The Pharma Innovation Journal 2021; SP-10(8): 461-463

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; SP-10(8): 461-463

www.thepharmajournal.com
Received: 22-06-2021
Accepted: 24-07-2021

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Goniozus nephantidis: A hymenopteran weapon for management of coconut black headed caterpillar

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Abstract
Among the important bio agents, the most promising bio agents against *O. arenosella* are larval parasitoids *Bracon hebetor*, *Goniozus nephantidis*, pupal parasitoid *Brachymeri anosatoi* and anthocorid predator *Cardiastethu sexiguus. Goniozus nephantidis*or. *G. nephantidis* is a natural enemy that has been used to effectively control *opisina arenosella* walker in India and Sri Lanka. For mass rearing of *G. nephantidis* back-headed caterpillar (*Opisina arenosella* Walker) and rice moth (*Corcyra cephalonica* Stainton) could be used as hosts. Activity period of larval parasitoid, *Goniozus* sp. was observed from 3rd week of August to 4th week of October. There was significant reduction in the population of *O. arenosella* after third to sixth releases in treated palms, when compared to control palms. The larval parasitoids treatment (*G. nephantidis*) had more impact to reduce black headed caterpillar population as compared to predators *Cardiostethus exiguus* and control.

Keywords: coconut black headed caterpillar, *Goniozus nephantidis*, and parasitoid

Introduction
Among various insect pests infesting coconut palm, *Opisina arenosella* Walker (Lepidoptera: Oecophoridae) stands out as predominant leaf feeder in peninsular India. This caterpillar attacks palms of any age from nursery to grown up plants causing severe yield loss ranging from 25 to 75 per cent (Lal, 1968) [9]. Severe damage to coconut leaflets results in reduction in the number of flower spikes produced, increased immature nut fall and retardation of growth (Dharmaraju, 1963) [4]. Among the different natural enemies recorded on this caterpillar, the larval parasitoid *Goniozus nephantidis* (Muesebeck) was considered to be very efficient in the field due to its specificity.

Goniozus nephantidis or *G. nephantidis* is a natural enemy that has been used to effectively control *opisina arenosella* walker in India and Sri Lanka. On 28 April 2012, the Department of Agriculture, Thailand imported *Goniozus nephantidis* from Sri Lanka. When tested for its safety and effectiveness in controlling *opisina arenosella* walker, it is found that they are safe to use in Thailand. Among all parasitoids, *G. nephantidis* is one of the gregarious larval parasitoid responsible for the reduction in pest population under field conditions to the extent of 60 to 70 per cent. Hence, *G. nephantidis* is being widely used in the biological control programmes (Venkatesan *et al*., 2007) [19]. In Gujarat, coconut climbing is very expensive due to non availability of expert climbers and the farmers are very reluctant to adopt the pest management practices in the crown area due to this difficulty. The potent bio agent, *G. nephantidis* may be recommended as larval parasitoid for management of black headed caterpillar.

The coconut ecosystem is rich in predators and parasitoids. In India, 43 species of parasitoids and 51 species of predators have been recorded on coconut black headed caterpillar, *O. arenosella.* Among them *Goniozus nephantidis* Muesebeck is a dominant parasitoid and is responsible in controlling the populations build up of *O. arenosella* up to the extent of 60 to 70 per cent. The desirable characteristics of the parasitoid like easy mass multiplication with an alternate host, gregarious nature and high fecundity makes the parasitoid promising to be used for controlling the pest population under field condition (Nisha *et al.*, 2006) [11]. Hence, *G. nephantidis*is being widely used in the biological control programmes (Venkatesan *et al*., 2007) [19].

Biology of *Goniozus nephantidis*
Sreekanth and Muralimohan (2013) [15] revealed that the oviposition rate of *G. nephantidis* was higher (89.15 ± 7.63) and the oviposition period was longer (29.55 ± 5.24) in larger female

parasitoid than in smaller ones. The maximum numbers of eggs of *Goniozus swirskiana* Muesebeck on larvae of *Batrechedra amydrula* Meyrick were laid on the 5th lateral segment and there were not a single egg on first and last segment of abdomen. The female deposited about 32, 71 and 10 eggs on dorsal, lateral and ventral surface of larva, respectively (Sadeghi *et al.*, 2012) [13]. The incubation, larval, pupal and adult period of *G. thailandensis* was 3.1 ± 0.0, 4.1 ± 0.0, 13.5 ± 0.1 and 20.5±0.1 days, respectively on sapodilla fruit borer (Witethom and Gorth, 1994) [20].

Making use of *Goniozus nephantidis*

In India and Sri Lanka, it is advised to release adult *Goniozus nephantidis* to control *Opisina arenosella* Walker in mildly affected area with the ratio of 500 *Goniozus nephantidis* per Rai. The *Goniozus nephantidis* should be release every month when the sun is setting. The more *Goniozus nephantidis* are released the faster the result.

G. nephantidis* potential parasitoid for *O. arenosella

Revealed that both the hosts are equally suitable for rearing of *G. nephantidis.* Oviposition period was observed significantly more on host *C. cephalonica* than the host *O. arenosella*. Adult emergence was more when *G. nephantidis* was reared on *C. cephalonica* (80.44 %) as compared with other host *O. arenosella* (77.38 %). Female longevity was significantly more on host *C. cephalonica* (21 to 32 days with an average of 25.70 ± 3.16 days) than the host *O. arenosella* (11 to 30 days with an average of 19.15 ± 4.72 days). Significantly more number of days recorded in female total life period reared on host *C. cephalonica* (33 to 45 days with an average of 38.75 ± 3.60 days) than host *O. arenosella* (23 to 40 days with an average of 32.30 ± 4.60 days). Overall study showed that both the hosts are equally suitable but for mass multiplication of *G. nephantidis* in laboratory, artificial host *C. cephalonica*is most useful as rearing technique of this host is standardized as compare to natural host *O. arenosella* (Gurav *et al*., 2018) [5].

The pre release larval population ranging from 71.9 to 168.9 per 10 leaflets in the affected villages completely decreased after innundative bio agents release in three to six months after release (Chalapathirao *et al*., 2018) [2]. Pre conditioning of the parasitoid, *G. nephantidis* with frass and damaged coconut leaves should be done while rearing the parasitoid in the laboratory for maximizing parasitisation of coconut black headed caterpillar (Gurav *et al*., 2018) [6]. According to Lyla *et al*. (2006) [10] the trunk method of release of *G. nephantidis* suppressed the pest population up to sixth releases of the parasitoid. The trunk method of release was low cost and easy to operate under the field condition. Release of larval (*Bracon hebetor, Goniozus nephantidis*) and pupal (*Brachymeria nosatoi*) parasitoids could bring down pest population from 16.73 to 8.73/palm with 30 per cent parasitisation. *Cardiastethu sexiguus*an anthocorid predator also proved effective in pest suppression from 102.3 to 5.4/palm with 21.5 per cent of population. The release of bio-agents could be employed for successful suppression of blackheaded caterpillar which was safe, economical and perpetual wing of IPM (Sujatha & Chalam 2009) [15].

Gurav *et al*., 2018 [6] revealed that percent parasitization, *G. nephantidis* was the dominant parasitoid under Navsari conditions of Gujarat state. Maximum parasitization was observed in Navsari taluka in the month of May (11.76 %) followed by April (10.07 %) while lowest was 2.63 per cent in Chikhali taluka in the month of May.

Venkatesan, *et al.* (2009) [18] showed that the mean percent of adult production was significantly higher (91.3%) for *G. nephantidis* than *B. brevicornis* (81.8%). Subaharan (2008) [16] indicated that 63 per cent of G. nephantidis oriented to the arm with Opisina arenosella Walker hemolymph followed by 35 per cent to O. arenosella frass. The starved parasitoids were more attracted towards food source honey (32%) than the larval products (26.0%). Kapadia and Mittal (1993) [8] revealed that the parasitism by *G. nephantidis* on *O. arenosella* was higher and varied from 18.52 to 58.34 per cent with maximum recovery (52.20%).

Goniozus nephantidis (Muesebeck) is found to have strong parental care for its progeny, the influence of different densities of *G. nephantidis* and its host, *Corcyra cephalonica* (Stainton) on the behaviour ecology of the parasitoid was studied. Interaction between different densities of the host and parasitoid revealed that a ratio of 1:1 was significantly superior to all other ratios resulting in maximum parasitism (9.0 larvae /female), fecundity (93.2/female) and number of progenies (75.2/female). Exposing more than one *C. cephalonica* larva did not significantly increase the parasitizing efficiency, fecundity and progeny produced. Conversely, exposing a single *C. cephalonica* larva to several female parasitoids adversely affected the biological attributes of the parasitoid. Increasing the densities of either host insects or parasitoids had an inverse relationship with oviposition behaviour, parasitism efficiency and progeny production of the parasitoid establishing the important and significant role played by host–parasitoid density (Venkatesan *et al.*, 2007) [19].

According to Rajamanikam *et al.*, (2002) [12] the root feeding of coconut palm with azadirachtin 5% EC @ 10 ml + 10 ml water followed by the release of promising larval parasitoids among the treatment *G. nephantidis* (29.40% parasitism) and *Braconbrevicornis* (16.96% parasitism) and pupal parasitoid, *Trichospiluspupivora* (6.25% parasitism) at 21 days after treatment was found effective against coconut black headed caterpillar. Shivanand and Deshapande (2011) [14] reported that the activity period of larval parasitoid, *Goniozus* sp. was observed from 3rd week of August to 4th week of October.

The larval parasitoids treatment (*G. nephantidis*) had more impact to reduce black headed caterpillar population as compared to predators *Cardiostethus exiguus* and control (Anonymous 2015) [1]. According to Chandrashekara *et al*. (2017) [3] there was a higher initial larval population ranging from 21.46 to 22.19 numbers per ten leaflets in October month without parasitization which gradually decreased to 1.87 numbers/ten leaflets in treatment (Conditioned) with 67.95 per cent parasitization and 4.50 numbers/ten leaflets in treatment (Unconditioned) with 58.45 per cent parasitization. In untreated control, larval population of 17.64 numbers/ten leaflets with 3.61 per cent parasitisation was recorded and it showed an increase in larval population. The conditioned parasitoids were more efficient in reducing black headed caterpillar population with higher per cent parasitization compared to unconditioned parasitoid.

Conclusion

G. nephanditis is potential parasitoid to black headed caterpillar due to its wider parasitic potential. Easy to mass produce due to some good attributes *viz*., short life cycle, high fecundity, perfect site of oviposition and maximum progeny production. Temperature ranging from 25^0C to 30^0C found to

be an optimum regime for mass production of *G. nephanditis* parasitoids. In field condition, host guarding or parental care of the *G. nephanditis* are able to competitive to other natural enemies and thus prevent/minimize the hyper parasitism. Frequent release of the parasitoid at certain intervals will helps to reduce the black headed caterpillar population.

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