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Rice leafhopper and planthopper honeydew as a source of host searching kairomone for the mirid bug predator, *Cyrtorhinus lividipennis* (Reuter) (Hemiptera: Miridae)

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ABSTRACT: **Kairomonal activity of honeydew of rice green leafhopper (GLH) *Nephotettix virescence* (Distant) and planthoppers *viz.*, brown planthopper (BPH) *Nilaparvata lugens* (Stål) and whitebacked planthopper (WBPH) *Sogatella furcifera* (Horv) on their mirid bug predator *Cyrtorhinus lividipennis* (Reuter) was studied in the laboratory. Honeydew of all the hoppers was found to be attractive to all stages of the mirid bugs both in the Petri-dish and olfactometer bioassays. Mirid bugs were attracted to the treated spot, moved quickly on the untreated area, searched slowly on the treated spot making sharp turns and showed antennal palpation. When choice was given between BPH and WBPH honeydew, mirid bugs preferred to move towards BPH honeydew. When choice was given among BPH, WBPH and GLH honeydew, mirid bugs showed the highest response to GLH honeydew followed by that of BPH and WBPH. Mirid bug nymphs perceived and reached the honeydew source quickly compared to the females. In olfactometer studies, mirid bugs behaved similarly when released in groups and individually.**

KEY WORDS: *Cyrtorhinus lividipennis*, honeydew, kairomone, *Nephotettix virescens*, *Nilaparvata lugens*, *Sogatella furcifera*

Mirid bug, *Cyrtorhinus lividipennis* (Reuter) is the most important predator of rice brown planthopper, *Nilaparvata lugens* (Stål), whitebacked planthopper, *Sogatella furcifera* (Horv) and green leafhopper *Nephottetix virescens* (Distant). This predator feeds on the eggs and first-instar nymphs of hopper pests. Successful parasitism or predation is the result of finding and attacking suitable hosts by insect parasitoids. The most important factors mediating the location of a host are semiochemicals through different sources. Different chemicals may be involved in host habitat location, host location, host recognition and host attack (Vinson, 1976). The information on how the mirid -bug locates its host habitat or host is very scanty. And also, at present there is no mass rearing technique available for this predator. Attempts have been initiated to find out the different sources of semiochemicals from insect host and host plant (rice) which mediate host habitat and host finding by the mirid bug. Present investigation deals with the influence of semiochemicals sourced from the insect on orientation of predatory mirid bugs.

Honeydew which is an excretory product of BPH, WBPH and GLH is used in the present studies to investigate its kairomonal activity in the host finding behaviour of mirid bugs.

MATERIALS AND METHODS

The insect hosts *viz.* BPH, WBPH and GLH were reared on TN1 rice plants in rearing cages in the greenhouse at 30 ± 5° C and 70 ± 10 per cent relative humidity. Mirid bugs were reared on BPH oviposited rice plants TNI and different stages of the predator were maintained in separate cages.

Honeydew from the leaf and planthoppers was collected separately by using capillaries and parafilm sachets. One end of the capillary tube was kept on honeydew droplet on the plant and it was collected into 5ml culture tubes. In another method, 10 hoppers were released in parafilm sachet and it was tied to the rice plant stem and next day honeydew was collected into glass bottles. It was stored in refrigerator and used without any dilution for bioassay studies.

Bioassay Studies

Petri-dish Bioassay

Filter papers (15cm diam) were treated centrally with 200micro litres of honeydew of BPH, WBPH, GLH and distilled water (control). Papers were used 30minutes after treatment. The filter paper was kept in 15cm diameter Petri-dish and the treated areas were circled with pencil. The insects were starved for 4 hours prior to the starting of the experiment. Thirty nymphs, 30 mated females and 30 males of mirid bugs were released individually in the Petri-dish 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 and antennal palpation.

Olfactometer bioassays

Both, choice and no choice experiments were conducted using 'Y' tube olfactometer with 35cm arm length and 4cm diameter. Air was passed through cylinders containing distilled water, charcoal powder and honeydew source at one end and control at other end to get humid and odourless air passed through both arms of the olfactometer. Sterilized, absorbent cotton treated with one ml of honeydew served as the source and cotton treated with distilled water served as the control. Nymphs, females and males of mirid bugs were released in the centre of the olfactometer in-groups of 20, replicated 6 times, in factorial randomized block design. In another experiment, they were released individually. Observations like number of mirid bugs present at the honeydew source up to a distance of 5cm, at the centre and at control end were recorded at 30 minutes with groups and at 10 minutes intervals in individual experiments after their release. Choice was given among BPH, WBPH and GLH honeydews and also between BPH and WBPH honeydews. Each test material was alternated between the arms to avoid bias Data were analyzed statistically and using Duncan's Multiple Range Tests separated the means. In another experiment all stages of mirid bugs were released individually in the centre of olfactometer and time taken to reach the honeydew source was recorded. Between experiments, all glass apparatus was cleaned with acetone and distilled water.

RESULTS AND DISCUSSION

Petri-dish Bioassays

In Petri-dish studies 83 to 100 per cent of all stages of mirid bugs were attracted to the honeydew treated spot whereas only 20-50 per cent of mirid bugs was attracted to the distilled water treated spot. In general, nymphs perceived and reached the honeydew spot quickly compared to females and males. Nymphs and males made many visits (7-8) and spent less time per visit whereas females made few visits (2-3) and stayed on the spot more time per visit. But total time spent by them was not significantly different for different honeydews and different stages of mirid bugs. Antennal palpation was observed in all individuals (Table1). Mirid bugs reached the distilled water spot late and just passed through the spot without spending any time on the spot.

Immediately after release, mirid bugs

Table 1. Petri-dish bioassays on kairomonal activity of hopper honeydew on mirid bugs

Honeydew	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
BPH	93.33a	93.33a	86.67ab	2.40ef	7.86c	3.26ef	47.00a	49.33a	2.33a
WBPH	96.67a	90.00ab	83.33ab	1.68f	6.58cd	4.37de	42.50a	50.50a	6.00a
GLH	100.00a	100.00a	100.00a	2.93ef	6.90cd	2.20ef	54.00a	52.50a	4.50a
D. Water	50.00bc	20.00d	40.00c	12.50b	21.17a	11.33b	1.33c	1.33c	1.83b

Figures followed by same letter are not significantly different at 5 % level.

searched on the untreated area and walked fast. After reaching the spot, they walked slowly making sharp turns and searching with the antennae. They searched the sides and top of the Petri-dish by remaining above the spot and directing the antennae towards the honeydew spot in the bottom Petri-dish. After searching for sometime on the spot, they came out of the spot and again visited the spot. Short flights were observed in males. These results are in conformity with the results of Jahan and Islam (1998) (*Metasyrphus helvolus* on brown soft scale), Islam and Jahan (1993) (*Anagyrus pseudococci* on citrus mealy bug), Bouchard and Cloutier (1984) (aphid parasitoids) and Mc Ewen *et al.* (1993) (Chrysopids) who observed similar behaviour after exposure to the honeydew treated spot.

In the present studies, honeydew was attractive up to 1.5 hours. Shaltiel and Ayal (1998) also found that kairomonal activity of honeydew decreased as the honeydew aged and lost its activity completely within 72 hours. Mirid bugs spent more time on the honeydew treated spot compared to untreated area and spent more time during the first visit compared to the subsequent visits. Both sexes of mirid bugs showed positive responses to the honeydew of all three hoppers. Powell and Zhang (1983) reported that males and females of cereal aphid parasitoids responded equally to aphid honeydew but Bouchard and Cloutier (1984) and Budenberg (1990) reported that female aphid parasitoids responded strongly than males to aphid honeydew. In the present studies both virgin and mated females showed response to the honeydew.

Olfactometer bioassays

Mirid bugs were attracted to the honeydew source in the olfactometers even from a distance of 30cm suggesting the presence of some volatile chemicals in the honeydew and similar results were observed by Bouchard and Cloutier (1985), Wickremasinghe (1989), who showed that honeydew is an attractant in olfactometers for various aphidiids. Hagen *et al.* (1971) and Budenberg and Powell (1992) also reported the presence of some volatile chemicals in honeydew and artificial honeydew.

Mirid bugs did not exhibit any significant differences in their preferences to the honeydew of three hoppers in no choice and group releases in olfactometers eventhough highest number of mirid bugs were attracted to BPH and GLH honeydew compared to WBPH honeydew (Fig.1).

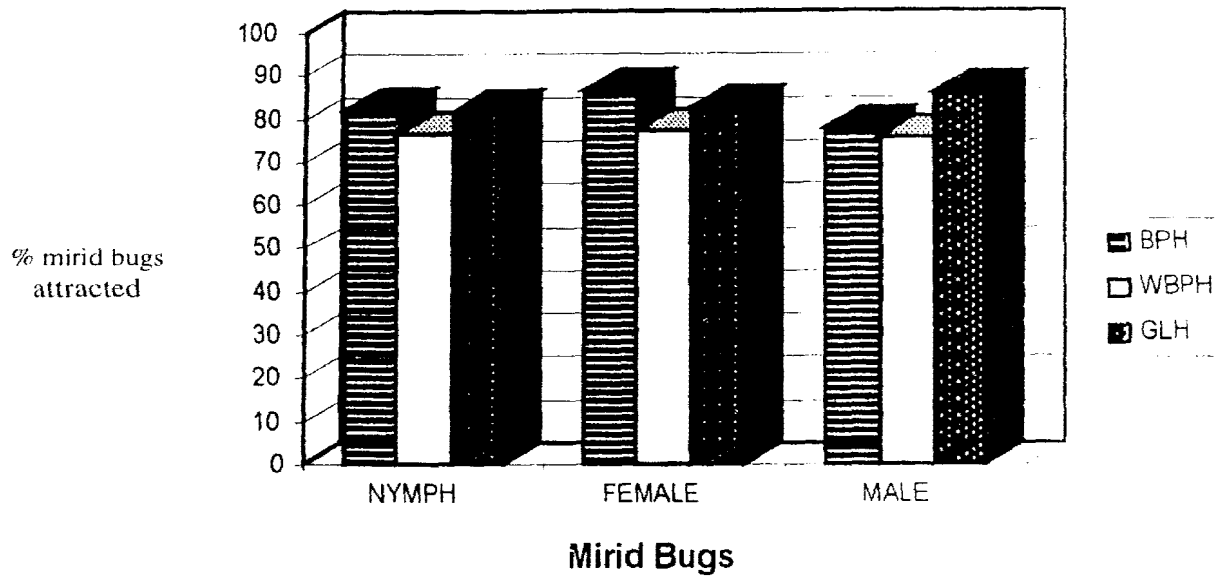

Fig. 1. Kairomonal activity of hopper honeydew on mirid bugs

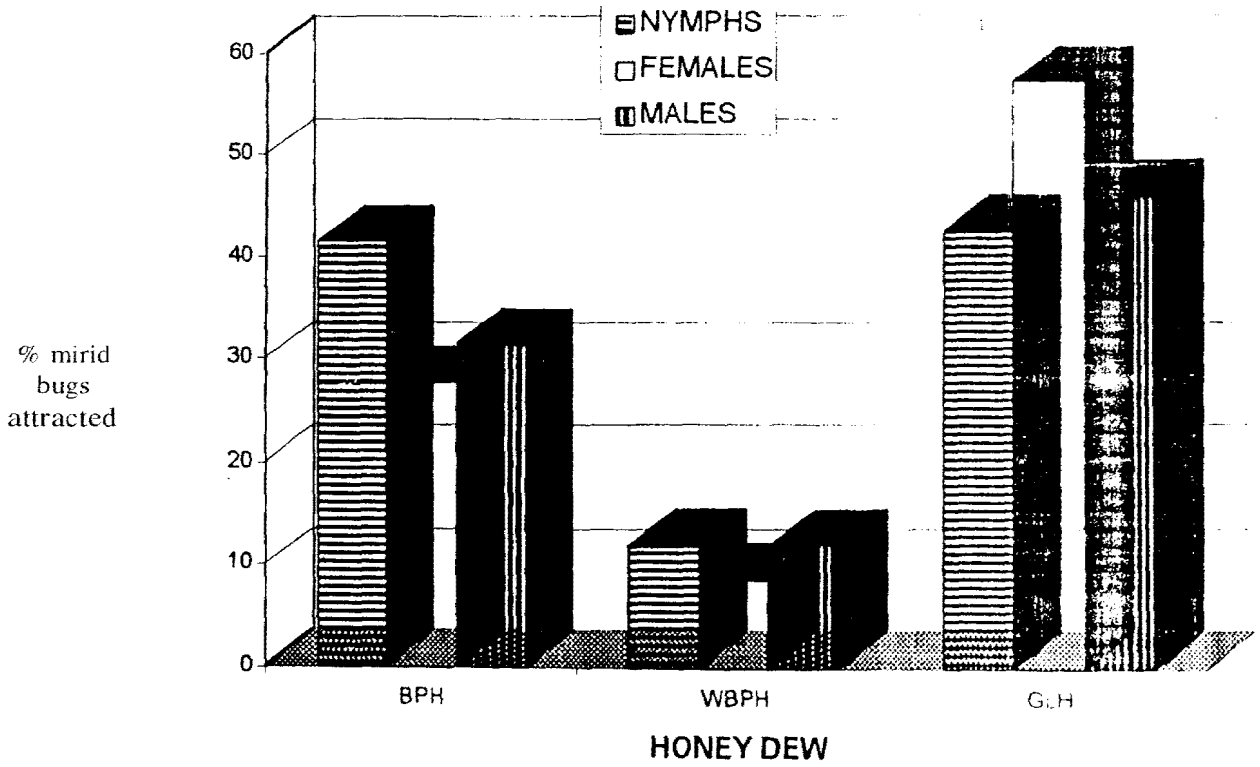

Fig. 2. Relative performance of mirid bugs to honeydew

All stages of mirid bugs preferred to move towards BPH honeydew compared to WBPH honeydew when choice was given between them. GLH honeydew was proved to be the most attractive of the three honeydews *viz.* BPH, WBPH and GLH when choice was given among them followed by that of BPH and WBPH (Fig.2). Budenberg and Powell (1992) observed that the syrphid *E. balteatus* showed preference to rice grain aphid and pea aphid honeydew compared to that of nettle aphid.

Nymphs perceived and reached the honeydew source quickly followed by males whereas the females took longer time to reach the honeydew source (Table 2).

Mirid bugs when released individually in the olfactometers behaved similarly as in the group releases. BPH honeydew was the most preferred one by mirid bugs followed by WBPH and GLH honeydew (Tables 3 and 4).

Table 2. Time taken by the mirid bugs to reach the honeydew source

Honeydew	Time taken by the mirid bugs(min)			
	Nymph	Female	Male	Mean
BPH	2.62ab	4.62a	3.04ab	3.43a
WBPH	1.54c	3.65ab	3.29ab	2.82a
GLH	1.69bc	3.83ab	3.5ab	3.01a
Mean	1.95b	4.03a	3.28ab	

Figures followed by same letter are not significantly different at 5% level of significance.

Table 3. Kairomonal activity of hopper honeydew on mirid bugs

Honeydew	Mirid bugs attracted (%)			
	Nymph	Female	Male	Mean
BPH	93.75ab(48)	97.92a(48)	90.28abc(36)	93.98a
WBPH	80.55cd(72)	81.82bcd(66)	87.5abc(60)	83.29ab
GLH	83.33bcd(72)	77.08d(48)	81.25cd(48)	80.56b
Mean	85.88a	85.61a	86.34a	

Figures in parentheses are numbers of mirid bugs tested.

Means followed by same letter are not significantly different at 5% level.

Table 4. Comparison of response of mirid bugs in group and individual releases in olfactometers

Treatment	Mean of mirid bugs attracted to honeydew (%)	
	Group	Individual
BPH Honeydew - mirid bug nymphs	81.98	93.75
BPH Honeydew - mirid bug females	86.23	97.92
BPH Honeydew - mirid bug males	77.83	90.28
WBPH Honeydew - mirid bug nymphs	76.29	80.55
WBPH Honeydew - mirid bug females	77.22	81.82
WBPH Honeydew - mirid bug males	75.18	87.5
GLH Honeydew - mirid bug nymphs	81.24	83.33
GLH Honeydew - mirid bug females	82.26	77.08
GLH Honeydew - mirid bug males	86.05	81.25
Mean	85.94	80.48

T value = 2.12(0.05), 2.921 (0.01)

Table T value = 2.04

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