Mysore J. Agric. Sci., 57 (4) : 311-319 (2023)

Efficiency of Two Different Light Traps in Attracting Different Functional Groups in an Organic Farming System

N. Shreya[1], Vidya Mulimani[2], N. Sumithramma[3] and A. R. V. Kumar[4]
[1]Department of Entomology, Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga - 577 412, [2,3&4]Department of Entomology, College of Agriculture, UAS, GKVK, Bengaluru - 560 065
e-Mail : vidyamulimani34@gmail.com

Authors Contribution

N. Shreya : Conceptualization, investigation and data analysis;
Vidya Mulimani & N. Sumithramma : Supervision and evaluation;
A. R. V. Kumar : Editing

Corresponding Author :
Vidya Mulimani
Department of Entomology, College of Agriculture,
UAS, GKVK, Bengaluru

Received : July 2023
Accepted : August 2023

Abstract

A study on comparison of two different light traps in an organic farming system was conducted in J-block of GKVK campus maintained by Research Institute on Organic Farming (RIOF), University of Agricultural Sciences, Bengaluru, Karnataka for understanding the proportion of pest and non-pest species of insects caught in a Solar light trap and an electric White LED light trap, by evaluating the various ecological functional groups of trapped insects. The experiment was conducted in the organic farm, University of Agricultural Sciences, GKVK, Bengaluru, India. The study was conducted over a period of 7 months from February 2022 to August 2022 in 14 days interval. The two traps were placed at a distance of 700 meters and run simultaneously for 12 hours from 6:45 PM to 6:45 AM. The trapped insects were categorized based on their feeding habits and taxonomic affiliations *viz*., herbivores, predators, parasitoids, scavengers, mycophages, pollinators and medically and veterinary important insects. A total of 4713 insects were trapped in Solar light trap among which, predators recorded 64 per cent, scavengers 27 per cent and herbivores 8 per cent. The White LED light trap caught 2795 insects in total, which included, predators 42 per cent, herbivores 28 per cent, scavengers 28 per cent and pollinators 1.14 per cent. In Solar light trap as well as White LED trap, greater proportion of non-herbivores (92% and 72% respectively) were trapped compared to herbivores (8% and 28% respectively). These results thus suggest potential harm to the local beneficial fauna and a consequent damage to the balanced agro-ecology. In this context, deployment of any type of light trap for the sole purpose of pest management is not a tenable option.

Keywords : Light traps, Solar light traps, Functional groups, Herbivores, Predators, Parasitoids, Scavengers, Mycophages, Pollinators

Pest is an organism that causes economic loss in agriculture. Insect pests are one of the reasons for reduced crop production and economic loss *i.e*, in agriculture as well as animal husbandry. Despite the fact that complete eradication of pest is impossible, we can control or manage them, which is called pest management. The term 'integrated pest management' (IPM) refers to a strategy in which different techniques, such as cultural, mechanical, biological and chemical treatments are combined or integrated in a harmonious way so that they cause least harm to the ecosystem. Mechanical methods include collection and destruction of caterpillars, covering fruits with bags, use of pheromone traps etc. In addition, light traps are employed by the farmers in agriculture to manage pests (Lalasangi, 1988 & Matata *et al.,* 2017). Pheromone traps are suggested for pest management in agriculture since they are species-specific. Light traps, however, do not distinguish between pestiferous and non-pestiferous species. As a result, light trap has not been recommended as a stand-alone method in IPM. However, light traps are one of the useful tools in IPM, but they should not be employed as control agents, but can be used for monitoring abundance of pests, as an early warning system and to determine the Economic Threshold Level (ETL) (Baehaki *et al.,* 2017). Ma and Ma (2012) suggested that light trap can catch many harmless non-pest or beneficial insects, there is a need to use them cautiously. Various sources of light such as mercury vapour, fluorescent, incandescent, black light are used in light traps. These sources vary in their ability to catch different kinds of insects of different ecological functional groups depending on the range of wavelength they emit and intensity of light (Ramamurthy *et al*., 2010 and Southwood and Henderson, 2000). Solar light trap is currently popular among the farmers of Karnataka with LED's using solar power. Farmers use light traps without realizing their limitations. Farmers are unable to distinguish between beneficial, harmful insect species, pestiferous and non-pestiferous ones. They get excited whenever they see large number of insects caught in the trap, thinking that all the trapped insects are pestiferous. As a result, Solar light trap has become famous among farmers. This is the present status of light trap in Karnataka. Solar light traps are widely used in pest management because they are believed to be ecologically less harmful. However, little is known about their impact on the non-target organisms. In the light of these observations, there is a need for understanding the insects caught in the light traps and their ecological functional groups. Therefore, this study was initiated to understand the proportion of insects caught in Solar light trap, performing different ecological functions, including pest species. Two kinds of traps using different sources of energy, solar and AC electric power emitting different wavelengths were compared in terms of their efficiency in attracting different functional groups.

MATERIAL AND METHODS

The experiment was conducted in the organic farm in J-block of GKVK campus maintained by Research Institute on Organic Farming (RIOF), University of Agricultural Sciences, Bengaluru, Karnataka, India. It falls under the eastern dry zone of Agro-climatic zones of Karnataka, with latitude 13° 05'' N, longitude 77° 34'' E and at an altitude of 928 meters above the mean sea level. Laboratory observations were carried out at the Department of Entomology, University of Agricultural Sciences, Gandhi Krishi Vignana Kendra, Bengaluru, Karnataka. Average rainfall and temperature during the study period was 132.66 mm and 29.69 °C, respectively.

Design of the Light Traps

Two light traps were selected for the studies *viz*., a Solar light trap and regular white LED light trap. The Solar light trap consisted of a solar panel to absorb sunlight; an electronic circuitry to convert solar to electric power; battery to store electric energy; bulb (5 Watt LED) that emits blue light (370-390 nm); plastic bucket fitted below the bulb on a ring fixed on the stand; baffle fitted around the bulb, which serves as interception; one-meter stand to hold solar panel and the ring and the bulb. Attracted insects die after falling into the plastic bucket containing insecticide. White LED light trap of modified Robinson model consisted of an LED bulb surro unded by baffles; plastic bucket fitted below; the plastic bucket contained insecticide to kill the trapped insects .

Light Trap Installation

The traps were placed at a distance of 700 meters and run simultaneously at 14 days interval. Each time, the traps were run for 12 hours *i.e.,* 6:45 PM to 6:45 AM. As far as possible, sampling was avoided on heavy rainy days but was done on the immediate following dry days.

Insects attracted to light were collected in a collection chamber placed at the bottom of the trap. A cotton swab dipped in insecticide was put in the light trap collection chamber to anesthetize the insects. The insects were removed from the collection chamber in the early morning and the specimens were air dried under mercury vapour lamp.

Processing of Insects

Insects were sorted out based on their morphological features in to Operational Taxonomic Units (OTUs). Collected insects were identified up to the family level by following Johnson and Triplehorn (2004). Within each family, OTUs were separated based on morphological differences. These OTUs were considered as species. The data was utilized to tabu late different orders and families. Insects were classified into functional groups based on taxonomic affiliation for each of the OTUs caught in the two traps and used in analyses to determine their diversity and abundance over a period of seven months (Table 1).

Data Analysis

Species richness, Simpson index and Shannon-Weiner index of diversity were estimated to ascertain the number of species present and their evenness. Species richness measures the number of species present in an area. Simpson index takes into account the variance of the species abundance and distribution. It can be calculated by formula,

$$D = 1 - \left(\sum n(n-1)\right) / N(N-1)$$

Where,

D = Simpson Index

n = Total number of organisms of a particular species

N = Total number of organisms of all species

Shannon-Weiner index of diversity accounts for both abundance and evenness of the species present in an ecosystem. It can be represented by the formula,

$$H' = -\sum P_i \ln p_i$$

Where,

H'= Shannon Weiner index

p_i = Proportion of individuals of species *i*.

$\ln p_i$ = Natural logarithm to base e of p_i

Margalef's (1950) diversity index is a species diversity index to compensate for the effects of sample size by dividing the number of species in a sample by the natural log of the number of organisms collected and is worked out using formula,

$$D_{mg} = S\text{-}1/ \ln N$$

Where,

D_{mg} = Margalef's diversity index

S = Number of genera recorded

N = Total number of individuals in the sample

ln = Natural logarithm.

Rank Test for Comparing Two Traps was done using Wilcoxon Signed-Rank Test

The Wilcoxon Matched-Pairs Signed Ranks Test is used to compare two related samples, matched samples or to conduct a paired difference test of repeated measurements on a single sample to assess whether their populations mean ranks differ. It is a nonparametric test and this test doesn't assume normality and used to test the ordering of the data and is worked out using formula,

Wilcoxon value (z) = (T- SD) / Mean

Where,

Mean = [N (N+1)] /4

Standard deviation (SD) = $\sqrt{[\{N (N + 1) (2N + 1)\} /24]}$

z = Wilcoxon value

T= Sum of like signed ranks

N= Number of samples

Results and Discussion

A total of 4713 insects were trapped in Solar light trap, whereas the White LED light trap caught 2795 insects over the period of 7 months. The trapped insects were classified into 7 groups *viz.,* herbivores, predators, parasitoids, scavengers, mycophages, pollinators and medically and veterinary important insects (Table 1).

Light traps found to attract not only pestiferous insects, but also beneficial insects like predators and parasitoids. The Solar light trap caught 5 functional

TABLE 1

Functional groups of insects caught in Solar light trap and LED light trap

Ecological functional groups	Order	Solar light trap Family	Solar light trap No. of individuals	LED light trap Family	LED light trap No. of individuals
Herbivores	Coleoptera	Chrysomelidae	17	Chrysomelidae	8
		Elateridae	98	Elateridae	31
		Tenebrionidae	8	Tenebrionidae	11
		Scarabaeidae	37	Scarabaeidae	33
		Curculionidae	8	Curculionidae	36
		Bostrichidae	2	Phalacridae	8
		Silvanidae	6	Brentidae	2
		Erotylidae	2		
		Phalacridae	2		
		Sub total	**180**		**129**
	Hemiptera	Miridae	38	Miridae	181
		Delphacidae	7	Delphacidae	124
		Cydnidae	106	Cydnidae	42
		Cicadellidae	12	Cicadellidae	179
		Rhyparochromidae	15	Rhyparochromidae	21
		Pentatomidae	1	Pentatomidae	8
		Coreidae	2	Meenoplidae	8
		Meenoplidae	2	Psyllidae	4
		Gryllidae	5	Lygaeidae	14
				Tingidae	4
				Alydidae	1
				Derbidae	1
				Achilidae	1
		Sub total	**188**		**588**
	Orthoptera	Acrididae	-	Acrididae	10
		Sub total	**-**		**10**
	Hymenoptera	Formicidae	-	Formicidae	8
		Sub total	**-**		**8**
	Lepidoptera	Pyralidae	14	Pyralidae	12
		Erebidae	9	Erebidae	8
				Geometridae	1
		Sub total	**23**		**21**
	Diptera	Agromyzidae	-	Agromyzidae	8
		Muscidae		Muscidae	16
		Sub total			**24**
		Total	**391 (8%)**		**780 (28%)**

Table 1 Contd...

Ecological functional groups	Order	Solar light trap		LED light trap	
		Family	No. of individuals	Family	No. of individuals
Predators	Coleoptera	Dytiscidae	325	Dytiscidae	3
		Carabidae	117	Carabidae	3
		Staphylinidae	2013	Staphylinidae	192
		Anthicidae	7	Cybocephalidae	2
		Cybocephalidae	4	Lampyridae	7
		Sub total	**2466**		**207**
	Hemiptera	Miridae	3	Miridae	82
		Veliidae	4	Veliidae	2
		Notonectidae	1	Notonectidae	18
		Reduviidae	3	Reduviidae	10
		Mesoveliidae	1	Corixidae	37
		Naucoridae	1	Nabidae	2
		Corixidae	264		
		Sub total	**277**		**151**
	Dermaptera		22		10
		Subtotal	22		10
	Neuroptera	Hemerobiidae	1	Hemerobiidae	2
		Mantispidae	-	Mantispidae	1
		Sub total	**1**		**3**
	Mantodea		1		-
		Sub total	**1**		**0**
	Hymenoptera	Formicidae	203		792
		Sub total	**203**		**792**
	Diptera	Ephydridae	47		-
		Certopogonidae	-		7
		Sub total	**47**		**7**
		Total	**3017 (64%)**		**1170 (42%)**
Parasitoids	Hymenoptera	Scelionidae	1	Mutillidae	2
		Sub total	**1**		**2**
	Diptera	Tachinidae	-		17
		Sub total	**0**		**17**
		Total	**1 (0.02%)**		**19 (1.00%)**
Scavengers	Coleoptera	Heteroceridae	279	Scarabaeidae	197
		Scarabaeidae	251	Hybosoridae	100
		Hybosoridae	19	Lycidae	2

Table 1 Contd...

Ecological functional groups	Order	Solar light trap		LED light trap	
		Family	No. of individuals	Family	No. of individuals
		Hydrophylidae	17		
		Sub total	**566**		**299**
	Blattodea	Blattidae	2		6
		Termitidae	169		408
		Sub total	**171**		**414**
	Trichoptera		427		3
		Sub total	**427**		**3**
	Diptera	Chironomidae	130	Chironomidae	40
				Celyphidae	2
				Bibionidae	13
				Neriidae	1
				Calliphoridae	9
				Platystomatidae	4
				Stratiomyidae	1
				Heleomyzidae	3
		Sub total	**130**		**73**
	Collembola	Entomobryidae	1		-
		Sub total	**1**		**0**
		Total	**1295 (27.00%)**		**789 (28.00%)**
Mycophages	Coleoptera	Endomychidae	6		-
		Coccinellidae	3		1
		Sub total	**9**		**1**
		Total	**9 (0.09%)**		**1 (0.04%)**
Medically important	Diptera	Tabanidae	-		2
		Culicidae	-		2
		Sub total	**0**		**4 (0.14%)**
Pollinators	Diptera	Anthomyiidae	-		5
		Syrphidae	-		1
		Sub total	**0**		**6**
	Hymenoptera	Apidae	-		26
		Sub total	**0**		**26**
		Total	**0**		**32**
		Grand total	**4713**		**2795**

groups *i.e.,* herbivores (8%), predators (64%), parasitoids (0.02%), scavengers (27%) and mycophages (0.19 %) (Fig. 1), whereas, the White LED had caught 7 functional groups *viz.*, herbivores (28%), predators (42%), parasitoid (1%), scavengers (28%), mycophages (0.04%), pollinators (1.14%) and medically important insects (0.14%) (Fig. 2).

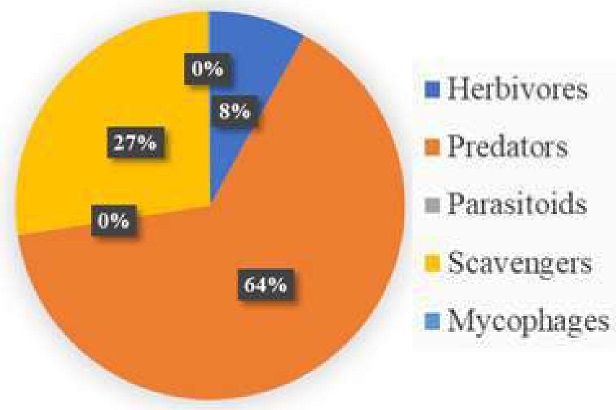

Fig. 1 : Functional groups of insects caught in Solar light trap

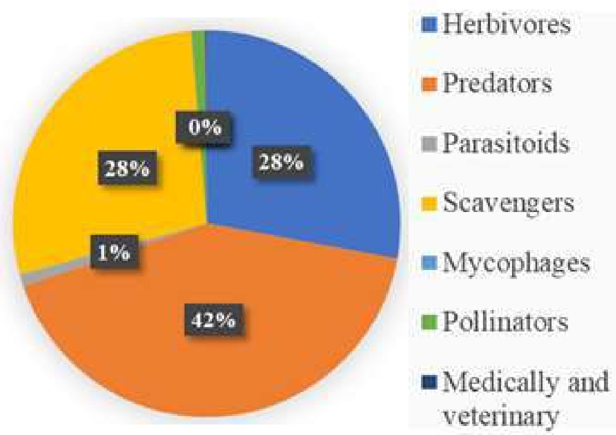

Fig. 2. Functional groups of insects caught in White LED light trap

In the present study, White LED, which emits broad range wavelength light (mixtures of wavelength, cannot be measured), caught a greater number of predators (42%), followed by herbivores (28%), whereas, in Solar light trap (370-390 wavelength), which emits UV-A light, predators (64%) were trapped more, followed by scavengers (27%). In Solar light trap, order Trichoptera which belongs to scavenger group, was 427 in number, whereas, in the White LED light trap only 3 trichopterans were trapped, which means trichopterans are very much selective in terms of attractiveness towards wavelength of light. Hence, it can be concluded that, the wavelength and intensity of the light source influences the attraction of insects. Similar findings are also reported by Singh *et al.* (2018) from the rice ecosystem by using lighttrap as one of the components of IPM. Insects belonging to 8 orders and 18 families (7 orders, 26 species and 15 family predators and single order Hymenoptera, 3 families and 4 species are parasites) were recorded.

The study overwhelmingly demonstrated that the light traps in general, including the commercial Solar trap, are attracting more of the non-herbivorous than the herbivorous and more often than not, beneficial insects that included large numbers of predators, parasites, mycophages and scavengers. *i.e.,* in Solar light trap, a greater number of non-herbivores *i.e.,* 4322 (92%) were trapped compared to herbivores, 391 insects (8%) and in White LED light trap the proportion of non-herbivore group was 2015 insects (72%) and that of herbivore was 780 (28%) (Fig. 3 and 4).

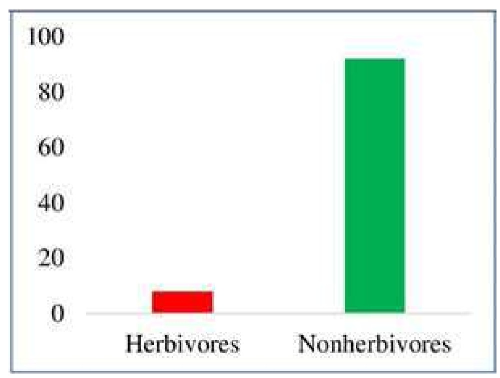

Fig.3 : Herbivores and nonherbivores caught in solar light trap

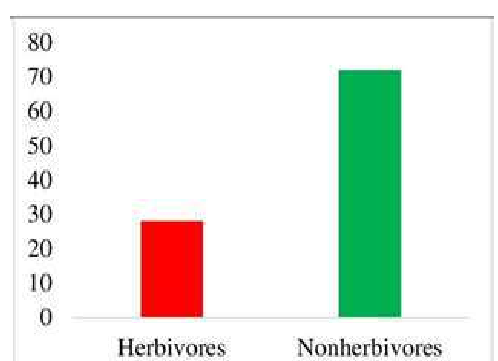

Fig. 4 : Herbivores and nonherbivores caught in white LED light trap

Ma and Ma (2012) also concluded that use of light traps for controlling insect pests is not advised, as they kill both pests and beneficial insects. But it may be possible to reduce the numbers of beneficial insects trapping in light traps by adjusting nightly trapping time, based on differences in the timing of the nocturnal flight peaks of target pests and beneficials. The findings of Baehaki *et al.* (2017) showed that the Solar cell light trapped 97.79 per cent of insect pests and 2.21 per cent predators based on the total number of catches on the mercury light trap model.

Diversity Indices for Functional Groups

Simpson diversity index with respect to number of insects in different functional groups was more in White LED light trap (0.67), than in Solar light trap (0.51). It shows that the diversity of the insects was maximum in the White LED light trap (Table 2).

TABLE 2

Diversity indices for the ecological functional groups of insects caught in two light traps

Ecological functional Group	Number of insects trapped in	
	Solar light trap	LED light trap
Herbivores	391	780
Predators	3017	1170
Parasitoids	1	19
Scavengers	1295	789
Pollinators	0	32
Mycophages	9	1
Medically important	0	4
Total	4713	2795
Mean	673.29	399.29
SD	1257.66	550.78
Diversity indices		
Dominance_D	0.49	0.33
Simpson_1-D	0.51	0.67
Shannon_H	0.86	1.18
Evenness_e^H/S	0.47	0.46
Margalef	0.47	0.76
Equitability_J	0.53	0.60
Wilcoxon value	0	
p=0.05	0.48	

Shannon diversity index was more in White LED light trap (1.18) than in Solar light trap (0.86). In the present study the more diversity was seen in White LED light trap. Evenness of the insects caught on the light traps was more in Solar light (0.47) than in White LED light trap (0.46). Margalef index was more in White LED light trap (0.76) than in Solar light trap (0.47). The equitability of the insects caught was more in White LED light trap (0.60) than in Solar light trap (0.53).The Wilcoxon value for number of insects caught in Solar and White LED traps is zero, which gives p value of 0.48, which means, p>0.05, hence there is no significant difference in number of insects caught in Solar and White LED light traps.

These results thus may suggest potential harm to the local beneficial fauna and a consequent damage to the balanced agro-ecology. In this context, deployment of any type of light trap for the sole purpose of pest management is not a tenable option. Secondly, light traps are by nature being generalist insect samplers, are ideal for short term insect sampling for purposes such as faunal enumeration and ecological studies. The results of the present study, as indicated above, are also vociferously supported by many earlier studies. Therefore, in conclusion, it is suggested that Commercial Solar light traps as is being promoted for purposes of pest management may be with held until further studies to understand their impact on the local fauna and agro-ecology.

The light traps, wave length and intensity of the light source not with standing, are basically generalist scanners of the local fauna. As a result, it is of importance for us to understand how important are they in the management of pestiferous insects in any cropping system. Many different light sources are in vogue, with great variation in the intensity and wavelength range. These would greatly influence the type of insects caught. Nevertheless, without any prior studies, currently in the state of Karnataka, Solar LED based light traps are being promoted in a big way. Therefore, in order to understand the utility of this kind of commercially available trap was needed to be studied. Present study aimed at understanding the utility of these traps.

References

BAEHAKI, S. E., ISWANTO, E. H. AND MUNAWAR, D., 2017, relationship of predators flight and rice pests that caught on the light trap of mercury (ML-160 Watt) BSE-G3 model and light trap of solar cell (CFL-20 Watt). *International Journal of Entomology Research*, **2** (4) : 79 - 85.

JOHNSON, N. F. AND TRIPLEHORN. C. A., 2004, Borrer and DeLong's introduction to the study of insects. Brooks Cole, Belmont, CA. pp. : 864.

LALASANGI, M. S., 1988, Bionomics, loss estimation and control of pod borer, *Maruca testulalis* (Geyer) (Lepidoptera, Pyralidae) on cowpea (*Vigna unguiculata* (L) Walp). *Mysore J. Agric. Sci.,* **22** : 187 - 188.

MA, G. AND MA, C. S., 2012, Differences in the nocturnal flight activity of insect pests and beneficial predatory insects recorded by light traps: Possible use of a beneficial-friendly trapping strategy for controlling insect pests. *European Journal of Entomol.*, **109** (3) : 395.

MATATA, J. K., GYANESHWAR, JHA, KUMAR, A. R. V. AND GANESHAIAH, K. N., 2017, Temporal patterns of insect diversity in Bengaluru: A study using light traps. *Mysore J. Agric. Sci.,* **51** : 78 - 84.

RAMAMURTHY, V. V., AKHTAR, M. S., PATANKAR, N. V., MENON, P., KUMAR, R., SINGH, S. K., AYRI, S., PARVEEN, S. AND MITTAL,V., 2010, Efficiencyof different light sources in light traps in monitoring insect diversity. *Munis Entomology & Zoology*, **5 (**1) : 109 - 114.

SINGH, SHARMA, A. K., SAXENA, A. K., PANDAY, A. K. AND S. H. KAKADE, 2018, taxonomic analysis of phototactic beneficial insects as biocontrol agents (Predators and Parasites) collected in light trap in rice ecosystem at Jabalpur. *Journal of Entomology and Zoology Studies*, **6** (3) : 850 - 853.

SOUTHWOOD, T. R. E. AND HENDERSON, P. A., 2000, Ecological methods. Black well Science, UK, pp. : 269 - 292.