial foods. Keeping in view, the need for conservation of mirid bugs in the field during off-season and to manipulate their behaviour by attracting them to the treated surface, honey and sucrose were tested as food and kairomones for attracting the mirid bugs in the laboratory and greenhouse.

Materials and Methods

Raising of rice plants and rearing of host insects

Rice plants of variety TN1 were grown in the greenhouse at 30 $\pm$ 5°C and 60 $\pm$ 10 % relative humidity. The BPH was reared

Table 1. Kairomonal activity of honey and sucrose on *C.lividipennis*

Honey dew	% mirid bugs attracted			Time taken to reach the spot (min)			Time spent on the spot (min)		
	Nymph	Female	Male	Nymph	Female	Male	Nymph	Female	Male
Honey (50%)	100.00a	90.00a	94.29a	4.24b	6.26b	3.03b	26.91a	30.09a	34.11a
Sucrose (50%)	85.71a	94.29a	88.57a	3.15b	7.65b	3.15b	22.17a	33.23a	36.39a
D.Water	50.00b	21.43b	41.43b	12.14a	21.00a	11.43a	4.20b	4.86b	6.10b

Petridish bioassays. No. of mirid bugs tested for each treatment = 30. Six replications consisting of five individuals each. Figures in a column followed by same letter are not significantly different at 5 per cent level (DMRT).

Table 2. Attraction of *C.lividipennis* to honey and sucrose

Concen-tration	% mirid bugs attracted							
	Released in groups of 10				Released singly (25 mirid bugs / concentration)			
	Nymphs	Females	Males	Mean	Nymphs	Females	Males	Mean
Honey								
10%	54.17a	55.00a	51.67ab	53.67ab	73.33a	26.67d	60.00c	53.33b
25%	62.50a	67.50a	70.83a	66.94a	73.33a	50.00a	73.33a	65.53a
50%	38.33b	34.17b	60.83a	44.44b	55.33b	43.33b	66.67b	55.11b
100%	34.33b	33.53b	30.83b	32.49c	50.55b	39.33c	55.23d	48.37bc
Sucrose								
10%	32.08b	41.3ab	34.24a	35.87b	20.00b	46.67a	46.67a	37.78a
25%	40.68a	41.1ab	35.38a	39.06a	53.33a	33.33b	20.00b	35.56a
50%	31.04b	46.6a	29.24b	35.62b	13.33b	26.67b	26.67b	22.22b
100%	24.05c	46.8a	22.45c	31.09c	13.33b	20.00c	20.00b	17.78b

Olfactometer bioassays. 1) Group tests: 4 treatments 6 replications (10 insects/ replication). 2) Released in groups of 10 and no choice tests. 2) Released individually 4 treatments. 5 replications and 5 mirid bugs per replication. Figures followed by same letter in a column are not significantly different at 5 per cent level (DMRT)

Table 3. Attraction of *C. lividipennis* sto honey and sucrose at different concentrations in olfactometers

Mirid stage/ material tested	% mirid bugs attracted				
	Concentration				
	10%	25%	50%	100%	mean
Nymphs					
Honey	55.83a	54.50a	54.67a	53.57a	54.64a
Sucrose	44.17b	45.00b	45.33b	46.43b	45.23 b
Females					
Honey	60.83a	56.67a	54.17a	56.67a	55.00a
Sucrose	39.17b	43.13b	45.83b	43.33b	45.00b
Males					
Honey	56.67a	52.50a	54.17a	52.50a	53.96a
Sucrose	43.33b	47.50b	45.83b	47.50b	46.04b

Insects were released in groups of 10. choice between honey and sucrose 13 replications and 10 insects per replication. Figures followed by same letter in a column are not significantly different at 5 per cent level (DMRT)

on 40 days old rice plants in wooden cages in greenhouse. Mirid bugs were reared on BPH oviposited rice plants. The adult mirid bugs were confined to these plants for 2-3 days for oviposition and emerging nymphs were allowed for required period in separate cages to obtain nymphs or adults of specified age. Honey and sucrose were evaluated for their role as kairomones in attracting mirid bugs in the petridish (no choice tests), olfactometer (choice and no choice tests) and greenhouse bioassays (choice tests) and for their effect on the survival of mirid bugs on the rice plants and in test tubes.

Petridish Bioassay

Filter papers were treated centrally with 200 microlitres of honey, sucrose (50% concentration) or distilled water (control). Papers are used 30 minutes after treatment. The filter paper was kept in 15 cm diameter petridish and the treated areas were marked with pencil. The insects were starved for 2 hours prior to the starting of the experiment. Thirty nymphs, 30 mated females and 30 males of mirid bugs were released individually in the petridish outside the treated area and their subsequent movements were recorded manually. The observations were recorded for one hour on the predators movements like number of mirid bugs attracted to the treated area, time taken by the mirid bugs to get attracted to the spot, time spent on the treated and untreated area, number of visits made by the mirid bug. For each treatment there were six replications with five mirid bugs for each replication. Percentage of mirid bugs attracted was calculated, arcsine transformed, analyzed by Randomized Block Design (RBD) and means were separated by Duncan's Multiple Range Test (DMRT).

Olfactometer bioassays

Honey and sucrose at different concentrations *viz.*, 10, 25, 50 and 100 per cent were evaluated in both choice and no choice experiments using 'Y' tube olfactometer with 35 cm arm length and 4 cm diameter. In choice experiments, choice was given between honey and sucrose at the same concentration and they were replicated thirteen times. In no choice experiments, honey and sucrose at different concentrations were tested separately along with distilled water as control and they were replicated six times. Air was passed through cylinders containing distilled water, charcoal powder and honey or sucrose source at one end and control at other end to get humid and odourless air. Sterilized, absorbent cotton treated with half ml of honey, sucrose served as the source and cotton treated with distilled water served as control. Nymphs, females and males of mirid bugs were released in the center of the olfactometer in groups of 10 and also individually. In the individual releases, 25 mirid bugs were released for treatment consisting of five replications with five mirids per replication. Observations like number of mirid bugs present at the honey or sucrose source, at the center and at the control end were recorded at 10 minutes after their release. The data were analyzed in RBD after arcsine transformation and the means were separated by DMRT. To confirm the role of honey and sucrose as kairomones to mirid bugs, a choice experiment was conducted in the greenhouse using rice plants sprayed with honey and sucrose at different concentrations mentioned for olfactometer tests. Plants sprayed with honey, sucrose and unsprayed plant were arranged equidistantly in the cage and 100 each of nymphs, females and males of mirid bugs were released in the centre of the cage. The mirid bugs settled on different plants were recorded. Percentage of mirid bugs attracted to different sources was calculated. Each treatment was replicated 7 times. In all the bioassay studies, nymphs, females and males of mirid bugs were tested.

Longevity of mirid bugs on honey and sucrose

Honey (50%) and sucrose (50%) were evaluated for their effect on longevity of mirid bugs either by releasing on the rice plants or by maintaining in the test tubes. The plants were covered with mylar tubes and mirid bugs were released singly. The test materials were provided in small parafilm cups, which were adhered to or near the plants and inside the test tube. The materials were replenished in the parafilm cups whenever necessary. Twenty each of adults and nymphs were tested for each treatment and their mortality was recorded.

Results and Discussion

Attraction of mirid bugs to honey and sucrose in petridishes

In the petridishes, honey and sucrose (50%) attracted 85.7 - 100 per cent of *C. lividipennis* and only 21.7 to 50 per cent were attracted to distilled water treated spot (Table 1). Mirid bugs responded equally to honey and sucrose. There was no significant difference in the number of different stages of mirid bugs *viz.*, nymphs, females and males attracted to honey or sucrose. *C. lividipennis* took less time to reach the honey or sucrose treated spot (3.03 - 7.65 minutes) compared to that to reach the distilled water spot (11.43 - 21.00 minutes). Time taken by females (6.26 - 7.65 minutes) to reach the spot was significantly more compared to the time taken by males (3.03 - 3.15 minutes) and nymphs (3.15-4.24 minutes). Mirid bugs spent more time (22.17 - 36.39 minutes) on honey and sucrose treated spots compared to that spent on distilled water treated spot (4.86-6.10 minutes).

Response of mirid bugs to honey and sucrose in olfactometers

More number of mirid bugs (66.94%) and individual stages like nymphs and females were attracted to honey at 25 per cent concentration compared to other concentrations. In general, sucrose at 25 per cent concentration was attractive to nymphs and males, whereas sucrose (50% and 100%) was attractive to females. When the mirid bugs were released singly, honey at lower concentrations (10 and 25%) was more attractive than that at higher concentrations (50 and 100%) (Table 2).

When different stages of *C. lividipennis* were given a choice between honey and sucrose at 10, 25, 50 and 100 per cent in olfactometers, more number of mirid bugs were attracted to honey (54.64% nymphs; 55.00% females; 53.96% males) compared to sucrose (45.23% nymphs; 45.00% females; 46.04% males at all concentrations (Table 3).

The present findings are in conformity with the findings of earlier workers who reported that parasitoids and predators were attracted to honey in the olfactometers. In a multichoice experiment with honey, egg yolk and Corcyra eggs, 23.4 per cent adult *C. lividipennis* were attracted to honey sachet (Bentur and Kalode, 1985). Adults of *Chrysoperla carnea* (Stephans) were attracted to honey solution in olfactometers (Dean and Satasook, 1983; Bakthavatsalam and Singh, 1996). In a four-arm olfactometer, the larvae of aphid predator, *Episyrphus balteatus* (De Geer) was attracted to sucrose, which was found to be a feeding stimulant for the larvae (Bargen *el al.,* 2000). The whitefly parasitoid, *Microplitis croceipes* (Cresson) females searched and found sucrose faster in their search for food (Stapel *et al.,* 1997).

Attraction of C. lividipennis to plants sprayed with honey and sucrose

At concentrations 10, 25 and 50 per cent significantly higher number of mirid bugs were attracted to honey sprayed plants (56.43, 56.27 and 48.11%, respectively) compared to plants sprayed with sucrose (32.14, 31.97 and 34.33%, respectively) (Table 4). But at 100% concentration, plants sprayed with honey or sucrose attracted equal percentage of mirid bugs (43.20 to 44.80%). At all concentrations, unsprayed plants attracted significantly lowest number of mirid bugs (11.99-17.24%). These results revealed that honey and sucrose were attractive to the mirid bugs.

The present findings are in agreement with the earlier workers who sprayed honey and sucrose on the plants and concentrated natural enemies. Predators like *Agonum dorsale*, all Carabids and *Philanthus* sp. and lady bird beetles were more abundant in the honey sprayed plots compared to unsprayed plots (Ben Saad and Bishop, 1976b; Monsrud and Toft, 1999). Sucrose alone dissolved in water was also used successfully to concentrate adult lady beetles and lacewings in treated crops (Ewert and Chiang, 1966; Schiefelbein and Chiang, 1966; Carlson and Chiang, 1973, Ben Saad and Bishop, 1976b; Evans and Richards 1997, Nicholos and Neel, 1977; Canas and Neel, 1998).

Survival of C. lividipennis on honey and sucrose

Nymphs and adults provided with honey and sucrose (50)% with out prey insect survived for 7.2 to 8.5 days on the plants whereas they survived for 4.5 days on the control plant without honey or sucrose. The mirid bugs survived only for 1 to 2.4 days in the test tube (with honey or sucrose) without plant (Table 5). Several laboratory studies

Table 4. Attraction of *C.lividipennis* to plants sprayed with honey and sucrose in greenhouse

Honey/sucrose Concentration	% insects attracted			
	Nymphs	Females	Males	Mean
10%				
Honey	60.92a	64.22a	44.14a	56.43a
Sucrose	27.92b	23.96b	44.54a	32.14b
Unsprayed plant	11.16c	13.09c	11.32b	11.86c
25%				
Honey	58.78a	58.14a	51.88a	56.27a
Sucrose	31.24b	31.02b	33.48b	31.97b
Unsprayed plant	14.89c	10.84c	14.64c	13.46c
50%				
Honey	57.19a	44.66a	42.49a	48.11a
Sucrose	30.30b	40.53a	32.17ab	34.33ab
Unsprayed plant	12.51c	13.87b	25.34c	17.24c
100%				
Honey	55.88a	38.59ab	39.93ab	44.80a
Sucrose	31.98ab	50.13a	47.51a	43.20a
Unsprayed plant	12.14c	11.28c	12.57c	11.99b

Green house cage experiments. 3 treatments and 7 replications. Choice Experiments. In each concentration, figures in a column followed by same letter are not significantly different at 5 per cent level (DMRT)

Table 5. Longevity of *C lividipennis* on honey and sucrose

Treatment	Duration in days			
	On plants		Test tubes	
	nymphs	females	nymphs	females
Honey 50%	8.5a	7.2b	2.0a	2.3a
Sucrose 50%	8.3a	8.4a	2.1a	2.4a
Control plant	4.5c	4.6d		
D. Water			1.0b	1.0b

Figures followed by same letter in a column are not significantly different at 5 per cent level (DMRT)

proved that honey and sucrose could increase predator and parasitoid longevity. On concentrated honey, mirid bug nymphs could survive for 3.1 days (Bentur and Kalode, 1985) and honey supported better survival of the mirid bugs at International Rice Research Institute (IRRI 1981). Yu *et al.* (1996) reported that honey solution would supply the necessary nutrients for the development and growth of *C. lividipennis.* Honey prolonged the lifespan of adults *of Hyperaspis notata* (Mulsant), a coccinellid predator on mealy bug *Phemicoccus manihoti* Matile Ferrero (Dreyer *et al.,* 1997). Maeda *el al.* (2002) reported that the nymphs of the predator, *Onus senderi* (Poppius) fed on 30 per cent sucrose solution, lived longer and reached later instar. Larvae of two species of *Chrysopa* when offered sucrose fed on it in the laboratory (Downes 1974).

The data thus clearly indicated that honey and sucrose could attract, act as kairomones and support the survival of *C. lividipennis.* So these materials could be used under field conditions to attract mirid bugs to the plant and to make them survive for shorter periods when the prey (pest) populations are low.

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