Monitoring Emergence Pattern of Coconut Black-Headed Caterpillar *Opisinaarenosella* Walker (Lepidoptera: Oecophoridae) Using Sex Pheromone Traps

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Abstract

The pheromone mass trapping programme for coconut black-headed caterpillar (BHC), *Opisinaarenosella* Walker under development at the south eastern dry zone of Karnataka calls for a proper monitoring system. Experiments conducted at Bidadi, Nelamangala, Nittur and Thyamagondlu near Bangalore, peninsular India to establish the emergence pattern of BHC indicated that nearly six emergence peaks of moths were recorded in 18 months. The duration of emergence and non-emergence periods of moths was approximately 41 days (SD= ±3.93) and 48 days (SD= ±4.35) respectively. The maximum number of days of moth and non-moth emergence was recorded during March, April and May. The studies on emergence pattern throughout the generation indicated that the moth emergence followed a normal curve. The moth emergence pattern of BHC in four coconut gardens at Nelamangala, Thyamagondlu, Nittur and Bidadi indicated the occurrence of spatially segregated moth emergence. The present studies provided thoughtful information on flight pattern of BHC in each generation and also throughout the year. Such basic results are helpful in designing pheromone based pest control strategies.

Keywords: Monitoring, moth emergence patterns, *Opisinaarenosella*, Sex pheromone traps

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Introduction

Coconut black-headed caterpillar (BHC), *Opisinaarenosella* Walker (Lepidoptera: Oecophoridae) is an important and most destructive pest in many commercial and subsistence coconut cultivated areas in India. Moderate to high population densities of *O. arenosella* causes considerable yield loss. BHC has its natural range extends from India (Nirulla, 1956), Sri Lanka (Perera, 1987), Burma (Ghosh, 1923), Bangladesh (Alam, 1962) and Thailand (Bao-qian*et al*., 2013). Damage to coconut in India first recorded from Andhra Pradesh in 1909 (Rao *et al*., 1948) and this is frequently noticed in South India.

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 in affected palms often take several years to recover completely. Further, *O. arenosella* attack results in heavy yield loss (> 50 %) and the infested palms can realize normal yield potential during the fourth year following the pest attack, provided the pest infestation is brought under control (Chandrika Mohan *et al*., 2010).

Pest monitoring is an essential component of pest management, particularly for planning of pheromone trapping program for its management (Riedl and Croft, 1974; Riedl *et al*., 1976). In BHC, monitoring helps to establish the time, duration and moth emergence pattern throughout the year. This information is essential to determine the time to install pheromone traps, servicing and make them ready to trap the male moths before starting of the moth emergence. For several lepidopteran pests light traps and sweep nets were frequently employed in monitoring the field and fruit crops (Willson and Trammel 1980; Howell 1984; Durant *et al*., 1986; Knodel and Agnello, 1990; Vincent *et al*., 1990, Delisle, 1992).Previously, light traps were exploited for monitoring and trapping of BHC adults. But light traps were less energy-friendly and attract target as well as non-target species, and also their applications in pest management program was limited (Muralimohan *et al*., 2007). Although several techniques like light traps, larval and pupal population sampling can be used to monitor the BHC activity, recent development in identification and development of sex pheromone traps and their utility was exploited in the monitoring program.

Currently no precise information is available on BHC emergence pattern in dry regions of major coconut growing areas of southern Karnataka, where BHC is an endemic pest. The sex pheromone produced by the female BHC has been identified, artificially synthesized and field tested by the Bio-Control Research Laboratory (PCI), Bangalore (Bhanu *et al*., 2009; 2011). But its use in monitoring BHC was not explored under Indian conditions. Monitoring in the absence of scientific data on trap performance, scientists and coconut growers in Karnataka have been reluctant to use pheromone-baited traps. Flight activity is an essential component for planning pheromone mass trapping technique. The present study was conducted to explore the possibility of using the sex pheromone for monitoring the BHC emergence pattern. The specific objectives were to determine the time and duration of moth emergence for each generation as well as generations throughout the year and emergence pattern of spatially segregated populations. Data from this study will be used to provide monitoring recommendations and guidelines for pheromone trap installation as well as release of larval parasitoids.

Materials and methods

Dispenser Formulations

Pheromone compound ((Z,Z,Z)-3,6,9-tricosatriene) used in the present trials was synthesized at Bio-Control Research Laboratory (BCRL), India. The purity of the synthesized pheromone compound was maintained as >99 %. The synthetic pheromone compound was impregnated in pvc vials to prepare the pheromone lures. Pheromone concentrate was stored at -17°C till use. Before preparations of the lure, the compound was exposed to room temperature (24±1°C) for 30 min.

Pheromone trap

Pheromone lure containing 100 µg of synthetic pheromone was used in the trap. Two types of commercially available pheromone traps at Pest Control Pvt. Ltd. (BCRL, Bangalore) were used in this study. The traps were, wing vane traps (25×25 cm) with sticky area inside the trap and cross vane traps (50×25 cm) with sticky area all around the traps.

Field studies

The number of generation cycles and duration of each cycle of *O. arenosella* was studied from 6th July 2011 to 5th January 2013.To study the time and duration of moth emergence in each generation as well as in generations throughout the year, an infested coconut garden of 1.1 ha at Bidadi (12°45'38.21"N 77°25'50.51"E elev-2309ft) with 129 trees of 30 years old were selected. In order to ascertain the seasonal activity of BHC moths, ten pheromone traps placed for 18 months were used to record the moth activity. Old and damaged pheromone traps were replaced with new traps once in every 3 months. Wing vane traps used for first 5 months, later, the wing vane traps were replaced with cross vane traps. The observations on starting and ending of moth emergence in each generation, duration of non-emergence period and number of moths trapped in each generation were recorded. The observations were repeated for all flight period during 18 months.

The location specific BHC moth emergence for four different places was observed using pheromone traps. For this study, infested coconut gardens at Bidadi (12°45'38.21"N 77°25'50.51"E elev-2309ft), Nelamangala (13°05'47.76"N 77°21'12.59"E elev-2880ft), Nittur (13°19'31.45"N 76°51'00.48"E elev-2621ft) and Thyamagondlu (13°12'05.24"N 77°17'50.08"E elev-2940ft) were chosen.

Trap placement

The traps with pheromone lures were installed at the crop canopy level to the middle fronds of the palms (120). Traps were distributed randomly throughout the study area. Care was taken while installing the trap to ensure the proper placement and fresh traps were placed as and when they got damaged. Traps were checked once in a week to record the number of moths trapped in the pheromone traps. The trapped moths were removed during each count.

Analysis of data

Moth catches in ten traps in all the generations were expressed as total or mean moths trapped/10 trap/ generation. Regression analysis was used to determine the trapping pattern of male moths throughout the generation.

Results and discussions

The trap catches of BHC male moths in 10 pheromone traps were able to indicate moth emergence peaks. Six distinct moth emergence periods of BHC males were recorded at Bidadi, near Bangalore, Karnataka, indicating nearly five generations of BHC per year (Fig. 1). The duration of moth emergence and non-emergence periods of moth varied from 34 to 45 days and 44 to 56 days, respectively. The maximum number of days of moth emergence and non-emergence was recorded during March, April and May. From these studies, it is inferred that on an average moth emergence period lasted for 41.50 days (SD= ±3.93) followed by 48.16 (SD= ±4.35) days of non-emergence period (Table 1).

The pheromone trap catches indicated clear-cut information regarding initiation and end of moth emergence. Based on this information one can install the traps before moth emergence starts. Observations on moth emergence pattern in six generation cycles indicated occurrence of discrete generation cycles in *O. orenosella*. The existence of discrete generation cycles in *O. arenosella* was mentioned for the first time by Perera (1987) from Sri Lanka. In India many workers reported discrete generation cycles in *O. arenosella*. Ram Kumar *et al*. (2006) validated occurrence of discrete generation cycles with definite periodicity in peninsular India. They further suspected that discrete generation cycles may not be related to seasonality. One of the prominent behaviour of BHC is to stay for long time in the same field if there is no biotic and abiotic pressure affecting on it. This may be due to its

Table 1. Monitoring seasonal activity of BHC at Bidadi, 2011 and 2012

Period		Total moth emergence period (Days)	Non emergence period of moths (Days)	Total moths trapped in monitoring traps (N=10)
06-07-2011	16-08-2011	41	-	310
17-08-2011	01-10-2011	-	45	
02-10-2011	05-11-2011	34	-	110
06-11-2011	20-12-2011	-	44	
21-12-2011	01-02-2012	42	-	106
02-02-2012	20-03-2012	-	47	
21-03-2012	05-05-2012	45	-	67
06-05-2012	01-07-2012	-	56	
02-07-2012	15-08-2012	44	-	50
16-08-2012	02-10-2012	-	47	
03-10-2012	15-11-2012	43	-	25
16-11-2012	05-01-2013	-	50	
Mean±SD (N=10)		41.50±3.93	48.16±4.35	

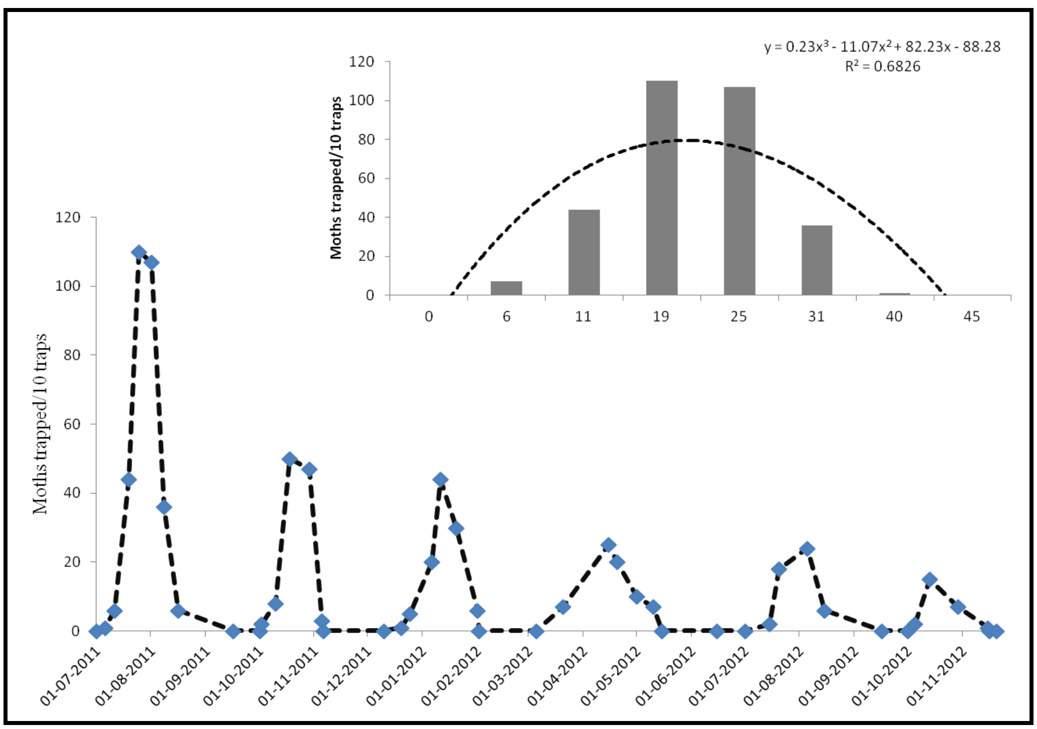

Figure 1. Pattern of moth emergence recorded using pheromone traps for six generations (inserted graph for BHC moth emergence from 10 traps data of one generation)

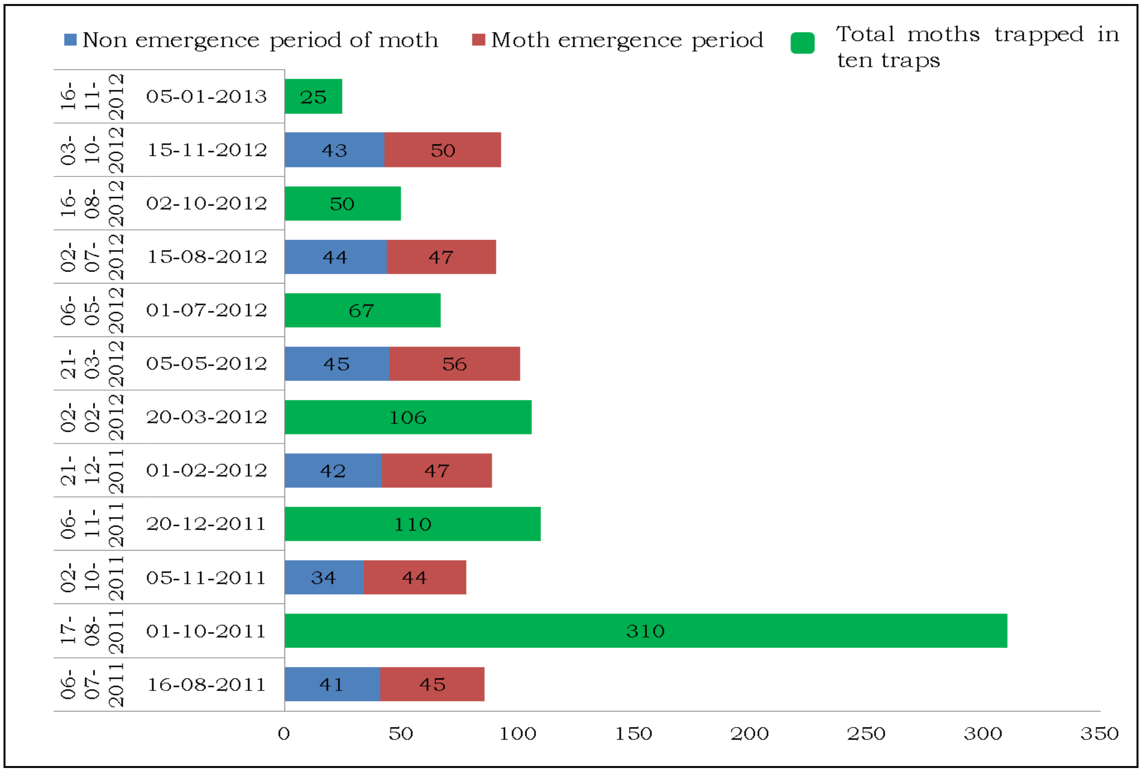

Figure 2. Duration of moth emergence and non-emergence period and number of moths trapped in pheromone traps at Bidadi, Bangalore, 2011-13

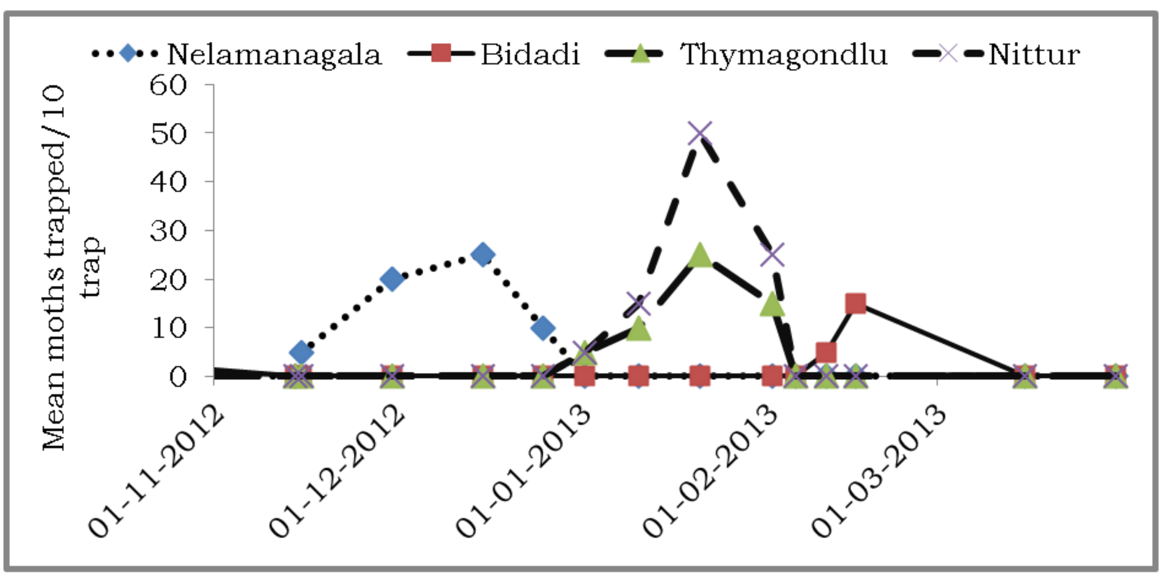

Figure 3. Pattern of BHC moth emergence at four different locations in and around Bangalore, 2012-13

poor flying capacity. If the coconut gardens are in a continuous belt, this pest slowly spreads from one field to other field and finally spreads into the entire belt. The discrete generation cycles in BHC has a significant implication to implement mass trapping. Based on monitoring data, the pheromone traps can be installed during 6th larval instar or pupal stage of the pest. In the subsequent generation traps / lures can be replaced at 70-80 days once, based on the visual observations on stage of pests. The ideal stage for release of larval parasitoids is 20 days after the moth emergence period in any generation; it can be coinciding with 3rd to 5th instar larval stages.

The study on emergence pattern of BHC male moths throughout one generation indicated that the moth emergence followed normal curve ($y = 0.23x^3 - 11.07x^2 + 82.23x - 88.28$; $R^2 = 0.6826$). The moth emergence period lasted for 40 days including 10 days of low emergence period. This was followed by peak emergence period of 20 days and again emergence decreased to the extent of negligible numbers for another 10 days. Male moth catches in the pheromone traps decreased from one generation to next indicating BHC population reduction due to continuous mass trapping of male moths in the monitoring field. Initially the trap catches were 310, and in subsequent generations, the catches reduced to 110, 106, 67, 50, and 25moths/10 traps (Table 1). Judging from trap capture data, BHC moth emergence was not seasonal and it noticed throughout the year. Chandrashekharaiah (2013) studied the population fluctuation of BHC under natural infested coconut garden. The results indicated that the population showed increasing trend initially up to third generation. After reaching the threshold level, the population showed a declining trend and larvae persisted in the field. The traps must be used when the population level is in the initial stage of infestation or before it reaches maximum infestation for effective management of BHC by using pheromone traps.

Muralimohan (2006) established the phenomena of spatially segregated populations in BHC based on the sampling made on immature stages in two places in south eastern dry zone of Karnataka. In the present study, the trap catches at four places indicated the occurrence of spatially segregated generations. In this study, the BHC population at Nelamangala underwent the life cycle early compared to the other three places. After Nelamangala, the moth emergence was recorded at Thyamagondlu and Nittur, overlapping with each other. The late moth emergence was recorded in Bidadi. This study clearly established that BHC populations are temporally and spatially segregated particularly with respect to moth emergence. These changes may be due to biotic/abiotic factors, considered to be the major factor affecting the life-cycle phenology of insects. But, definite reasons are not yet established. Based on the outcome of this study, it is recommended that the pheromone traps placement should not be universal or same for all the places. But initially traps should be installed based on only the visual observation on stage of the pest and in subsequent generations, the traps can be placed after 70-80 days after initial set up.

Conclusions

In the present study, precise monitoring of moth activity was demonstrated using pheromone traps. Apart from moth activity, the trap catches indirectly gave an idea of BHC population density and emergence pattern. Based on this information, there is a possibility of mass trapping of BHC males using pheromone traps, which can be implemented keeping in view of the following points. Verify the stage of the pest before installation of pheromone traps, Trap setting would be taken up during 6th larval and pupal stage of the pest and ensure that the traps and lure placement should be preceded by the moth emergence, Moth emergence will end within 40 days, with peak emergence of 20-25 days. During this time, the damaged and fully saturated traps with moths should be replaced with new traps, After moth emergence if the population persists, the traps should be serviced and/or replaced with new traps for targeting next generation, The lure should be replaced during initial stage of moth emergence so that it covers entire moth emergence period, The pheromone trap catches also give reliable information of when to release the larval parasitoids. Based on the trap catches it is inferred that the larval parasitoids like *Goniozusnephantidis* Muesbeck (Bethylidae: Hymenoptera) can be released during 60 days after trap set up or 20-25 days after end of moth emergence coinciding with last larval instars.

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