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STUDIES ON FIELD BIOLOGY OF *OPISINA ARENOSELLA* WALKER : A KEY PARAMETER MASS TRAPPING

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Coconut black headed caterpillar is a defoliating pest in East Asian countries. Due to great difficulties in managing this pest, present study was undertaken to know biology and explore the utility of BHC sex pheromone for its management. The data on field collected pupae were pooled across sites and estimated biological parameters. The sex ratio was favorable to female at all the places *i.e.* female biased sex ratios (1 : 1.17). But there was no significant difference in their numbers across generations and locations. Observations on adult emergence indicated that approximately 50 per cent of the pupae emerged into adults. Out of 100 per cent of male and female pupae only 45.66 and 54.25 per cent were male and female pupae, respectively. At the study site pupal parasitisation ranged between 6.67 to 21.00 per cent with an average of 14.20 ± 5.46 per cent. The partial life table indicated that the survivorship rate at the larval and pupal stages were 39.37 and 49.09 per cent, respectively. In adult stage, majority of the (98.16%) moths emerged were normal and most likely to be involved in reproduction and multiplication. In mass trapping, a total of 1156 moths were trapped in 120 traps. During this period 75.00 per cent of the larvae were parasitized by *Goniozus nephantidis* and 21.48 per cent of pupae by *Meteoridea* sp., *Brachymeria* sp. and *Xanthopimpla* sp. The larval population recorded after mass trapping indicated significantly less compared to earlier generation.

Key words : Coconut, Black headed caterpillar, Larval and pupal parasitisation, Life table, Mass trapping.

INTRODUCTION

Coconut (*Cocos nucifera* Linn.) is a major plantation crop widely cultivated in tropical countries because of its multiple uses. All parts of this palm are used in one way or the other. The consumption of fresh coconuts for culinary purpose is a common practice in South India. Now-a-days, consumption of tender coconut water is considered desirable from medicinal point of view. Coconut is grown in 93 countries of the world and among them Indonesia, Philippines, India and Sri Lanka together account for 78 per cent of total world production (SME NEWS, 2012). Kerala stands first in area and production. Although Karnataka stands second in area, it takes third place in total production of nuts (Rethinam & Singh, 2007).

The coconut palm is inflicted by a number of pests of major and minor importance (Thampan, 1975). Nearly 751 insect pests of coconut have been recorded world over (Child, 1974). Most species of the beetles that feed on leaves of higher plants belong to either of the two largest families of the beetle, Curculionidae and Chrysomelidae, both of which are entirely phytophagous. Some species of Curculionidae and Scarabaeidae are borers in palm buds, which result in damage to the fronds as they open (Howard *et al.*, 2001). Among major pests of coconut in India, apart from coconut mite, rhinoceros beetle and red palm weevil, the black-headed caterpillar (BHC), *Opisina arenosella* Walker

(Lepidoptera : Oecophoridae) is considered a serious pest during growth period.

The BHC is an important and most destructive pest in many commercial and subsistence coconut cultivated areas, because moderate to high density population of BHC do indeed cause considerable yield loss. The pest infestation is mainly confined to the lower fronds, and in severe infestation, several hundreds to thousands of larvae can be observed on a palm. The caterpillar feeds on chlorophyll by scraping lower epidermis of leaflets and constructs galleries of silk and frass. The infested fronds give burnt-up appearance and affected palms often take several years to recover completely. Further, BHC attack results in heavy yield loss (> 50 %) and the infested palms can regain to the normal yield potential during the fourth year following the pest attack, provided pest infestation is curtailed (Chandrika Mohan *et al.*, 2010).

A combination of cultural, biological and chemical control measures have been employed to manage the pest. Artificial defoliation (cutting of lower fronds), and application of synthetic insecticides have no or very short period impact on pest population and releases of natural enemies have also not been effective in reducing the pest menace. Presently, a majority of the coconut gardens in Karnataka were severely infested with this pest and no management practices have been found effective. Now only, the sex pheromone released by the females was identified, artificially synthesized and field tested by the Bio-Control Research Laboratory (PCI), Bangalore (Bhanu *et al.*, 2011).

In lepidopteran pest, the key factors especially like density of pest in the infested area, the ratio of traps to pest (female) population, the strength of attractiveness of traps and organisms, and the degree of the pest's endemism in the area (Carde, 1976). In majority of insects, the emergence of both sexes and calling period rarely are synchronous. The variation favors males being trapped over locating females, since the traps emit the pheromone continuously. In order to use the sex pheromone trap for monitoring and mass trapping, it is essential to know biology of pest. Hence, this study.

MATERIALS AND METHODS

For estimation of natural mortality at pupal and adult stages, the infested coconut leaves from Nelamangala (13°05'47.76"N77°21'12.59"E 877.824m), VC Farm (12°34'18.80"N76°49'30.14"E 710.4888m), Bidadi (12°45'38.21"N77°25'50.51"E 703.7832m), Nittur (13°19'31.45"N76°51'00.48"E 798.8808m) and Thyamagondlu (13°12'05.24"N77°17'50.08"E 896.112 m)near Bangalore were brought to the laboratory regularly at Behaviour testing lab, BCRL for observations. Three hundred leaflets from 15 randomly selected infested coconut palms were collected and brought to the laboratory. The leaflets from all the palms were pooled and brought to the laboratory. The field collected larvae and pupae were separated and larvae were provided with newer leaves for pupation. The pupae were sex separated and placed in plastic box (30×20×20 cm) with wet tissue paper for emergence. Observations on sex ratio, number of adults emerged, number of abnormal, parasitized and normal and abnormal adult counts were made. The data recorded was used for calculating the per cent natural mortality for all the places. The developmental fate of all stages was recorded and used to develop a partial life table for *O. arenosella*.

To study natural mortality at larval stage, BHC infested coconut fields at Bidadi (two fields) and Thyamagondlu (one field) were chosen and larval counts were made during early and late instars of their developmental period. In Bidadi, early instar larval count was made on 1/7/2011 and late instar larval count was recorded on 2/8/2011. In this 90 palms were chosen in three ha area. On each palm two fronds were selected *i.e.* at middle and another at lower portion of the palm. In each frond 20 randomly selected leaflets were selected for larval counts. Another coconut garden one km away from the earlier field was also selected and sampling for BHC was made in the manner explained earlier. In Thyamagondlu, 60 palms were sampled.

Effect of mass trapping with 40 traps/ha on moth catches was conducted at Yelachegere near Bangalore. A 3.2 ha coconut plot with approximately 380 palms, all of which were infested with BHC. The pheromone traps at the rate of one trap for every three palms were installed in a zig-zag manner in the three hectare plot. Larval counts were taken once before moth emergence and again after moth emergence. Periodically, observations on moths trapped in the traps were recorded and tabulated.

RESULTS

The data on field collected pupae were pooled across the sites and parameters like mortality rate at larval, pupal and adult stages were recorded. Out of 100 per cent of *O. arenosella* pupae collected from Mandya (49.52% male (M) and 50.47% female (F)), Bidadi (40.48 % M and 59.15% F), Nelamangala (42.60% M and 57.38% F), Thyamagondlu (47.1% M and 52.89% F) and Nittur (48.61% M and 51.38 F), 45.66 ± 3.93 (Mean ± SD) and 54.25 ± 3.93 per cent were male and female, respectively. The sex ratio was favourable to female at all the places *i.e.* female biased sex ratios (1: 1.17). But there was no significant difference in their numbers across the generations and locations (Table 1).

Observations on adult emergence indicated that approximately 50 per cent of the pupae emerged into adults. Out of 100 per cent of male and female pupae only 45.66 and 54.25 per cent were male and female pupae, respectively. There were non-significant differences in male and female across locations. But, significant different was noticed (t value = 4.68, df = 29, $p < 0.001$) between number of emerged (49.64%) and abnormal (36.14) pupae. Significant differences were also noticed (t value = 6.15, df = 29, $p<0.001$) in pupae that emerged to adults (49.64%) and parasitized (14.20%) by natural enemies. In study site, pupal parasitisation ranged between 6.67 to 21.00 per cent with an average of 14.20 ± 5.46 per cent. Significantly the highest (t value = 4.43, df = 29, $p < 0.001$) number of abnormal pupae (36.14%) recorded than the pupae parasitized by natural enemies (14.20%). The abnormal pupae were ranged from 28.10 to 48.57 per cent with an average of 36.14 ± 8.56 per cent. The parasitiods like *Apanteles* sp., *Bracon* sp., *Goniozus nephantidis*, *Meteoridae* sp., *Brachymeria* sp. and *Xanthopimpla* sp. were recorded on pupae. Most of the adults emerged were normal. Significantly higher number of adults was normal (98.16%) than abnormal (1.02%) (t value = 6.25, df = 30, $p < 0.001$).

A partial life table of *O. arenosella* was constructed based on stage-specific mortality in the populations. The observations collected from Bidadi, Mandya, Nelamangala, Thyamagondlu and Nittur were pooled for construction of life table. The partial life table indicated that the survivorship rate at the larval and pupal stages were 39.37 and 49.09%,

Table I : Life table characteristics of field collected *O. arenosella* larvae and pupae during 2011- 2013.

Places of collection	Total pupae collected	Male (%)	Female (%)	Adults emerged (%)		Abnormal pupae (%)	Parasitization (%)	Adults emerged (%)	Malformed adults (%)
				Male	Female				
Mandya[1]	210	49.52	50.47	25.00	35.84	48.57	21.00	30.47	1.50
Bidadi[2]	2685	40.48	59.15	58.41	58.37	28.10	17.57	54.22	2.06
Nelamagngala[3]	392	42.60	57.38	47. 90	55.55	34.00	13.77	52.28	2.00
Thyamagondlu[4]	1707	47.10	52.89	63.68	54.47	29.23	12.00	58.75	1.83
Nittur[5]	703	48.61	51.38	50.85	54.05	40.83	6.67	52.50	1.85
Mean		*45.66*	*54.25*	*49.48*	*51.65*	*36.14*	*14.20*	*49.64*	*1.84*

n : 100 leaflets from 15 randomly selected infested coconut palms/sample; 1 : 2 samples; 2 : 18 samples; 3 : 4 samples; 4 : 11 samples; 5 : 8 samples

Table II : Life table analysis of *O. arenosella* constructed based on field collected BHC larvae and pupae.

Life stages	Total numbers examined	Causes of mortality	Mortality by numbers	Mortality by (%)	Survival rate (%)
Larvae*	13715	Birds, spiders, lizards, carabid beetle, *Goniozus* sp. *etc.*	8316	60.63	39.37
Pupae**	5697	Natural mortality or mortality due to unknown factors and other factors like occurrence of parasitoids *Meteoridae*, *Brachymeria* sp. and *Xanthopimpla* sp.	2869	50.35	49.56
Adult**	2828	Abnormal adults	52.00	1.84	98.16

* : Examined under field conditions; ** : Examined in laboratory

respectively. In adult stage, majority of the (98.16%) moths emerged were normal and most likely to be involved in reproduction and multiplication. Birds, spiders, lizards, carabid beetle, *Apanteles* sp. *Bracon* sp. and *Goniozus* sp. are the potential predators and parasitoids on larval stages. Three hymenopteran parasitoids species like *Meteoridae*, *Brachymeria* sp. and *Xanthopimpla* sp. were commonly found in pupal stage (Table II).

A total of 1156 moths were trapped (9.63 moths/trap) in 120 traps. During this period 75.00 per cent of the larvae were parasitized by *G. nephantidis* and 21.48 per cent of pupae by *Meteoridea* sp., *Brachymeria* sp. and *Xanthopimpla* sp. The larval population recorded after mass trapping indicated significantly less (0.034 larvae/leaflet) ($t=35.93$, $df=39$, $p<0.01$) compared to earlier generation (1.39 larvae/leaflet) (Table III).

Table III : BHC larval and pupal parasitisation, male moths trapped in pheromone traps and reduction in larval numbers in Nelamangala.

Generations	Larval parasitisation (%)	Pupal Parasitisation* (%)	Total number of moths trapped	Mean (±SD) No. of larvae per leaflet**
Before Mass trapping	75.00	21.48	1156.00	1.39±0.89
After Mass trapping	0.00	17.30	0.00	0.03±0.70

* : Field collected BHC culture examined in laboratory; ** : Mean number of 400 leaflets in 2 fronds/ 10 palms /ha

DISCUSSION

Use of sex pheromone in pest management is an emerging area of interest. Presently, the identification and validation of pheromone compounds, for major insect pests of economically important crops, are more concern area of interest. During 1960-80s, identification of pheromone compounds were made for quite a large number of insect pests. But their applications in pest management found to limited numbers. In the present study, effect of mass trapping of *O. arenosella* male moths on population was investigated.

The success of mass trapping of male moths was mainly due to male moth trapping and also occurrence of natural enemies. Apart from these, the success also depended on life history of BHC. Since a large number of male moths were trapped using pheromone traps, in BHC single male mating was more prevailing (Ram Kumar, 2002), a drastic reduction in mating resulted in the reduced fecundity in the next generation. In addition, even a delay in mating, via a reduction in the number of available males, may also contribute to reduction of pest population in the subsequent generations (Carde, 1976; El-Sayed, 2006; Ram Kuamar, 2002). Male protandry, eclosion before females (Muralimohan *et al.*, 2008), is an additional factor that improves mass trapping. Early emergence of male would tend to increase the capture rate, which resulted in decreased mating success. Moth emergence pattern also favoured the mass trapping. One such type was discrete generation cycles (Ram Kumar, 2002) where in moth emergence period was followed by non emergence of moths. In BHC, males emerged in a stretch of 35-40 day, so that by placing the pheromone traps during peak moth emergence period one can catch the maximum number of moths.

The mortality rate at larval, pupal and adult stages was recorded from the field collected larvae and pupae. The results indicated that the sex ratio of BHC was favourable to female *i.e.* female biased sex ratios (1 : 1.17). Similar observations were also made by Ram Kumar (2002). Further observations on adult emergence indicated that approximately 50 per cent of the pupae emerged into normal adults. A partial life table of *O. arenosella* was constructed based on stage-specific mortality in the populations. The partial life table indicated that the survivorship rate at the larval and pupal stages were 39.37 and 49.09 per cent, respectively. In adult stage, majority of the (98.16%) moths emerged were normal and involved in reproduction and multiplication.

The major reasons for stage-specific mortality of BHC were biotic factors like predators and parasitoids. Ram Kumar (2002) recorded 11 species of parasitoids and 5 species of predators from survey conducted in Karnataka. In the present study, 60.63 % larval mortality was recorded. The predators like birds, spiders, lizards, carabid beetle, *G. nephantidis* were recorded during field observations. Similarly Ram Kumar (2002) reported that the larval numbers/palm leaflet decreased as the stage advanced and suspected that major predators (Anthocorid and Carabid beetles) and parasitiods (*Apanteles taragamae, Bracon brevicornis, G. nephantidis*) were responsible for downsizing the larval population. In the present study, 50.34% of pupal mortality was recorded due to natural mortality or mortality due to unknown factors and other factors like occurrence of parasitoids *Meteoridae hutsone, Brachymeria* sp. and *Xanthopimpla* sp. Muralimohan *et al.* (2008) recorded out of 100% pupae collected 44.22% parasitized, 41.34% moth emergence and remaining 14.44% did not have emergence from them. Ram Kumar (2002) recorded major parasitoids during the survey in Karnataka *viz. B. nephantidis, G. nephantidis, Trichospilus pupivorus, Tetrasticus* sp., *Xanthopimpla punctata, X. nana nana* and *Xanthopimpla* sp. Apart from these, *Meteoridae hutsoni* as larval-pupal parasitoid were recorded.

Pheromone traps are more effective in suppressing BHC population. Further, the method was are eco-friendly, without causing any environmental hazards and safe to non-target organisms. This technology can also be easily combined with other management practices without any adverse effect. With these results, the pheromone traps can be recommended for the management of BHC either alone or in combination with release of larval parasitoid, *G. nephantidis.*

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