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Research Article

Parasitism performance of *Aenasius bambawalei* (Hayat) on *Phenacoccus solenopsis* (Tinsley)

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Abstract: The *Aenasius bambawalei* Hayat (Hymenoptera: Encyrtidae) is a solitary nymphal endoparasitoid of mealybug, *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae). The parasitism performance of *A. bambawalei* on the 3rd nymphal instar of *P. solenopsis* at different densities 20, 30, 40 and 50 *P. solenopsis* was tested. The results showed that the maximum number of *P. solenopsis* parasitized and male and female adults emerged at 30 *P. solenopsis* density than other densities. Similarly, the maximum sex ratio M: F (1: 1.7) was found at 50 *P. solenopsis* density as compared to others. The highest parasitization percentage was observed on 3-day old *A. bambawalei* at all *P. solenopsis* densities. The 30 *P. solenopsis* density is the most preferred and suitable for mass rearing of *A. bambawalei* and the 3-day old parasitoid use of biological control programme to control *P. solenopsis*.

Keywords: *Aenasius bambawalei*, *Phenacoccus solenopsis*, Parasitism, Densities

1. INTRODUCTION

Cotton mealybug (*Phenacoccus solenopsis*), originated in Central America, is considered a widespread pest in Pakistan. It has been reported from China and India destroyed the cotton industry in the previous few years [1-2]. In Pakistan, *P. solenopsis* appeared in 2005 first time, reported in Districts Sanghar and Vehari, Pakistan, during 2006 and 2007 the economic losses of cotton were 40 % and reached 3.1 million bales affected by this pest, which was the most destructive. *P. solenopsis* damaging has distributed throughout the growing fields of cotton in Pakistan and it has become a major insect pest of cotton and several important crops [3].

It is a highly polyphagous mealybug species attacking more than 200 plants including field and medicinal plants, ornamentals, weeds, and horticultural crops [4-6]. It is infested the fruits, leaves, main steams, branches, roots, and trunks feeding on phloem sap [5]. Mostly leaves and shoots are damaged by the huge amount of honeydew production that is responsible for the growth of sooty mold. [7].

P. solenopsis is difficult to control with pesticides since it is protected by a hydrophobic wax layer that acts as a barrier to penetration of pesticides [7]. Applied and natural biological control methods are essential in the successful management of insect pests. It is well known that natural enemies of insect

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pests play a vital role in biotic balance, reducing the level of insect pest population below the economic injury level. Mostly synthetic pesticides reduce the beneficial predators and parasitoids. The value of biocontrol is now well recognized, principally in the context of environmental protection as well as the sustainable strategy of pest management [8].

Several parasitoid species play a vital role in biological control methods and the Encyrtids are known as effective parasitoids of mealybug [9-10]. *Aenasius bambawalei* is a primary parasitoid of *P. solenopsis* in various regions of the world like India [11-13], southern China [14], Pakistan [15], and Iran [16]. It is an effective nymphal solitary endoparasitoid of *P. solenopsis* and due to the natural conditions, there is a good mortality factor for controlling this pest. It has been recognized that parasitism has a profound effect on population growth, development, and host fecundity. In Southwestern Iran, the parasitism percentage of *P. solenopsis* through *A. bambawalei* was up to 95 % in 2012 when insecticides were not used to control this pest [16].

The present study was designed to determine the parasitism performance of *A. bambawalei* on the 3rd nymphal instar of *P. solenopsis* (a) effect of different *P. solenopsis* densities of on *A. bambawalei* parasitization, adult emergence, and their sex ratio (b) parasitization effect of different *A. bambawalei* ages on different densities of *P. solenopsis*.

2. MATERIAL AND METHODS

2.1 Insect Collection and Rearing

The experiment was conducted at the Biocontrol laboratory of Entomology Section, ARI, Tando Jam, during 2020-21. The mummies or parasitized mealybug was collected directly in plastic jars from the field of (Tomato, okra, cotton, and Abutilon theophrasti weed plant) surrounding Sindh Agriculture University, Tando Jam, and shifted in plastic glass jars. After the full emergence of *A. bambawalei* healthy parasitoids were released on its host colonies of *P. solenopsis*. The culture of the parasitoid and its host were continued in plastic glass jars, at 27 ± 2 ^{o}C with 60 – 70 % Relative Humidity. After freshly emerged adult parasitoid female and male were taken from the reared culture and allowed for 24 hrs to mate and 50 % honey and 50 % water of solution was also provided as a source of food.

2.2 Experimental Design

The laid out experiment was a Completely Randomized Design with four treatments and each treatment with three replications. The freshly emerged female and male adult parasitoid were paired together for allowed to mate (24 hrs). After the next day's mating, the healthy mated female of the parasitoid was transferred or released in glass jars along with mealybugs on the leaf of abutilon weed for parasitization. After two days females were removed from the plastic jars. The parasitized host mealybugs were reared on tomato and abutilon leaves. Used camel brush and daily clean the jars to avoid contamination of diseases. The data of parasitization were recorded daily of adult parasitoid life and adult emergence and sex ratio of male or female also recorded. The 2nd experiment (1 day, 3 days, 7 days, and 15-day old parasitoid) at 24 hrs mated female was provided to 3rd nymphal instar of the host was four different densities 20, 30, 40, and 50 mealybugs in each glass jars. The data of parasitization were recorded after 24 hrs. The parasitization percentage was calculated through the formula is;

$$\text{Parasitization }\% = \frac{\text{No. of } P. solenopsis \text{ parasitized}}{\text{Total } P. solenopsis} \times 100\ \%$$

2.3 Statistical Analysis

The data was subjected through ANOVA (analysis of variance) using 8.1 Statistix software and the significant difference between the means of treatments was compared by LSD at $P \leq 0.05$.

3. RESULTS

The results indicated the number of mealybugs parasitized, parasitization percentage of male and female adult emergence, and sex ratio of *A. bambawalei* shown in Table 1. The highest number of *P. solenopsis* parasitized was recorded (305 ± 17.6) at 30 *P. solenopsis* density and the lowest number of *P. solenopsis* parasitized

(211 ± 13.3) was observed at 20 *P. solenopsis*. Similarly, the maximum parasitization of 42.2 % was recorded on 20 *P. solenopsis* density and the minimum parasitization of 18.9 % was observed on 50 *P. solenopsis*. However, the highest male and female adult emergence (120 ± 7.9 and 167 ± 15.7) was observed on 30 *P. solenopsis* density and the lowest male and female adult emergence (74 ± 4.9 and 116 ± 7.8) was recorded on 20 *P. solenopsis* density. Similarly, the maximum sex ratio M: F (1:1.7) was recorded at 50 P. solenopsis density and the minimum sex ratio M: F (1:1.4) at 30 *P. solenopsis* density.

The results regarding parasitization efficiency of different ages of *A. bambawalei* (1 day, 3 days, 7 days, and 15-day old parasitoid) on different densities of *P. solenopsis* (Fig. 1). However, the highest parasitization percentage was observed on 3- day old *A. bambawalei* at all *P. solenopsis* densities and lowest parasitization percentage was observed on 15-day old *A. bambawalei* at all *P. solenopsis* densities. The best results were found on 3-day old parasitoid at 30 *P. solenopsis* density with 71.1 %.

4. DISCUSSION

The present study aimed to examine the Parasitism performance of *A. bambawalei* on the 3rd nymphal instar of *P. solenopsis* at different densities 20, 30, 40, and 50 mealybugs at under laboratory

Table 1. Effect of different *P. solenopsis* densities on *A. bambawalei* parasitization, adult emergence and sex ratio.

Densities of *P. solenopsis*	No of P. solenopsis Parasitized	Parasitization (%)	Adult emergence		Sex ratio
			Male	Female	M: F
20 *P. solenopsis*	211 ± 13.3^{b}	42.2	74 ± 4.9^{b}	116 ± 7.8^{b}	01:01.6
30 *P. solenopsis*	305± 17.6^{a}	40.7	120 ± 7.9^{a}	167 ± 15.7^{a}	01:01.4
40 *P. solenopsis*	296±16.7^{a}	29.6	110 ± 6.5^{a}	162 ± 8.0^{a}	01:01.5
50 *P. solenopsis*	236±15.6^{b}	18.9	81 ± 6.9^{b}	134 ± 6.3^{ab}	01:01.7

Means followed by the same letters in similar columns are not significantly different (P > 0.05).

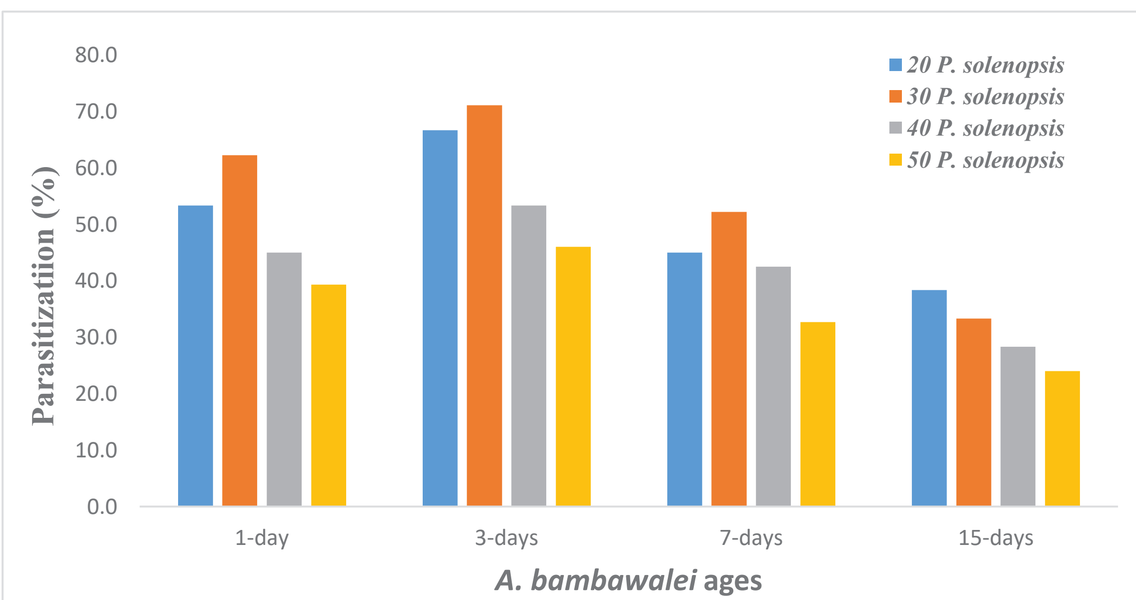

Fig. 1. Parasitization (%) of *A. bambawalei* different ages on *P. solenopsis* different densities.

conditions. All the parameters such as the number of *P. solenopsis* parasitized, parasitization percentage, adult emergence, and sex ratio of *A. bambawalei*. [17] studies on natural enemies of the mealybug (*P. solenopsis*) have reported a huge number of *A. bambawalei* on the different instars of mealybug. They also reported that the third nymphal instar of *P. solenopsis* is the most suitable stage of host for *A. bambawalei* mass rearing.

The results are supported by many past researchers, Zhang *et al*. [18] also reported that the maximum parasitization was on the 3rd nymphal instar of *P. solenopsis*. The highest number of the parasitized mealybug was recorded at 30 density and the lowest number of *P. solenopsis* parasitized was observed at 20 density. These results are in accordance with previous findings of Joodaki *et al*. [19], they reported that the maximum number of parasitized *P. solenopsis* nymphs by *A. bambawali* was 9.4 at density (64 nymphs) and reached a minimum of 1.8 at a density (2 nymphs). However, the parasitized nymphs increased with increase the number of hosts. Feng *et al*. [14] reported that the parasitized *P. solenopsis* increased with increased *P. solenopsis* density.

In the present study, the maximum parasitization percent was found on 20 *P. solenopsis* density and the minimum parasitization percent was observed on 50 *P. solenopsis*. Similar results were observed by Kumar *et al*. [11] and Ram and Saini [20]. The highest number of adults were found at 30 densities of *P. solenopsis* and the lowest male and female adults emerged at 20 *P. solenopsis* density. Shahzad *et al.* [21] and Iftikhar *et al*. [22] reported similar results the highest emergence of the parasitoid in the 3rd nymphal instar of mealybug.

However, the maximum sex ratio M: F (1: 1.7) was recorded at 50 *P. solenopsis* density, and the minimum sex ratio M: F (1: 1.4) 30 *P. solenopsis* density. Similar findings, the highest sex ratio of female wasps was recorded at the third instar mealybug nymph and the maximum male sex ratio was observed at the second instar host stage [23-25]. However, the highest parasitization percentage was observed on 3-days old *A. bambawalei* 71.1 % at 30 *P. solenopsis* density and lowest parasitization percentage were observed on 15-days old *A. bambawalei* 24.0 % at 50 *P. solenopsis* density. Similarly, Ignacimuthu and Jayaraj [8] also observed that 5-days after the emergence of *A. vexans* parasitoid highest number of mealybugs parasitized.

5. CONCLUSIONS AND RECOMMENDATIONS

The present study confirmed that *A. bambawalei* parasitized the *P. solenopsis*. They significantly decreased the third instar of mealybug. Thus, it was confirmed through this study *A. bambawalei* will be useful to control *P. solenopsis*. Further study is much needed to observe the complete functional response of the parasitoid on various densities of different insect pests.

6. CONFLICT OF INTEREST

The authors declare no conflict of interest.

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