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Light trap - induced suppression of coconut slug caterpillar, *Macroplectra nararia* Moore menace in East Coast of India

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Coconut (*Cocos nucifera* L.) is a versatile palm in India and primarily confined to the four southern states accounting 90 % of the area. Andhra Pradesh occupies about 1.05 lakh ha with a production of 12,264 lakh nuts (Mathew, 2011).One of the major factors limiting production and productivity in coconut is the infestation by pests. Among different caterpillar pests that feed on coconut leaves, the slug caterpillar, *Macroplectra nararia* Moore (Limacodidae:Lepidoptera) causes sporadic and gradient out break during summer months. Presence of long hairs and tubercles on the dorsal and lateral sides of the caterpillar causes intense irritation to human skin.

The early instar caterpillar feeds from under surface of the leaflets by scraping the surface tissues giving a glistening appearance on the feeding areas. The later instar caterpillar devours lamina leaving only the midrib. Scorched / burnt appearance of leaves is the characteristic symptom observed in the field on severe infestation. When larval population is high, green petioles, spathes and nuts are also damaged in addition to leaves (Fig.1). In case of out breaks, all the functional leaves get dried up leaving only the spindle leaves, which results in pre-mature drooping of leaves and shedding of nuts, delayed spathe emergence and reduction in yield (Sujatha *et al.,* 2008; Rajan *et al.,* 2011*).* The pest causes damage even to intercrops like banana/cocoa and surrounding hedge plants like *Pithecellobium dulce* (Roxb. Benth), agave, weed plants *etc.* Out break of slug caterpillar in East Godavari district of Andhra Pradesh was reported in coconut by Sujatha *et al.* (2008) and in oil palm from West Godavari district of Andhra Pradesh by Kalidas (2002).

Positive phototactic phenomenon of certain lepidopteran moths was well exploited in pest monitoring, mass trapping and destruction due to economical feasibility and easiness in pest control. In order to test this strategy in the coconut slug caterpillar, present field investigations were undertaken with different light sources (incandescent lamps, Compact fluorescent lamps and gas lights) and trapping methods (water pan, window bucket with water and yellow sticky trap) in the slug infested coconut gardens of East Godavari district of Andhra Pradesh in the months of May and June, 2009.

The present studies were carried out in severely slug caterpillar infested coconut plantation (two acres each) in four villages *viz.*, Sakinetipalli, Nagullanka, Ganti and Gondi of East Godavari district of Andhra Pradesh during May and June, 2009. Three kinds of light sources i.e., incandescent lamps, Compact fluorescent lamps (CFL) and gas lights with three trapping arrangements i.e., water pan on the ground, window bucket with water below the light and yellow sticky trap

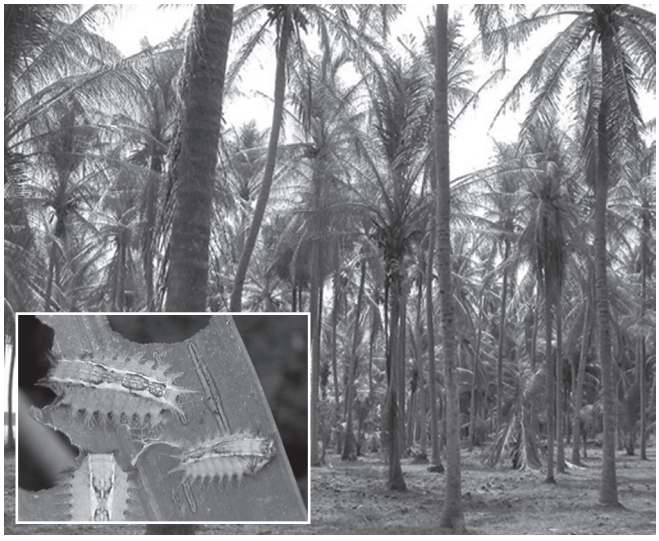

Fig. 1. Slug caterpillar infested coconut garden (Inset: Coconut slug cater pillar)

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on the ground below the light source were used. The lights are arranged in two different heights i.e., 45 cm above the ground level and another one at 120cm above the ground level whereas gas lights are arranged in the water pan itself. Light sources and trapping methods used in the studies are given below:

I. 500 W incandescent lamp arranged at 45 cm above the ground level and water pan

II. i) 8 W Compact fluorescent lamp arranged at 45 cm above the ground level and water pan

ii) 8 W Compact fluorescent lamp with window bucket with water at 120 cm above the ground level

iii) 14 W Compact fluorescent lamp at 45 cm above the ground level and sticky trap

iv) 14 W Compact fluorescent lamp with window bucket with water arranged at 120 cm above the ground level

III. i) 18 W Compact fluorescent lamp arranged at 45 cm above the ground and water pan

ii) 18 W Compact fluorescent lamp with window bucket with water at 120 cm above the ground level

iii) 18 W Compact fluorescent lamp at 45 cm above the ground and sticky trap

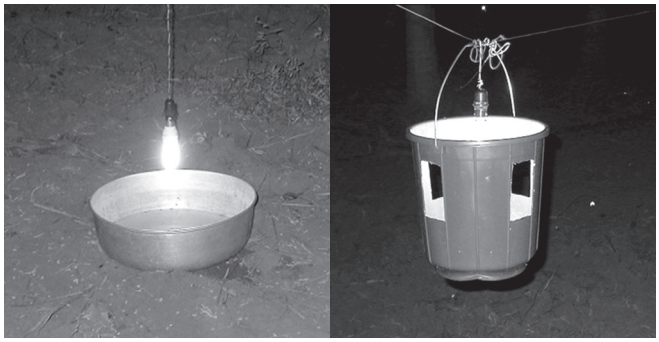
iv) 100 W incandescent lamp arranged at 45 cm above the ground level and water pan

v) 100 W incandescent lamp with window bucket and water arranged at 120 cm above the ground level

vi) 100 W incandescent lamp arranged at 45 cm above the ground level and sticky trap

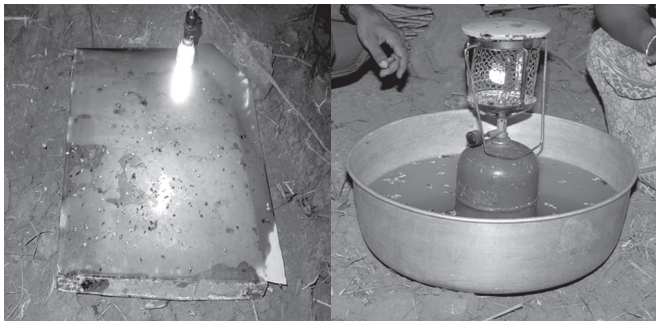
IV. Gas light placed in water pan.

The light sources *viz.*, incandescent lamps (100 W and 500 W) and Compact fluorescent lamps (8W, 14W and 18 W) were held independently over the water pan, yellow sticky traps and window bucket (Fig.2). Generator (3 KV) was the source of electricity for illuminating the lamps. Observations were recorded through out the night from 17.00 h to 05.00 h at hourly intervals for ten consecutive nights and number of moths captured per trap per hour and peak trapping h in the night were recorded. Average of moths trapped in 10 nights per light per night in different light sources, different methods of trapping, peak time of moth trapping, sex ratio of moths attracted *etc.*, were arrived by compiling the data and presented.



Compact fluorescent lamp arranged at 45 cm above the ground level and water pan

Incandescent lamp with window bucket with water arranged at 120 cm above the ground level



Compact fluorescent lamp at 45 cm above the ground level and yellow sticky trap

Gas light placed in water pan

Fig.2. Various lights and trapping methods

The observations from 17.00 h to 05.00 h revealed that the slug caterpillar moths were not trapped from 17.00 to 19.00 h. The moth's attraction towards the light source was started from 19.00 h onwards and attained peak in between 21.00 to 24.00 h and gradually the moth catch ceased by 03.00 h (Table1). It was found that, in a night the moth activity extended for 8 h *i.e.*, from 19.00 h to 3.00 h with peak attraction period of 3 h at all the light sources used. It is also observed that both the male and female moths were attracted to all the light sources. It is note worthy that, Philippines Coconut Authority (Anon., 2003) found placement of gas operated light trap over a basin of water from 6.00 pm to 8.00 pm @ 2 /ha to be effective in killing adult moths which is redolent of present investigation. Moth activity was observed only after dusk *i.e.*, 19.00 h in the gardens even though light traps were arranged by 17.00 h confirming the fact that moths did not respond to light source before dusk.

Among the various incandescent lamps installed for the capturing of the adult moths, the 500 W lamps and water pan recorded the highest catch of 685 moths/ night followed by 100 W lamps and water pan (490.9 moths/night) and 100 W lamps and yellow sticky

Table 1. Light trap studies against coconut slug caterpillar – peak time of moth attraction

Particulars of light	Time of observation (in h)/no. of moths attracted/hour											
	17.00 to 18.00	18.00 to 19.00	19.00 to 20.00	20.00 to 21.00	21.00 to 22.00	22.00 to 23.00	23.00 to 24.00	24.00 to 01.00	01.00 to 02.00	02.00 to 03.00	03.00 to 04.00	04.00 to 05.00
100 W Incandescent lamp	—	—	21.6	18.7	30.5	37.6	66.4	45.0	33.5	32.6	—	—
500 W Incandescent lamp	—	—	87.0	21.0	42.0	221	251	63.0	—	—	—	—
8 W Compact fluorescent lamp	—	—	—	6.0	10.5	17.8	23.3	33.8	9.0	2.0	—	—
14 W Compact fluorescent lamp	—	—	—	18.5	34.0	27.3	39.5	18.0	25.5	—	—	—
18 W Compact fluorescent lamp	—	—	—	26.3	22.3	36.0	69.5	26.3	3.0	—	—	—
Gas light	—	—	—	18.6	15.3	26.0	25.0	—	—	—	—	—

trap (245 moths/night), whereas, minimum number of moths were recorded in 100 W lamp and window bucket with water (122.5 moths/night) (Table 2). In case of Compact fluorescent lamps tested for trapping the adult moths, the 18 W Compact fluorescent lamp with yellow sticky trap recorded the maximum catch of 293.5 moths/night followed by 18 W Compact fluorescent lamps with water pan (276.5 moths/night) and 18 W Compact fluorescent lamp with window bucket with water recorded lowest no of moths (89.0 moths/night). Gas light with water pan recorded minimum number of 83 moths/night (Table3) among the three light sources used *i.e.*, incandescent lamps, Compact fluorescent lamps and gas lights. The study revealed that incandescent source of light (500 W capacities) was the best for attracting more no. of moths. The above observation clearly indicates

Table 2. Number of moths attracted to different incandescent lamps

Type of light used	Type of trap used	Height of the bulb from ground level (cm)	Time of observation (in h)												Total
			17.00 to 18.00	18.00 to 19.00	19.00 to 20.00	20.00 to 21.00	21.00 to 22.00	22.00 to 23.00	23.00 to 24.00	24.00 to 01.00	01.00 to 02.00	02.00 to 03.00	03.00 to 04.00	04.00 to 05.00	
500 W Incandescent lamp	Water pan	45	—	—	87.0	21.0	42.0	221.0	251.0	63.0	—	—	—	—	685.0
100 W Incandescent lamp	Water pan	45	—	—	55.1	26.6	28.9	48.5	73.3	80.0	79.5	98.0	—	—	490.9
100 W Incandescent lamp	Window bucket + Water	120	—	—	—	19.5	24.5	21.5	34.0	23.0	—	—	—	—	122.5
100 W Incandescent lamp	Yellow sticky trap	45	—	—	10.0	10.0	37.0	43.0	92.0	32.0	21.0	—	—	—	245.0

Table 3. Number of moths attracted to different sources of light

Type of light used	Type of trap used	Height of the bulb from ground level (cm)	Time of observation (in h)												Total
			17.00 to 18.00	18.00 to 19.00	19.00 to 20.00	20.00 to 21.00	21.00 to 22.00	22.00 to 23.00	23.00 to 24.00	24.00 to 01.00	01.00 to 02.00	02.00 to 03.00	03.00 to 04.00	04.00 to 05.00	
8 W Compact fluorescent lamp	Water pan	45	—	—	—	—	7.0	11.0	25.0	46.0	8.0	—	—	—	97.0
8 W Compact fluorescent lamps	Window bucket + Water	120	—	—	—	12.0	14.0	24.5	21.5	21.5	10.0	4.0	—	—	107.4
14 W Compact fluorescent lamps	Yellow sticky trap	45	—	—	—	19.0	49.0	44.0	54.0	22.0	43.0	—	—	—	231.0
14 W Compact fluorescent lamps	Window bucket + Water	120	—	—	—	18.0	19.0	10.5	25.0	14.0	8.0	—	—	—	94.5
18 W Compact fluorescent lamps	Water pan	45	—	—	—	52.5	31.5	35	114	43.5	—	—	—	—	276.5
18W Compact fluorescent lamps	Window bucket + Water	120	—	—	—	—	11.0	37.0	25.0	10.0	6.0	—	—	—	89.0
18 W Compact fluorescent lamps	Yellow sticky trap	45	—	—	24.0	17.0	47.0	90.0	60.5	27.0	28.0	—	—	—	293.5
Gas light	Placed in water pan	30	—	—	—	18.6	15.3	26.0	25.0	—	—	—	—	—	83.0

that, intensity of light source plays a key role in attracting the moths.

When different capacities of the incandescent and Compact fluorescent lamp with water pan trapping method were observed, incandescent lamp with highest wattage *i.e.*, (500 W) was found effective in attracting more number of moths (500 W – 685 moths) followed by 100 W capacity (490.9 moths) than that of Compact fluorescent lamp (18 W – 276.5 moths; 8 W – 97 moths). Within the incandescent and Compact fluorescent lamp sources, higher number of moths were attracted to high capacity lamp (Fig.3).

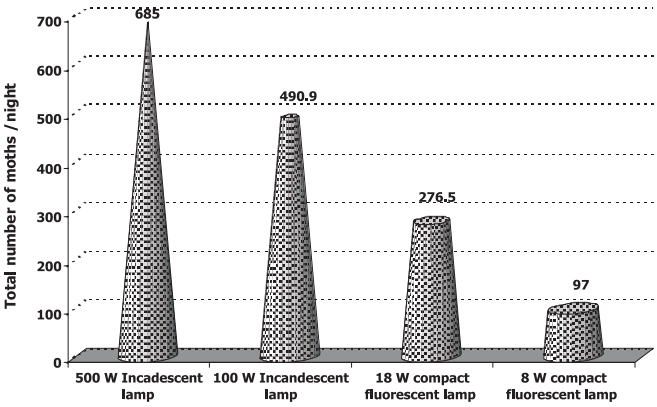


Fig.3. Light trap studies against coconut slug caterpillar – different capacities of lamp and water pan trapping method

These observations indicate that the incandescent bulbs are better than Compact fluorescent lamp and also high capacity lamps are better than that of the low capacity lamps. The 500 W Incandescent lamp is 1.40 times more efficient than the 100 W incandescent lamp, whereas, the 18 W Compact fluorescent lamp is 2.85 times more efficient than the 8 W Compact fluorescent lamp.

Among the various light sources with different methods evaluated for the mass capturing of the adult moths, the highest catch was recorded with light sources with water pan (incandescent + Compact fluorescent lamps: 767.4 moths/night) followed by yellow sticky trap (incandescent + Compact fluorescent lamps:538.5 moths/night) and the lowest was recorded in window bucket with water (incandescent + Compact fluorescent lamps: 211.5 moths/night) (Fig.4). Water pan on the ground below the light source was proved as the best method (Fig.5) by catching more number of moths followed by yellow sticky trap below the light source. Similar type of trapping method but with gas operated light was suggested by Crop Protection Division of Davao Research Centre, Agricultural Research and Development

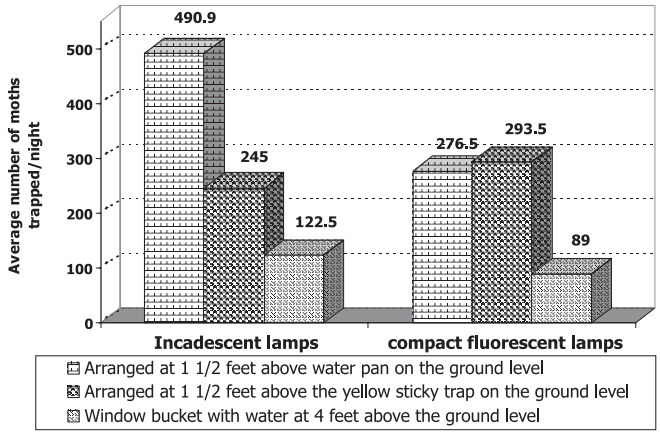


Fig.4. Light trap studies against coconut slug caterpillar – different methods of trapping

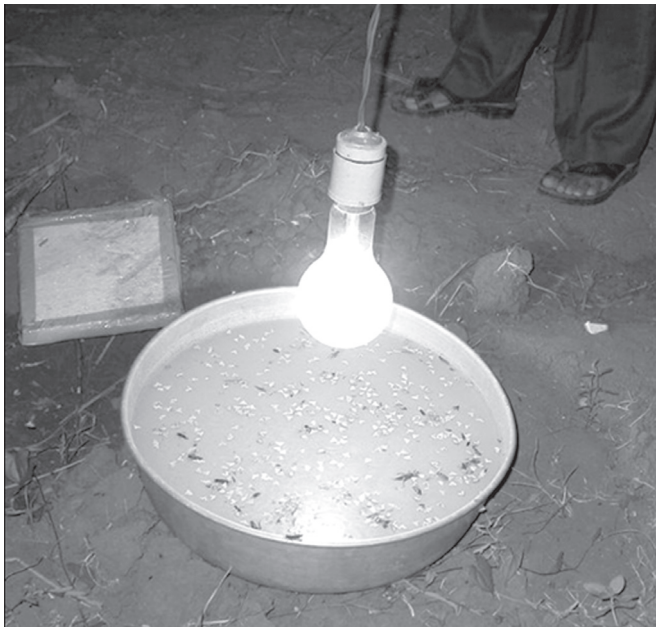


Fig.5.Highest catch of slug caterpillar moths with 500 W incandescent lamp

Branch, Philippine Coconut Authority for effective catching and destruction of coconut slug caterpillar (*Penthocrates* sp.*)*,which strongly supports the present investigation.

When the sex ratio of attracted moths in different methods of trapping was observed, both the male and female moths were attracted to all the light sources. More number of female (gravid female) moths were (sex ratio male to female - 1: 2.95) were recorded in case of 18 W Compact fluorescent lamp, 45 cm above the ground level with yellow sticky trap, when compared to that of 500 W and 100 W incandescent lamp and water pan (Table 4). This finding may be an indicative to state that yellow sticky trap attracts more female moths. Attraction of gravid females to yellow sticky trap may also be an indicative that yellow colour triggers egg laying of moths

Table 4. Light trap studies against coconut slug caterpillar – sex ratio of trapped moths

Particulars of light source	Trapping method	Moths trapped			Sex ratio [Male : Female]
		Male	Female	Total	
500 W Incandescent lamp	lamp at 45 cm height with water pan	474	211	685	1 : 0.45
100 W Incandescent lamp	lamp at 45 cm height with water pan	42	35	77	1 : 0.83
18 W Compact fluorescent lamp	lamp at 45 cm height with yellow sticky trap	22	65	87	1 : 2.95
Total		**538**	**311**	**849**	**1 : 0.58**

or gravid females are attracted towards yellow colour for egg laying.

Present studies also revealed that the number of moths attracted to light source are dependent on the moth population existing in that particular location and also damage intensity. Higher is the population (5 - 40 caterpillars/leaflet), higher is the damage (30-90 %), which in turn reflected in the trapping trends (65-685moths/night) (Table 5).

Table 5. Light trap studies against coconut slug caterpillar – intensity of pest population versus number of moths attracted

Location of the garden	Particulars of light	Intensity of pest [%]	Average number of moths / night (Avg.-10 nights)
Garden-I [Sakinetipalli]	500 W Incandescent lamp	90 (20-40 caterpillars/leaflet)	685
Garden-II [Ganti]	500 W Incandescent lamp	30 (5-15 caterpillars/leaflet)	65
Garden-III [Nagullanka]	500 W Incandescent lamp	40 (10-20 caterpillars/leaflet)	75

Insects during their flight at night rely on the light of the moon and other distant light sources in order to navigate through the darkness. The positive phototaxis is the primary reason that insects are attracted to artificial lights. The presence of photo taxis in coconut slug caterpillar, *M. nararia* was well proved by the present investigation. The trapping of slug caterpillar moths was higher in the Incandescent lamps over the Compact fluorescent lamps as the 500 W Incandescent lamps with water pan (685 moths/night) which was 2.34, 2.48, 6.37, 7.06 times more effective than the 18 W Compact fluorescent lamp + sticky trap, 18 W Compact fluorescent lamp + window bucket trap, 8 W Compact fluorescent lamp + window bucket trap and 18 W Compact fluorescent lamp + water pan respectively, indicating that attraction increased with increase of wattage. The Incandescent lamps convert only 10% of the electricity they use into light and convert the remaining 90 % into heat, whereas the Compact fluorescent lamps produce the same amount of light as an incandescent lamp but require only 20 % of the power because less energy is wasted in heat. Through the present investigation i.e., attraction of more number of moths with incandescent bulb in which 90% of electricity was converted into heat, it can be expected that moths are more attractive to the light with heat generation which needs further studies to confirm this fact. Kavaliers and Macvean (1980) reported action spectra for negative phototaxis of the larvae of wax moth, whereas, Preiss and Kramer (1984) found that moths are more sensitive to some wavelength of light. Similarly Jacas *et al.* (1990) established that orange light 610 nm was most preferred by *Opius concolor* adults followed by bluish-green 494 nm and red 678 nm. Jayanthi and Verghese (2009) recommended the light traps as an important IPM tool against the sapota seed borer, *Trymalitis margarias.*

By exploiting the positive phototaxis; attraction and destruction of slug caterpillar moths through light source is a key information brought out from the present investigation, which can also be employed as a tool for monitoring and a part of integrated pest management. The incorporation of mass capturing of coconut slug caterpillar moths through light traps in IPM would be an easy and economical method of pest management. Further studies regarding different colours of light, number of lights required for unit area, height of arrangement, different sources of power for illuminating lights, *etc.*, are to be conducted to refine the present method for effective implementation.

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