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SCOPE FOR MANAGING AGE-STRUCTURED POPULATIONS OF THE COCONUT BLACK HEADED CATERPILLAR, *Opisina arenosella* (Walker) USING SEX PHEROMONES

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ABSTRACT : The coconut black headed caterpillar, *Opisina arenosella* (Walker) (Lepidoptera: Oecophoridae), is a serious pest of coconut in India. Currently available options for managing this pest revolve mostly around artificial releases of natural enemies and insecticide treatments. In this paper, an attempt is made to elucidate scope for utilizing sex pheromones in pest management of any tropical multivoltine insect with discrete generations taking *O. arenosella* as a case study.

Key Words : Coconut black headed caterpillar, *Opisina arenosella*, pheromones

The coconut black headed caterpillar, *Opisina arenosella* (Walker) (Lepidoptera: Oecophoridae), is a menace for coconut cultivation in India (Rao *et al*., 1948) and Sri Lanka (Parera, 1987). The severity of the pest can be highlighted not by the fact that it can completely devastate a farmer during an outbreak, but also that it can take two years for a severely affected trees to realize original yields after the pest is eradicated from the orchard (Muralimohan and Srinivasa, 2008a). Currently available options for managing populations of this pest revolve mostly around artificial releases of natural enemies and insecticide treatments (Anonymous, 2003). These options target different developmental stages of the species; none aim at the adult stage. It is only recently that the phototropic behaviour of adults was proposed to be exploited through light trapping (Muralimohan *et al*., 2007). However, as light traps are less energy-friendly, and attract target as well as non-target species, their utility in pest management may be limited. Lately, chemical constituents of the sex pheromone released by females of the species have been artificially synthesized and tested (Anonymous, 2007). Sex pheromones are relatively environment friendly, and, if used intelligently, can be effective as a pest management tool. Therefore, we explore the options for integrating it into the scheme of pest management of the black headed caterpillar.

Several facets in the life cycle of *O. arenosella* provide valuable inputs for drawing a plan that integrates sex pheromones into the pest management scheme. Some of the important facets are: i) populations are spatially segregated (Muralimohan, 2006) and each segregated population follows discrete generation cycles (or, non-overlapping generations) (Parera *et al*., 1988; Muralimohan, 2006; Ramkumar *et al*., 2006); ii) the generation cycles are not synchronized across populations (Muralimohan, 2006; Ramkumar *et al*., 2006); iii) peak adult emergence period does not exceed 10–12 days in each generation (Muralimohan and Srinivasa, 2008b); iv) mean emergence time for males precedes females by 3 or 4 days in every generation (protandry) (Muralimohan and Srinivasa, 2008b); v) there is single mating among females and multiple mating among males (Ramkumar, 2002); and, vi) density of individuals within each population is very high (Ramkumar, 2002; Muralimohan and Srinivasa, 2008b). On the basis of the existing information on the life cycle of the insect, the possible approaches for exploiting sex pheromones have been logically explained in the following paragraphs. Incidentally, this would perhaps be the first attempt made to elucidate scope for utilizing sex pheromones in pest management of any tropical multivoltine insect with discrete generations.

Sex pheromones as tools of pest monitoring

Each discrete generation of *O. arenosella* lasts for 65 to 75 days (Ramkumar *et al*., 2006). Due to discrete generations, adults would be present for a fraction of the total time taken to complete a generation. Obviously, the same will be reflected in the pattern of catches if pheromone based traps for trapping moths, or simply pheromone traps, are operated continuously through the year; i.e., there will be alternating periods of 'moth' and 'no-moth' catches. *O. arenosella* has five generations per year (Ramkumar *et al*., 2006) and the moth period cumulated over a year does not generally exceed six months, which also means that there would not be any catch during the remaining period. In addition, populations are spatially segregated and the probability for any two segregated populations to be in the same stage of development may not be different from random (Muralimohan, 2006). This asynchrony would make it impossible to generalize trap setting dates (expecting adult catches) across populations. It would lead to a situation where farmers may have to scrutinize the developmental stage of the population before setting pheromone traps for managing populations of *O. arenosella*. As opposed to the area-centric approach that is commonly advocated by pest managers, this situation calls for a more farmer-centric approach where farmers affected by the same population should examine the developmental stage of the pest and set up traps independent of farmers affected by a different population of *O. arenosella* – a challenging proposition for pest managers.

Occurrence of discrete generations influences timing of all management options. From this context it is obvious that the developmental stages of the population are to be carefully monitored before scheduling any management option. However, as mentioned earlier, this would call for sampling and identification of the correct developmental stages at the level of the farmers. Instead, if pheromone traps could be utilized for monitoring the activity of adults, a schedule of different management options can be advocated to the farmers kick-starting at the beginning of the adult activity (as indicated by catches in the pheromone traps; Table 1). Here, sex pheromones can play a crucial role as a monitoring option. Obtaining an idea on the density of the population is the other obvious benefit from monitoring.

Sex pheromones for directly reducing pest populations

It would be both interesting and essential to scrutinize the new tool from the perspective of the adult emergence pattern and reproductive biology, especially because of the alternating moth and no-moth periods. If the tool is being utilized only for monitoring the moth activity period, then such a scrutiny might not be very essential; it would be indispensable if the tool is

Table 1. A hypothetical pest management plan, starting from the day when the first moth has been trapped in a pheromone trap. This plan is to show that there is scope for using sex pheromones in pest management of *O. arenosella*; it is 'not' a recommendation for adoption by pest managers

Day 1*	First catch in the pheromone trap
From day 7 to 20**	Mate disruption using sex pheromones
Between day 27 and 30	Insecticide application
Between day 45 and 50	Release of late-larval parasitoids
Between day 55 and 60	Release of pupal parasitoids

[*if pheromone traps are used for monitoring; **it is a suggestion made in this paper]

applied to influence the population size of *O. arenosella* through mass trapping of male moths. The primary concern is about time that is available for the traps to catch potential males. Although adults (males and females together) emerge little over 30 successive days in a generation, the peak emergence, constituting ~90% of the moths, lasts for 10–12 days around the mean emergence time (Muralimohan and Srinivasa, 2008b). As populations are protandrous (Muralimohan and Srinivasa, 2008b), the actual time available for the traps to catch potential males will be lesser than 10 days per generation. It must also be noted that during a moderate infestation, as many as 1000 moths per palm can be expected to be active (Muralimohan *et al.*, 2008), which suggests that population densities are generally very high. The reproductive biology of *O. arenosella* throws further challenges because both sexes are completely capable of mating on the night of emergence (Ramkumar, 2002; Ramkumar *et al.*, 2001) which decreases the probability of trapping an unmated male. Females are monandrous (mate singly to lay her full component of eggs) while males are capable of multiple mating (Ramkumar, 2002). In this situation, the benefits from trapping an unmated male can be expected to be low. When all these facts are put together it appears that the new tool will be truly tested by 1) the huge population of mate-ready *O. arenosella* moths that explode on to the scene; 2) low probability of trapping an unmated male; and 3) a lower benefit associated with trapping an unmated male. This tool appears to have a limited scope for causing an impact on the population size through mass-trapping of males.

However, it appears that sex pheromones can directly contribute towards downsizing populations of *O. arenosella* if they are used for disrupting natural mating. It is commonsensical that the concentration of pheromones produced per female would be relatively low when the population density is high, individuals within a population are synchronized and appear for a short time, and females are monandrous. It has been confirmed through personal communication with Bio-Control Research Laboratories, Bangalore (who have synthesized the pheromone) (Anonymous, 2007) that the quantum of sex pheromone produced per female *O. arenosella* is considerably low. Therefore, any attempt to increase concentration of pheromones in the air could confuse males and disrupt mating. In fact, appearance of moths in short bursts of time would only assist the strategy. Further, it has been shown that delayed mating, even by a day, can significantly reduce fecundity in females (Ramkumar *et al.*, 2001) which supports adoption of pheromones for mate disruption. Another factor that might play a significant role is that moths mate during the period between dusk and midnight (Muralimohan and Srinivasa, 2008b). Therefore, releasing synthetic pheromones in the late evening during peak adult periods might be useful. On the whole, it appears that there is a considerable scope for utilizing sex pheromones for regulating populations of the coconut black headed caterpillar. However, systematic studies based on the life cycle of the insect only can justify all the theory.

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