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Comparative Parasitic Potential of *Goniozus nephantidis* (Muesbeck) on *Galleria mellonella* and *Corcyra cephalonica* (Stainton)

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A B S T R A C T

Biological control is a living weapon and an excellent strategy over chemical control. *Opisina arenosella* Walker is one of the serious and endemic pests of coconut in India. The *O. arenosella* is attacked by many entomophagous insects during its developmental stages. Among them, *G. nephantidis* is a gregarious ecto-larval parasitoid and responsible for the reduction in the population pest under field conditions. There is a continuous demand for *G. nephantidis* throughout the coconut growing area. Generally, *Corcyra cephalonica is* used for mass rearing of *G. nephantidis*. While *Galleria mellonella* is used for rearing various entomophagous insects. To find out best laboratory host for mass rearing of *G. nephantidis* in laboratory, we investigated comparative parasitic potential of *G. nephantidis* on *G. mellonella* and *C. cephalonica*. The results revealed that, *G. nephantidis* female paralyzed the larva of *C. cephalonica* and *G. mellonella* within 2 to 3 hours after release. The average number of larvae parasitized by *G. nephantidis* were 6.10±1.07 and 5.85±0.88 on *G. mellonella* and *C. cephalonica*, respectively. The average clutch size was 12.65±3.31 and 12.45±3.31 eggs per of larva *G. mellonella* and *C. cephalonica*, respectively. There was a highly significant (t=11.62**) variation observed in the survival of *G. nephantidis* when reared on *G. mellonella* and *C. cephalonica*. Significantly highest survival of *G. nephantidis* observed on *C. cephalonica* (42.98±6.87%) than *G. mellonella* (18.58±6.41%). Among both the hosts, *C. cephalonica* could be utilized for the mass production of *G. nephantidis.*

Introduction

The coconut palm, *Cocos nucifera* L. belongs to family Arecaceae is "Tree of Life" as well as "*Kalpa vriksha*" provides livelihood to billions of people across the world. Coconut is widely cultivated in all the tropical regions of the world, growing particularly well in coastal areas near the sea on sandy beaches where it can tolerate salt spray and brackish soils. The major factors that contribute to the loss of production and productivity in coconut are damage due to environmental, fungal diseases and insect pests. The coconut palm is

infested by several insect pests. Among them, *Opisina arenosella* Walker causes severe damages to the foliage, depriving the palm of its photosynthetic area and thus, directly affecting the yield (Sujatha and Chalam, 2009). The black headed caterpillar, *O. arenosella* is one of the serious and endemic pests of coconut in India (Gurav., 2018). *O. arenosella* was observed in all talukas throughout the year in the range of 18.79 to 54.92 per cent in Navsari district. Biological control is a living weapon and excellent strategy over chemical control, which is modern and prestigious adoption at a global level. The black headed caterpillar is attacked by many entomophagous insects during its developmental stages. Among them, *Goniozus nephantidis* is a gregarious larval parasitoid and responsible for the reduction in the population pest under field conditions (Rao *et al.,* 2013). *G. nephantidis* an important larval ectoparasitoid of Coconut black headed caterpillar, *O. arenosella* is easily mass-produced in bio control laboratories either on *Corcyra* or *Gallaria melonella* (Linn) as factitious hosts and *O. arenosella* as the natural host. There is a continuous demand for *Goniozus* throughout the coconut growing area. The main aim of bio-control laboratory is timely availability of the natural enemies both qualitatively and quantitatively to the end users. The parasitic potential of a parasitoid can count the success of the bio control programme. However, to know the parasitizing efficiency and to maintain the quality of mass reared parasitoid under field conditions, it is important to determine the parasitizing efficiency of mass reared *Goniozus* under laboratory conditions. Considerable work on the parasitic potential of *Goniozus* is yet scanty. In this view, it was felt necessary to conduct research work on the parasitic potential of *G. nephantidis*. In the present study, we investigated the detailed observation on the ovipositional behavior and clutch size and Survival of *G. nephantidis* and the position of *G. nephantidis* eggs on *G. mellonella* and *C. cephalonica* larvae during the present investigation.

Materials and Methods

Number of parasitized larvae

The parasitized larvae containing eggs of *G. nephantidis* were removed regularly from the vials till the death of the female. Such larva was kept in paper strips in separate plastic vials. The plastic vial was covered with a perforated cap. Blackened larva was also considered to know the parasitic potential of a female of *G. nephantidis*. The results were expressed as the number of parasitized larvae of *G. mellonella* and *C. cephalonica* by *G. nephantidis*.

Clutch size (No. of eggs /larva)

The eggs laid by individual female per larva were considered as clutch size of single female.

Survival (%)

The egg laid on factitious hosts, *G. mellonella* and *C. cephalonica* by *G. nephantidis* were examined till adult emergence for per cent survival. The per cent survival was calculated by using formula,

$$\text{Survival (\%)} = \frac{\text{No. of adult emerged}}{\text{No. of eggs laid by female parasitoid within 24 hrs}} \times 100$$

Results and Discussion

Parasitic behavior of *G. nephantidis*

During the studies on parasitic behavior of *G. nephantidis*, fifth instar larva (Av. weight of larva 3.94 ± 0.68mg) of *G. mellonella* and third instar larva (Av. weight of larva 2.68 ±

0.19mg) of *C. cephalonica* were offered to parasitoid adults. The study revealed that the female of *G. nephantidis* inject venom and paralyzed the host larva within 2 to 3 hours after release. Adults of *G. nephantidis* started biting the larva of host for oviposition. The female inspected the host for about 20 to 30 seconds. It moved its antenna and searched around larval body. The female immediately moved to the dorsum of the host's thorax and attempted to attach its mandibles to it. The parasitoid attempted to move to the head of the host larva and sting between the head and thorax which was in the vicinity of the sub oesophageal ganglion.

Table.1 Parasitic potential of *G. nephantidis* on different hosts under laboratory condition

Sr. No.	Weight of larvae (mg)		Clutch size (No. of eggs/larva)		Parasitized larvae (No. of larvae/ female)		Survival (%)	
	5th instar larvae of Galleria	3rd instar larvae of Corcyra	Gm	Cc	Gm	Cc	Gm	Cc
1	3.50	2.80	16.00	14.00	7.00	6.00	13.75	37.93
2	3.50	2.80	7.00	12.00	5.00	5.00	20.00	50.00
3	3.50	2.80	16.00	14.00	6.00	6.00	29.03	33.93
4	4.40	2.80	10.00	13.00	7.00	6.00	26.79	38.60
5	4.40	2.80	9.00	16.00	7.00	7.00	14.10	48.33
6	4.40	2.50	13.00	13.00	5.00	5.00	12.94	46.30
7	5.00	2.50	10.00	14.00	4.00	6.00	17.65	41.30
8	5.00	2.50	14.00	14.00	7.00	7.00	24.44	48.00
9	5.00	2.50	17.00	10.00	6.00	5.00	27.12	28.95
10	3.50	2.50	12.00	11.00	7.00	5.00	10.53	33.33
11	3.50	2.57	12.00	12.00	7.00	5.00	12.07	41.82
12	3.50	3.00	16.00	11.00	7.00	4.00	25.00	42.86
13	3.20	3.00	11.00	14.00	7.00	6.00	17.50	40.91
14	3.20	3.00	10.00	14.00	6.00	6.00	17.78	52.08
15	3.20	2.70	17.00	14.00	7.00	7.00	22.39	46.67
16	4.50	2.70	9.00	12.00	6.00	7.00	15.79	38.00
17	4.50	2.70	10.00	8.00	4.00	6.00	6.00	52.78
18	4.50	2.50	19.00	11.00	5.00	5.00	15.52	54.05
19	3.20	2.50	14.00	9.00	5.00	6.00	16.07	44.68
20	3.20	2.50	11.00	13.00	7.00	7.00	27.08	39.13
Min.	3.20	2.50	7.00	8.00	4.00	4.00	6.00	28.95
Max.	5.00	3.00	19.00	16.00	7.00	7.00	29.03	54.05
Av. ± S.D.	3.94 ± 0.68	2.68 ± 0.19	12.65 ± 3.31	12.45 ± 1.99	6.10 ± 1.07	5.85 ± 0.88	18.58 ± 6.41	42.98 ± 6.87
Cal t	--	--	0.23NS		0.81NS		11.62**	
Gm= G. mellonella; Cc= C. cephalonica; **= Highly significant; NS =Non significant								

Parasitized larvae of *G. mellonella* by *G. nephantidis*

Parasitized larvae of *C. cephalonica* by *G. nephantidis*

Microscopic view Parasitized larvae of *G. mellonella* by *G. nephantidis*

Plate I

Microscopic view Parasitized larvae of *C. cephalonica* by *G. nephantidis*

Plate II

The larva remained passive at first and then attempted to keep away the parasitoid, but it was useless. The female left the larva for a short time and returned to it for walking upon its back, moving its antenna endlessly for assessing the size of the host and cleaning the external surface of the segment which was selected after examining with its mandibles. The female usually fed on hemolymph by cutting legs of the host and greedily licks it from a wound which cuts by mandibles. Moreover, the larva was moved by the female to find a suitable position. The feeding takes about 3 to 5 minutes. They deposited both single and multiple eggs clutches on hosts. The time taken from paralysis to eggs laying was about 30 to 50 minutes and during this time some paralyzed larvae were moved to a better position. The time for depositing a single egg varied from 2 to 4 minutes.

The paralyzed larva lasted for about 2 hours, after which it began to change its position. After the egg-laying process, the female showed a high degree of parental care to protect further eggs laying on same host as well as entry of any other parasitoid in the vicinity of parasitized larvae. The most preferred host segments for egg-laying of parasitoid was 5^{th} to 6^{th} abdominal segments of host larvae but there was no egg-laying observed on first and last abdominal segments and thorax of the host [Plate I and II].

Number of parasitized larvae

A perusal of data (Table 1) on parasitic potential of *G. nephantidis* on *G. mellonella* revealed that the number of larvae parasitized by adult parasitoid under laboratory condition varied from 4 to 7 larvae with an average of 6.10±1.07 larvae. However, it varied from 4 to 7 larvae with an average of 5.85±0.88 larvae on *C. cephalonica.* There was no significant difference observed in number of larvae parasitized by adult of *G. nephantidis* among both the hosts.

These findings are following Nandihalli and Prasad (1985) who reported that *C. cephalonica* and *O. arenosella* were equally suitable for *G. nephantidis*. In other studies Mohan and Nair (2002) reported that fifth or sixth instar larvae of *C. cephalonica* were the ideal for the multiplication of *G. nephantidis*. Shameer *et al.,* (2002) stated that the host

larvae either *O. arenosella* or *C. cephalonica* having an optimum weight of more than 70mg were more suitable for mass multiplication of *G. nephantidis*. Venkatesan *et al.,* (2004) noted that the highest net reproductive rate (42.6 females/female) obtained on *C. cephalonica* followed by *O. arenosella* (38.2 females/female). Moreover, Venkatesan *et al.*, (2009) reported that the maximum parasitism (9.0 larvae/female) was recorded with host-parasitoid ratio (1:1) on *C. cephalonica.* The present findings are corroborated with findings of Naganna and Shinde (2017) who reported that parasitoid paralyzes the larva of *C. cephalonica* within 2 to 3 hours after release. The female examines the host for about 20 to 25 seconds. The average number of larvae parasitized by adult parasitoid was 6.07±1.55 larva. The parasitic potential of *G. nephantidis* on *C. cephalonica* revealed that the number of larvae parasitized by adult parasitoid under laboratory condition varied from 4 to 7 with an average of 5.85±0.88 while, it varied from 4 to 9 with an average of 6.60±1.47 on *O. arenosella* larva (Gurav., 2018). The difference in parasitic potential of *G. nephantidis* on *G. mellonella* and *C. cephalonica* might be due to different host insects used in experiment, prevailing weather conditions in a particular locality and methodology employed for the investigation.

Clutch size

The clutch size of *G. nephantidis* presented in the Table 1. The data indicated that the clutch size varied from 7.00 to 19.00 eggs per larva with an average of 12.65±3.31 eggs per larva when reared on *G. mellonella*. Moreover, it varied from 8.00 to 14.00 eggs per larva with an average of 12.45±1.99 eggs per larva on *C. cephalonica.* There was no significant difference observed in clutch size among both the hosts. The present findings are more or less agreed with reports of Seetharama *et al.*, (2007) who stated that the clutch size ranged from 3 to 35 eggs per larvae (Av. 17.52±1.11eggs/larva) in case of *A. sahyadrics.* Moreover, these results are accordance with Naganna and Shinde (2017) who reported that the clutch size of *G. nephantidis* varied from 6.0 to 14.0 eggs per larva on *C. cephalonica* (Av. 8.97±2.09 eggs/larva). Gurav (2018) noted that the clutch size of *G. nephantidis* varied from 10 to 14 eggs per larva (Av. 13.00±1.08 eggs/larva) on *C. cephalonica* while, it varied from 8 to 16 eggs per larva (11.25±2.00 eggs/larva) on *O. arenosella* host. The difference in parasitic potential of *G. nephantidis* on *G. mellonella* and *C. cephalonica* might be due to different host insects used for an experiment, prevailing weather conditions in a particular locality and methodology employed for the investigation.

Survival (%)

The survival from egg to adult of *G. nephantidis* on *G. mellonella* and *C. cephalonica* was studied during present investigation. It was observed that per cent survival ranged from 6.00 to 29.03 per cent with an average of 18.58±6.41 per cent on *G. mellonella* however, it ranged from 28.95 to 54.05 per cent with an average of 42.98±6.87 per cent on *C. cephalonica*. There was a highly significant (t=11.62**) difference observed in survival of *G. nephantidis* when reared on *G. mellonella* and *C. cephalonica*. Significantly highest survival (42.98±6.87%) observed on *C. cephalonica* than *G. mellonella* (Table 1). More or less similar results were obtained by Venkatesan *et al.,* (2002) who recorded 69.76, 63.47 and 67.81 per cent survival of *G. nephantidis* on *C. cephalonica, G. mellonella* and *O. arenosella*, respectively. The disparity in survival of *G. nephantidis* might be due to different host insects used for experiment, prevailing weather conditions in a particular locality and methodology employed for the investigation.

In conclusion the investigation on parasitic potential revealed that there was no significant difference observed in a number of larvae parasitized by parasitoid and clutch size of *G. nephantidis* among both the hosts. However, significantly highest survival from egg to adult (42.98±6.87%) was observed on *C. cephalonica* than *G. mellonella* (18.58±6.41%). Among both the hosts, *C. cephalonica* could be utilized for mass production of *G. nephantidis* as compared to *G. mellonella.*

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