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Prey-predator Interaction and Info-chemical Behavior of *Rhynocoris fuscipes* (Fab.) on Three Agricultural Pests (Heteroptera: Reduviidae)

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ABSTRACT

Diversity, ubiquity of anti-predator adaptations has an important direct effect of info-chemical based phenomenon of prey and predator as well as prey density. This work explained three agricultural pests having info-chemical cues also influence the predatory efficiency of the reduviid predator of *Rhynocoris fuscipes* (Fab.). In this context, the aim of this study was to identify the prey-predator interaction with specific chemical cues on biological control agent of *Rhynocoris fuscipes* treated with three agriculturally important pests. The polyphagous reduviid predator *Rhynocoris fuscipes* (Fab.) (Heteroptera: Reduviidae) is a potential biocontrol agent for the red cotton bug *Dysdercus cingulatus* (Fabricius), tobacco caterpillar, *Spodoptera litura* (Fab.) (Lepidoptera: Noctuidae) and castor pest *Achaea janata* (Linn.). The influence of info-chemicals from these three species of groundnut pests on the prey-searching and probing behaviour of the reduviid predator was studied. The water fraction of the mixture of chloroform and methanol extract of *A. janata* elicited maximum response in *R. fuscipes* when compared with *S. litura* and *D. cingulatus*. Adults and fifth instars were consumed more time with *A. janata* extracts as compared to other instars. Minimum and maximum response was observed in case of *S. litura* and *D. cingulatus* extract. Among the five life stages fifth and adult stages of the *R. fuscipes* predators preferred fifth instar of *A. janata*, *S. litura* where as fourth and fifth nymphal instars were quickly preferred third to fifth instars of *D. cingulatus*. These findings could be used in the application of *R. fuscipes* as a biocontrol agent in the management of cotton, castor and groundnut pests.

Key words: Biopotential agent, Info-chemical, *Achea janata*, *Spodoptera litura*, *Disdercus cingulatus*

INTRODUCTION

Rhynocoris fuscipes is a polyphagous predator present in India. It is an effective biological control agent of cotton and groundnut pests (Ambrose and Claver, 1995, 1997; George *et al.*, 2000; Prasanna and Shirely, 2002). Semilooper, *Achea janata* (Linn.) is a key insect pest of castor, *Ricinus communis*. The larvae cause extensive defoliation during July-September and also feed on tender capsules Prasad *et al.* (2007). Another pest of *Dysdercus cingulatus* (Fab.) (Hemiptera: Pyrrhocoridae) is a serious pest of cotton which distributed in all the cotton growing regions in India. The chemicals, which govern the prey and predator sinteraction are generally

called info chemicals (Nordlund *et al.*, 1981; Ambrose and Claver, 1999). It includes kairomones and allomones, which influence the prey-predator interaction (Ananathakrishnan, 2002). The chemical cues emanating from the pests act as arrestants or stimulants to the predators and increase their search for the prey (Singh *et al.*, 2002). According to Duffey (1980), kairomones and allomones are especially present in the nutrient storage sites like gut, haemolymph and fat body. Many works have been carried out to find out the role of kairomones from hemipteran pests in bring forth (Barbosa and Saunders, 1985) and lepidopteron pests (Bakthavatsalem *et al.*, 2000; Singh *et al.*, 2002) in eliciting a host searching behaviour of many generalist predators. In reduviids, the chemical-based prey-predator interaction was studied by Sahayaraj and Paulraj (2001) and Sahayaraj and Delma (2004). Recently, Cokl and Millar (2009) published the prey predators signals emitted as modification of the physical and chemical environment and are translated by the receivers (predators) to provide information about such factors as the kairomonal expression and based upon the physiological or behavioural state. Currently, Deligeorgidis *et al.* (2011) studied modeling of Predatory Effect of Coccinellidae with various pests. Eventhough most of the above studies were carried out with organic solvent extract of any pests, very few work was done on water extracts. Hence, the present study aimed to investigate the behaviour of *R. fuscipes* on the fractions of the combination of both chloroform with methanol extracts of *D. cingulatus* (Fab.), *Spodoptera litura* (Fab.) and *Achea janata* (Linn.). So, that the info-chemicals present in the water fraction, that elicit the host seeking response in *R. fuscipes* can be identified.

MATERIALS AND METHODS

This research was conducted from July 15-2009 to January 27-2010. *R. fuscipes* was collected from the groundnut ecosystem and in and around the Scott Christian College, Nagercoil and Kanyakumari, India. Then collected various stages of this predators were maintained on *Corcyra cephalonica* (Stainton) larvae under laboratory conditions (30±1.5°C, L13:D11 Photoperiod and relative humidity 73±4%) using the method developed by Sahayaraj (2002). Different life stages of *S. litura* and *A. janata* then *D. cingulatus* were collected from the Erachakulam, then reared on groundnut, castor leaves and cotton leaves respectively under the same laboratory conditions. Laboratory emerged fourth instar larvae of *S. litura* and *Achaea janata* and adults of *D. cingulatus* (both male and female) were used for this study.

Extracts of the info chemicals from the experimental pests: The specific info chemicals emitting from *D. cingulatus*, *S. litura* and *A. janata* were extracted using mixture of chloroform and methanol (Singh *et al.*, 2002). Twenty to thirty-five adults were weighed and placed in a stopper bottle to which 75 mL of chloroform and methanol (1:1) was added. Then the bottle was shaken at room temperature for two hours and kept at 60°C in water bath for 20 min. After that the extract was fractionated in to mixture of chloroform, methanol and water soluble fractions then the latter fractions also been used for this experiment. The same procedure was followed for *S. litura* and *A. janata*.

Behavioural Bio-assay: Five armed glass olfactometer designed by Sahayaraj and Paulraj (2001), was used to study the feeding behaviour and consuming time was calculated by the method of Cohen (2000) of *R. fuscipes*.

Statistical analysis: Correlation was observed between the approaching behaviour and handling time for each pest separately (both control). One-way ANOVA test were performed to determine the

differences in the handling time between the controls (water) and test (water fraction of the pest mixture of chloroform and methanol extracts).

RESULTS

When the predators were introduced the central place of the olfactometer, *R. fuscipes* move towards odour source present in the Whatman paper with antenna facing direction mainly depends upon the needs of the each life stages of *R. fuscipes*. After getting a perfect orientation position, the reduviid palpated its antennae, then aroused and subsequently showed the other behavioural responses. Once the predators entered the test chamber, they exhibited exploration and probing behaviour by showing head lifting, approaching, rostrum cleaning and antenna cleaning.

R. marginatus showed maximum positive response on *H. armigera* as compared to that of *D. cingulatus* and *S. litura* (Table 1). Based upon this respect to *A. janata* extract shows, 60, 70, 80 and 75% of 2, 3, 4 and 5 instars of *R. marginatus* showed positive response, respectively. The preference of *R. fuscipes* decreased for *D. cingulatus* (20, 40, 35 and 20 of 2, 3, 4 and 5 instars, respectively) and further, decreased response was observed with *S. litura* extract (10% for 2 and 5 instars). In chi square test both the II and V instar results were significant for *A. janata* and only fifth instar nymphs showed significant response of *S. litura* extract, where as in *D. cingulatus* 1, 2, 2 instar showed a significant results at 5% level (Table 1).

The feeding behaviour of *R. marginatus* (in terms of consuming time) on three pest extracts is shown in Table 2. The second instar *R. fuscipes* exhibited maximum handling time in *A. janata* extract (12.28±2.49 min) followed by *S. litura* (8.54±0.45 min) finally fifth instar of *R. fuscipes* consumed the pest of *D. cingulatus* at 1.49±0.18 min. When compare with these three experimental pests. Among these pests *A. janata* showed more consuming time than other two pests. However, second and third instar nymphs of *R. fuscipes* showed no response on *D. cingulatus* extract. The third instar nymphs spent more time with The 4 and 5 nymphal showed maximum handling (10.31±2.40 and 11.46±1.57 min, respectively). From this study explained the consuming time was positive correlate with the instars of the *R. fuscipes* predators. One way ANOVA and

Table 1: Approaching behaviour of *R. fuscipes* to water soluble fraction of three pests

Response	Life stages			
	III-Instar	IV-Instar	V-Instar	Adult
<i>D. cingulatus</i>				
Positive	3*	3*	4*	2*
Negative	4*	0.2	3	2*
No response	3	0.5*	3*	6*
χ^2	4.103	1.503	1.94	7.25
<i>A. janata</i>				
Positive	3	5*	7*	3
Negative	2	2	2*	2
No response	5	3	1	5
χ^2	7.04	5.131	4.18	3.64
<i>S. litura</i>				
Positive	6	7*	8	6*
Negative	0	1*	0	2*
No response	4	2	2	2
χ^2	6.30	11.47	5.29	7.74

*Shows the significant at p<0.005% level

Table 2: Consuming time (in min) of *R. fuscipes* (N±SE) to the water fractions of the pests

Life stages of predators	Consuming time					
	<i>D. cingulatus</i>		<i>S. litura</i>		<i>A. janata</i>	
	Control	Experiment	Control	Experiment	Control	Experiment
III	08.33±0.27	-	4.11±0.37	0.20±0	10.36±1.02	9.56±1.6
IV	01.28±0.11	-	4.56±0.49	0.47±0.10	12.54±1.45	10.31±2.40
V	03.29±1.43	1.49±0.18	7.25±0.16	6.25±0.33	13.41±1.25	11.46±1.57
Adult	11.54±2.62	0.55±0.35	4.32±0.41	8.54±0.45	15.46±2.30	12.28±2.49

Student-test were performed. The tests showed there is no significant observation been made except between the fifth instars treated with water fraction of the pests extracts and control.

DISCUSSION

The notable findings of the present study were as follows, the predatory behavioural pattern of reduviid is arousal approach-rostral probing-injecting toxic saliva and it can help to paralyzing-sucking post predatory behaviour (Ambrose and Claver, 1995). The reduviids oriented towards the prey with facing antenna after getting a perfect orientation position, the reduviid palpated its antennae, then aroused and subsequently showed the other behavioral responses studied by Ambrose (1999). Similar info chemical based predatory behaviour related studies with other three economically important pests by the following authors Sahayaraj and Paulraj (2001), Jhansilakshmi *et al.* (2000) and Demirel (2007) ascribed in other predatory insects. When we compare the approaching behaviour with handling time by correlation, the results were significant ($p < 0.05$). It was suggested that the predators identify the volatile chemicals emitted by the prey body. The volatiles emotions by the faeces of the pests also act as attractants in prey-predator interactions (Nassar and Abdullah, 2005). The presence of such volatiles in the faeces may be attributed to the digestion of the plant products by the pests and other processes involving micro-organisms present in the faeces (Ambrose and Claver, 1995; Maran, 1999). It has been reported that there are instar or stage specific blend of chemicals emitted by feces of second or fourth instar larvae of *Pieris* species (Ananathakrishnan, 2002).

In the present study, the experimental pests treated with mixture of Chloroform and methanol immediately exuded fecal matter which was immiscible in the solvent. The immiscible solvent portion was fractionated with water and used for this study. Hence, we presumed that the volatiles present in the faeces not only act as attractants but also elicit an intense host searching behaviour. The predatory behavioural assay clearly showed the rostrum protrusion and sucking were not observed in 3, 4 instars against *D. cingulatus* extract followed by *A. janata* extract failed to elicit such as host seeking behaviour in *R. fuscipes*. Similar study was carried out by Usha Rani and Wakamura (1993). The same findings also agreed by Sahayaraj and Delma (2004) and Sahayaraj *et al.* (2007a, b) such as pest releasing volatiles mediate searching behavior at longer distances, not to mention of host insect volatiles or herbivore-derived chemicals The present study shows that the kairomones of the pest extract on the filter paper elicited by the common host seeking behaviour in *R. fuscipes*. The variation in the behaviour of *R. fuscipes* towards the three experimental pests might be due to the different volatile chemicals of the pests, as explained by Ananathakrishnan (2002) and George *et al.* (2004). Many researchers found out the volatile chemicals promoting the behaviour of natural enemies like *Rhynocoris* predators as well as the fact

that the same chemicals affect the growth and survival of herbivores indicate that manipulation of volatile profiles contribute significantly in biocontrol strategies (Annadurai *et al.*, 1990). Previously detailed studies made by Devanand and Rani (2008) certain plant extracts and other pest extract also employed sometimes predators possessed antifeedance and toxicity in the lepidopteran pest species (Yasuda, 1997). Therefore, the behaviour and success of natural enemies undergo considerable variations when the pest colonizes different host plant species in response to different volatile compounds which modify the behavioural sequence of natural enemies described by Nordlund *et al.* (1981). In case of that explained that the behavioural changes could be ascribed to the specificity of the predator to the prey (pest) species. The relationships between infestation ratio and population development of Pink Bollworm adults was investigated with the help of various info chemical based predatory behaviour reported by Unlu and Ozturk (2007).

CONCLUSION

From this study concludes when the three agricultural pests having info-chemical cues also influence the predatory efficiency of the reduviid predator of *Rhynocoris fuscipes* (Fab.). Normally predatory behaviour exhibited the exploration and probing behaviour by showing head lifting, approaching, rostrum cleaning and antenna cleaning based upon the unique nature of the preference of the reminiscent of pests. Among the life stages both fifth and adult stages of the *R. fuscipes* predators preferred fifth instar of *A. janata*, *S. litura*, where as fourth and fifth instar nymphs quickly preferred third to fifth instars of *D. cingulatus*. Finally, this research finding could be used in the application of reduviid predator such as *R. fuscipes* as a biocontrol agent in the management of cotton, castor and groundnut pests.

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