

Prey and stage preference of *Acanthaspis pedestris* Stål (Hemiptera : Reduviidae) on pests of cotton (*Gossypium hirsutum*)

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ABSTRACT

In India, agriculture is currently suffering an annual loss of about rupees 8.5 million due to insect pests. As chemical control is having many side effects and after effect, biological control is the best alternative to protect the crop from pest insects. Among the predator's assassin bug is one of the promising biocontrol agents. Therefore, a study was conducted to evaluate the efficacy of the *A. pedestris*, prey and stage preference on two lepidopteran cotton pests, *Helicoverpa armigera* Hubner and *Spodoptera litura* Fabricius. The assessment of a predator's ability to capture and consume the relevant stadia of the targeted insect pest enables one to effectively utilize a natural enemy for biocontrol in the agricultural ecosystem. Steady increase in prey consumption was recorded by means of the progression of the developmental stages of the predator. The adult female consumed more than the adult male. The consumption of predators was observed to be decreased with the advancement of prey stages. The First and 2nd instar *A. pedestris* were limited in their ability to capture large-sized prey in both the prey species. The predator's success in pest control depends on its willingness to eat the target prey. Cotton leaf worm *S. litura* was the preferred prey among the two prey species.

Key words : *A. pedestris*, cotton pests, *H. armigera*, prey preference, *S. litura*, stage preference

INTRODUCTION

Within most crop ecosystems, exist some pest insects that have no effective biological controls (Castane *et al.*, 1996). The use of insecticides to manage these pests frequently devastate natural enemy complexes and in turn encourages pest resurgence or secondary pest flares (Broadly and Thomas, 1995). Hence, biological control is an ideal method to overcome from the continuous use of insecticides. Assassin bugs (reduviids) are being recommended as potential biological control constituent in the Insect Pest Management Programmes.

Reduviidae is the largest family of predaceous land Heteroptera with considerable potential in biological control (Ambrose *et al.* 2006). Being the largest family/group of predatory insects, Reduviids, beneficial to farmers inhabit agroecosystem and predate upon a variety of insect pests (George *et al.*,

2021). Reduviidae is one of the least researched and most poorly understood families although evidence in support of their potential biological control are accumulating (Ambrose, 2000, 2003).

An understanding on predator-prey interaction is essential to realize the biological control potential of predators in agroecosystems. Although reduviids feed on a wide variety of arthropods, they exhibit a specific range of prey preference. Among the reduviids, *Acanthaspis pedestris* Stål is a key predator used in biological control of variety of insect pests (Ravichandran, 2004; Ravichandran and Ambrose; 2004, Rajan *et al.*, 2011, Ambrose and Kumar, 2016). *Helicoverpa armigera* Hubner and *Spodoptera litura* Fabricius are two insect pests that are difficult to eradicate in many agricultural crops. Although, *A. pedestris* has been observed preying on both these pests, its ability to capture and consume them and also the preference of developmental stages in both

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insects and therefore the most preferred insect among the two are largely unknown.

Selection of one stage over another could also affect the prey-predator interaction, so it is important to assess the stage preference and prey preference of any predator before utilizing the natural enemy for biological control (Ambrose 2003, Ravichandran 2004). Such assessment can identify the restrictions of the predator and its possible impact before furthermore costly experimentation is conducted in the field. Hence, the present study is aimed to identify the most preferred prey and most preferred stage of each insect among *H. armigera* and *S. litura* by *A. pedestris* nymphs and adults in the laboratory.

MATERIALS AND METHODS

The adults and nymphs of *A. pedestris* were collected and reared in the laboratory from the foothills of Kodaikanal (10.0°N, 78.0°E), Madurai District of Tamil Nadu, South India and reared in plastic containers (80 mL) at $30 \pm 2^\circ\text{C}$, relative humidity ranging from 75–80% and photo period between 11 to 13 h on the larvae of *S. litura* and *H. armigera* and the adults were allowed to mate. The eggs were collected and allowed to hatch the nymphs were raised up to adults. The adults and nymphs were separated into two groups, one group raised with *S. litura* and therefore the other with *H. armigera*.

Comparative predatory efficacy of each nymphal instar and adult of the reduviids (I instar, II instar, III instar, IV instar, V instar and adult male and female) *A. pedestris* towards the various size group of prey *S. litura* and *H. armigera* (0.1- 1.0, 1.1-2.0 and 2.1-3.0 cm long) were evaluated by no choice test. All the life stages of the reduviids *A. pedestris* (newly emerged nymphal instars and adult male and female) were tested against all the three different size group of prey insects separately. One reduviid predator and 20 larvae of anyone stage were introduced into a mesh cage covering a cotton plant. Larvae were placed on the leaves of the cotton. Predatory efficiency was assessed in terms of the number of prey consumed/ killed by the predator in 24 hours. This was carried out separately for all size groups of *S. litura* and *H. armigera*. Six replicates were maintained for every life stages of the predator and for every prey group. The variation

within the predation between the two prey species was subjected to the Students' 't' test.

RESULTS AND DISCUSSION

The results indicate that all the nymphal instars of *A. pedestris* preferred *S. litura* than *H. armigera* in all the size groups. When the smaller prey was provided (0.1 - 1.0 cm long), the first instar of *A. pedestris* consumed 3.33 ± 0.52 and 2.67 ± 0.52 larvae in *S. litura* and *H. armigera*, respectively. The consumption was increased by the development of nymphal instars and maximum consumption was observed within the adults. The adult female consumed 7.50 ± 0.55 and 6.50 ± 0.55 larvae of *S. litura* and *H. armigera*, respectively. The prey killed by the nymphal instars of the predator are more than the prey consumed (Fig.1). The variation in prey consumption and prey killed by different predator nymphal instars is not statistically significant in the nymphal instars, but it is significant in both adult males and females. The variation in the prey killed are statistically significant both in the instars and adults (Table 1).

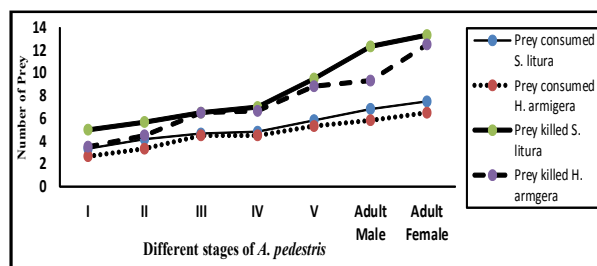


Fig. 1. The predatory efficiency of different stages of *A. pedestris* when fed on the small *S. litura* and *H. armigera*.

When medium sized prey was given (1.1 - 2.0 cm long) the first instar did not consume the prey and the consumption by the predators was reduced to 2.50 ± 0.55 and 1.33 ± 0.52 larvae in *S. litura* and *H. armigera* respectively by the second instar. The consumption increased as the nymphal instars progressed (Fig. 2). The prey consumption by the adult female was 5.67 ± 0.82 and 4.50 ± 0.55 on *S. litura* and *H. armigera* respectively. In each stage of the predator, there was a significant difference in consumption between the different prey species. Variations in the prey killed are also statistically significant in most of the cases (Table 1).

Table 1. Students 't' test values of different size groups of *A. pedestris* fed with different sized prey insect of *S. litura* and *H. armigera* (n =6; $\bar{x} \pm$ SD)

Stage of the predator	Small size		Medium size		Large size	
	Prey consumed	Prey killed	Prey consumed	Prey killed	Prey consumed	Prey killed
I	2.188 ^{NS}	3.488 ^{**}	-	-	-	-
II	2.224 ^{NS}	2.895 [*]	3.866 ^{**}	1.92 [*]	-	-
III	0.548 ^{NS}	0 ^{NS}	3.093 [*]	5.582 ^{***}	1.183 ^{NS}	2.126 [*]
IV	1.173 ^{NS}	0.803	3.970 ^{**}	1.42 ^{NS}	0.548 ^{NS}	0.889 ^{NS}
V	1.336 ^{NS}	2.391 [*]	3.316 ^{**}	5.051 ^{***}	0.454 ^{NS}	2.987 [*]
Adult ♂	2.853 [*]	7.577 ^{***}	3.487 ^{**}	2.52 [*]	2.381 [*]	4.326 ^{***}
Adult ♀	3.135 [*]	1.731	2.889 [*]	1.441 ^{NS}	1.657 [*]	2.817 [*]

*,**and*** : Significant at P=0.05, P=0.01 and P=0.001, respectively; NS : Not Significant.

When given large sized prey given (2.1 - 3.0 cm long) *A. pedestris* I and II nymphal instars did not consume or kill both prey species. The III nymphal instar consumes 1.50 ± 0.55 and 1.17 ± 0.040 prey in *S. litura* and *H. armigera*, respectively. The progression of nymphal instars increased consumption, and adults consumed more. Female predators consumed more larvae than the male predators (3.33 ± 0.52 and 2.67 ± 0.82 larvae in *S. litura* and *H. armigera* respectively). The prey killed by *A. pedestris*'s various nymphal instars exceeds the prey consumed (Fig. 3). Only in adult males there was statistically significant difference in consumption between the two prey species. The variation in the prey killed by both the predators are statistically significant except the fourth instar (Table 1).

The results showed that *A. pedestris* nymphs have the capacity to consume large numbers of the small sized *H. armigera* and *S. litura*. The size of the *A. pedestris* in comparison to its prey appeared to be the most important factor in capturing and consuming prey. *A. pedestris* first and second nymphal instars were unable to successfully prey on large *S. litura* and *H. armigera*. The high predation rates on the two prey species' early instars are of particular interest because these are the life stages of the pests most frequently targeted in the field for insecticidal control (Grundy and Maelzer, 2000). Hence the cotton crops where *H. armigera* and *S. litura* may be present, *A. pedestris* has the potential to consume or kill large numbers of these pests, potentially reducing populations to levels below the economic threshold. The observation is in line with the previous observations made by Weseloh (1998) in *Calosoma sycophanta* L. and George and

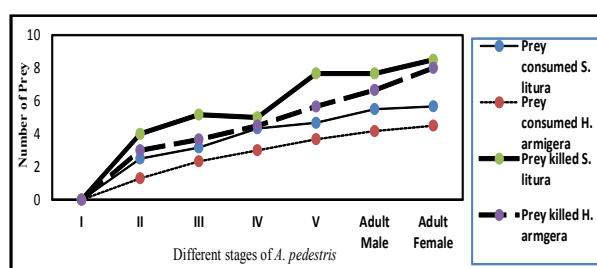


Fig. 2. The predatory efficiency of different stages of *A. pedestris* when fed on the Medium *S. litura* and *H. armigera* (n =6; $\bar{x} \pm$ SD).

Seenivasagan (1998) in *Rhynocoris marginatus* (Fabricius).

The preference for *S. litura* was significantly higher for *A. pedestris* than *H. armigera*. This could be due to the fact that the predator caught *H. armigera*, thereby it emitted a viscous defensive fluid that forced the predator to leave the prey and only after some time could the predator hold the same prey and suck the body fluid. Strong (1967) and Nault *et al.* (1973) noticed that some of the prey species secreted defensive secretions from the cornicle during predatory behavior to protect themselves from the predators. Sahayaraj (1991) reported similar findings in reduviids *Ectomocoris tibialis* Distant, *Catamiarus brevipennis* Servillei and George and Seenivasagan (1998) in *R. marginatus* Fabricius. Despite the fact that even though *H. armigera* produced defensive secretion, *A. pedestris* will not leave the prey and preferred it next to *S. litura*, implying that it was predatory.

More prey was consumed/killed by the female predator than by the male predator. The current findings are consistent with observations of Prabakar (1994) and Sahayaraj (1994). This is clearly due to the female's

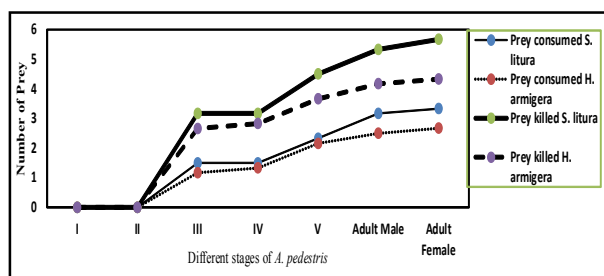


Fig. 3. The predatory efficiency of different stages of *A. pedestris* when fed on large sized larvae of *S. litura* and *H. armigera*.

higher nutritional requirements for reproduction. Furthermore, the predator killed more prey than it consumed to satiate themselves. So reduviid predators are important mortality factors to be conserved (Ambrose, 2000, Schaefer, 1988).

Laboratory consumption studies are unfortunately limited and provide only a relative measure of predation which may lead to over optimistic expectations of the potential of a biological control agent (Rosenheim *et al.* 1993). Field testing is therefore required to determine if *A. pedestris* has the search strategy and capacity to locate and prey on pest insects within a crop. Even though, preference for two lepidopteran prey insects have been recorded, always there will be distraction caused by alternate prey and the ability of *A. pedestris* to find and capture pests within crop canopies which requires further research.

CONCLUSION

The predatory efficacy of the assassin bug *A. pedestris* was assessed on two lepidopteran cotton pests, *H. armigera* and *S. litura*. Among the two prey species *A. pedestris* preferred *S. litura* than *H. armigera*. The consumption of predators was found to decrease as prey size increased. In both prey species, first and second instar *A. pedestris* were limited in their ability to capture large sized prey. The larger predator preferred the large- sized prey and smaller predator preferred the small sized prey. Therefore, this study clearly proved that the timely release of the appropriate life stages of the predator in synchronization with the availability of the particular stage of the pest population is very important in biological control programmes to achieve good result.

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