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Performance evaluation of locally developed black light trap for maize insects monitoring in Chitwan, Nepal

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ABSTRACT

Till today, the light traps in Nepal are found using with traditional type, which have not being recognized internationally. These light traps were of low efficiency for trapping insects as compared to black light trap (BLT). The black light tube (F10T8/BL) was used in newly constructed trap at National Maize Research Program (NMRP), Rampur, Chitwan, Nepal. Both traps were installed at the maize experimental field at NMRP during February to October, 2017. Data on insect numbers were recorded once in a week from dusk to down in two different days to minimize the light effects of each others. The total number of insects trapped in BLT was 2804 as compared to 868 in traditional light trap (TLT). Among the insect orders, Coleopterans were mostly trapped in BLT followed by Lepidopteron and Hemipterans. The results showed that the trapping efficiency of BLT was three fold higher than that of TLT. Therefore, black light trap was highly effective monitoring tool and its field applications are expected to be commercialized.

Keywords: Light trap design, Insects attraction, Diversity, Coleoptera, Temperature

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INTRODUCTION

Due to their high ecological diversification and short generation times, insects are useful indicators of environmental change (Thomas, 2005). Light trap is one of the very effective tools for monitoring and management of the insect pests as it mass-traps both the sexes of insect pests and also substantially reduces the carryover pest population. The most widely applied method to survey insects is to use light traps, which exploit their attraction to artificial light (Franzén & Johannesson, 2007). Light traps are also used to determine seasonal patterns of insects' density in the cropped areas. It also provides information related to insect distribution, abundance, flight patterns and helps to decide the timing of the application of management tools (Singh & Bambawale, 2012). There are number of types of light traps designed on the basis of different types of light mechanism. Typically, used lights are standard filament bulbs, mercury vapour bulbs, and fluorescent actinic tubes (Fry & Waring, 2001). The trapping mechanism in the light traps can be designed in various ways which affects trapping performance (Intachat & Woiwod, 1999). Three major factors must be considered in the design of any light trap: the first is an efficient light source, the second is an efficient apparatus for confining the specimens, and the third is an appropriate reception chamber with poison distributing mechanism for killing specimens and retaining them in good condition until they can be recovered for sorting (Hardwick, 1968). At the same time, a range of abiotic factors, such as temperature, rainfall, wind speed, moonlight, and cloud cover, need to be recorded at trap events to correct for their effects on insect flight activity and trap efficiency (Yela & Holyoak, 1997; Beck et al., 2011). Among different types of light trap, the black light trap (BLT) is used for collecting many insects that are active and flying at night and are attracted to UV light. They have consistently caught a higher abundance and greater variety of insects than other traps (Muirhead-Thomson 1991; Neupane, 1982). Their key feature is the low-wavelength light attractant, which lures a diversity of flying insects from the surrounding habitat. Attracting nocturnal insects with ultraviolet light is now in general use and presents the most effective collecting method for nocturnal species of the orders Coleoptera, Othoptera, Lepidoptera, but also for many species of Hymenoptera, Diptera, Neuroptera (Sotthibandhu & Baker, 1979). Different light sources that attract nocturnal insects, emit relatively large amounts of UV radiation (blue fluorescent lights, black lights, and mercury lamps) exert the strongest attraction (Aoki & Kuramitsu 2007; Cowan & Gries 2009). Pennsylvania insect light trap was initially used by the writer as a standard for comparison with other traps and was found outstanding (Frost, 1957). These traps were used for a variety of purposes, ranging from investigations in biodiversity, to pest monitoring, to taxonomic collections and for surveying a wide range of insect taxa (Baker 1985, Beck & Linsenmair 2006). In traditional light trap, a mercury vapour bulb (125-400 W) is used that requires relatively high current to maintain the arc consuming more electric power and thus are limited in its use which has been recovered by using BLT. Since, such BLT has not compared with the conventional trap; this study will shows significant value in monitoring different insects and will provide the reference to the researcher towards using the impacts of such light traps. Thus, the objective of this study was to construct efficient, standardized and cheapest black light trap based on the principle of Pennsylvania light trap, using locally available materials which was evaluated with traditional trap on the basis of insect trapping capacity.

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MATERIALS AND METHODS

Construction features of black light trap

The materials used in Pennsylvania light trap in USA are not available in Nepal thus, locally available low cost materials such as fiber for baffle, wood for tube holder frame, galvanized iron sheet for top cover, funnel and collection chambers and iron angle for support frame. The shape and size of the light trap was modified accordingly keeping basic principle of Pennsylvania light trap. The black light tube (F10T8/BL) used in the model was of 10 watt, emitting 350 nm UV rays. The length of the tube was 33 cm (ϕ 3 cm) which was fitted on the locally available plastic holders in vertical position and electrical connection was made with proper welding of 10 watt electrical chock. The holders were fitted on wooden base frame (Fig 1), which was tightened with the baffles. Four numbers of baffles (41cm long and 12 cm wide and 3.5 mm thick) made of fiber was framed on funnel at one end and top cover at another end (Fig 2). The dimensions of the rain shelter at top, the funnel, the insect collection chamber and iron stand are shown below in table 1. A 60^0 conical funnel having 28.5 cm and 5 cm in diameter at top and neck of the funnel respectively was bolted on the iron angled frame. The insect collection chamber has hanging mechanism on the funnel neck and based on the quick removal iron plate connected to the iron angled frame. The whole trap (Fig 3) has been fixed on the ground such that the lower portion of the light tube installed at a height of 1.5 m. Traditional light trap using 125 W bulb was compared to evaluate the efficacy of two traps.

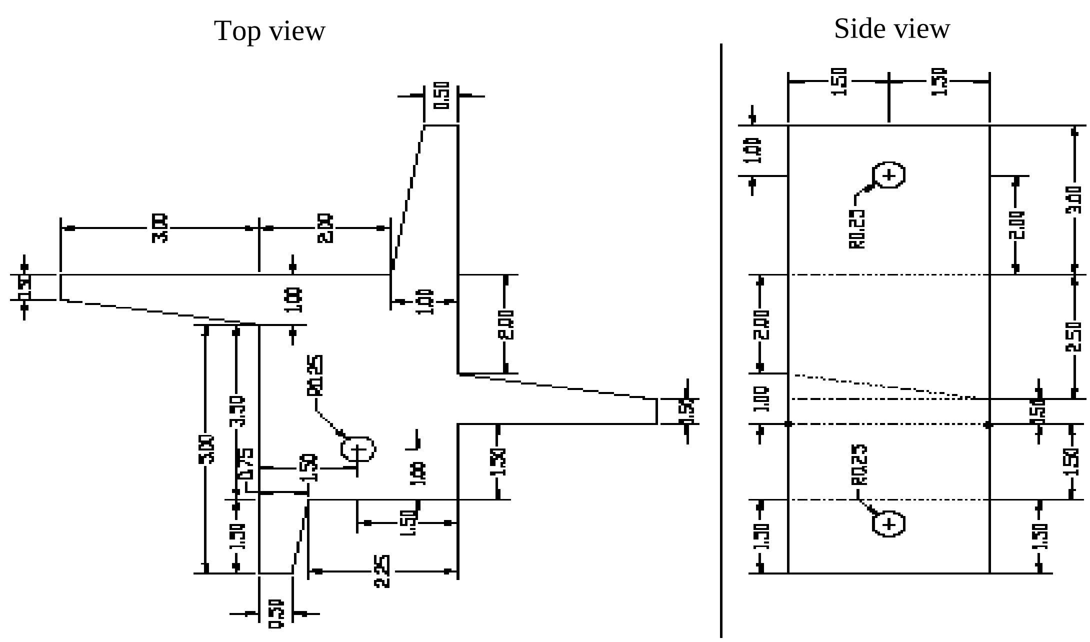

Fig. 1. Wooden base frame for tube holder

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Fig. 2. Baffle fitted with funnel and top cover

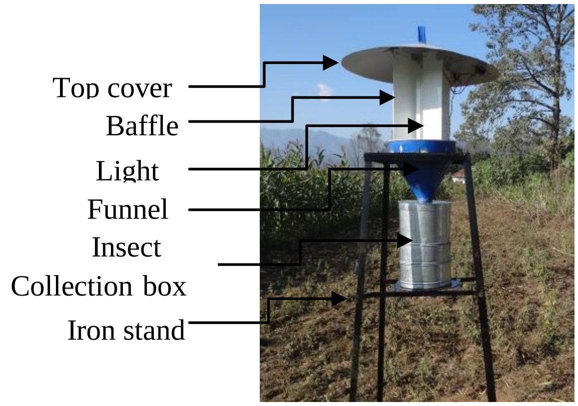

Fig. 3. Installed black light trap (BLT)

Working mechanism of light trap

As mention in the introduction section, the insects attracted due to emitted black light which strike on smooth white baffles surface and hence slide down in the insect collection chambers through funnel. Once the insects fall in the upper collection chamber, the sorting occur when the insects try to fly and find the opening for exit because of different dimensions of sieves at the bottom of each chambers (Fig 4). The sieve dimension of collecting chambers was chosen accordingly to categorize large, medium and small sized insects. This kind of shorting avoids damaging of wings, legs or antennae of insects, which helps identification of specimens. The collected specimens were killed using few drop of poison (ethyl acetate or carbon tetra chloride) in cotton which was kept inside each air tight collection chamber for few minutes.

Data collection

Both traditional and newly constructed black light trap (BLT) were placed in an open maize cropping area at experimental plots of NMRP, Rampur (latitude 27° 40' N, longitude 84° 19' E and altitude 228 m above msl) from February to October, 2017. The measurements were conducted once in a week from dusk to down in the fixed days. The traditional and black light trap were operated in two different days to minimize the light effects of each others. The collected insects were identified upto family level along with their taxonomic hierarchy and biological status to evaluate the performance of both traps.

Fig. 4. Insect collection chamber (a) sieve at bottom of collection chamber (b) insects sorting in different chambers

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Table 1. Construction features of black light trap (BLT)

Part of BLT	Dimension	Specification
Black light tube	Length 33 cm; ϕ3 cm	F10T8/BL; Emits 350 ηm wavelength (λ)
Rain shelter (at top)	ϕ 65 cm	GI sheet (20 gauge)
Baffle	Length 41 cm; width 12 cm and thickness 3.5 mm	Fibers sheet
Conical funnel	Inclination 60^o; ϕ28.5 cm (at top); ϕ5 cm (at neck)	GI sheet (20 gauge)
Iron stand	Vertical height 160 cm; Base plate for funnel 40 cm x 40 cm (at top); foot straggle 65 cm x 65 cm (at bottom)	Iron angle
Insect collection chamber	Top chamber (height 20 cm; ϕ30 cm with led) Middle chamber (height 10 cm; ϕ30 cm) Bottom pan (height 20 cm; ϕ30 cm)	GI sheet (20 gauge)
Base plate for collection chamber	Size 50 cm x 50 cm; Position 68cm from top plate	Iron plate; quick removal mechanism
Sieve mesh	Mesh ϕ 8 mm (for top sieve); mesh ϕ 5 mm for (middle sieve)	GI sheet
Wooden base frame for tube holder	Dimension as shown in fig. 1.	Wood

Weather parameters

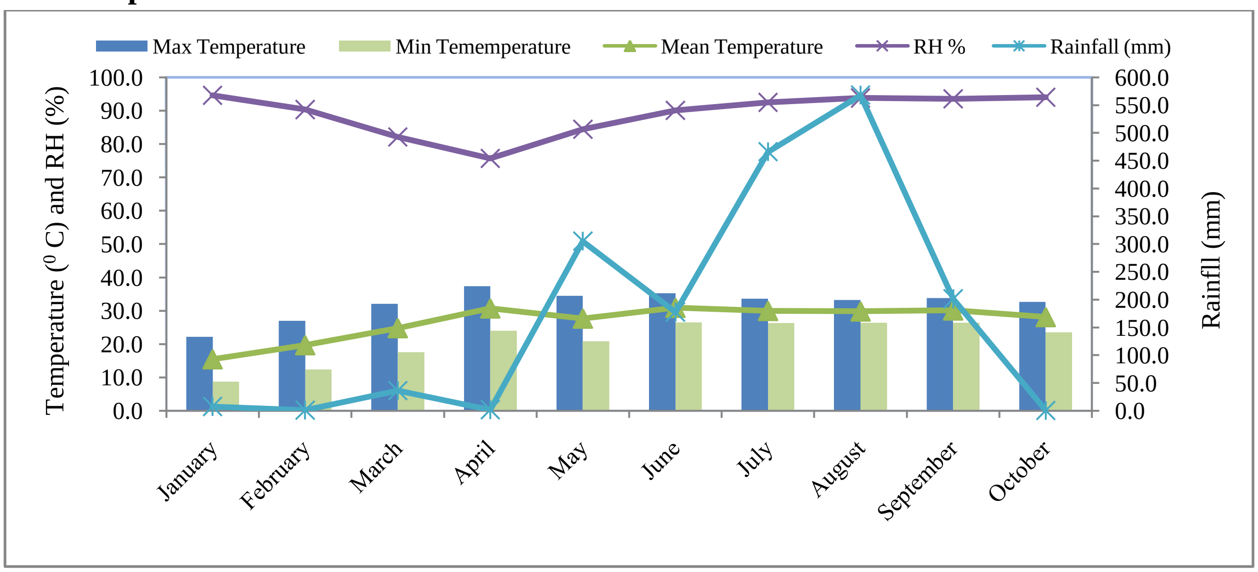

Figure 5: Weather parameters during experiment month of January to October, 2017 at NMRP, Rampur, Chitwan

RESULTS AND DISCUSSION

Insect numbers

Total number of insect catches was found higher in BLT as compared to TLP while monitoring at an interval of 15 days (Fig 6). The highest number (312) was trapped in mid August followed by end of April (295) and end of May (267). This result was similar to the result reported by Muirhead-Thomson (1991) that the BLTs had consistently caught a higher abundance and greater variety of insects during mid April to mid August than other traps. Similar results by (Mellanby, 1939; Holyoak, et al., 1997) showed that the higher insects were trapped from mid-

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May to the end of August. This may be because the higher temperature (Fig 5) increases flight activity and the numbers present in an area of both species and individuals.

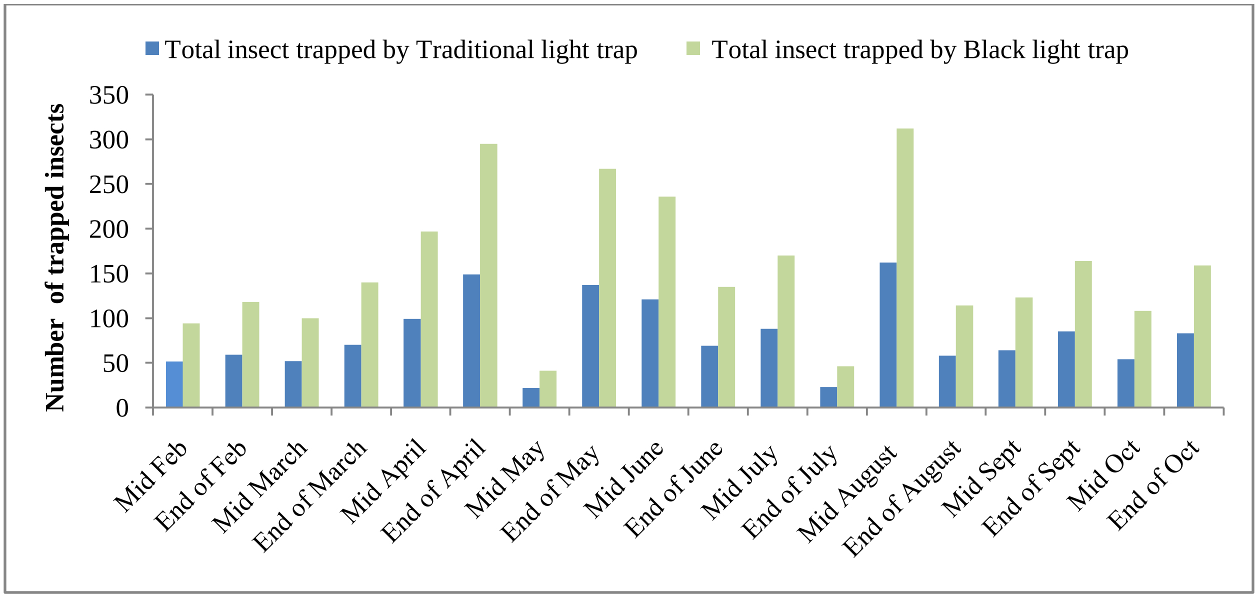

Fig. 6 Proportion of insect species with a peak in abundance in each month at NMRP, Rampur, Chitwan, Nepal, 2017

Insect species

The total number of insect species trapped was found higher in BLT than in TLP (Table 2). Among the trapped insect species in BLT, the highest number of white grub adults (1251) was caught followed by hairy caterpillars (512) and maize stem borers (297) monitored for 8 months from February to October, 2017.

Table 2 Number of insect species trapped at NMRP, Chitwan, during, 2017

Insect category	Insect numbers			
	Traditional light trap		Black light trap	
	Adult (No)	Percent	Adult (No)	Percent
Maize stem borers	67	7.72	297	10.59
White grubs	252	29.03	1251	44.61
Field crickets	82	9.45	253	9.02
Armyworms	24	2.76	73	2.60
Leaf folders	50	5.76	118	4.21
Red ants	82	9.45	245	8.74
Cutworms	38	4.38	55	1.96
Hairy caterpillars	273	31.45	512	18.26
Total	**868**	**100**	**2804**	**100**

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Similar performance was suggested by Kalleshwaraswamy et al. (2016) who collected 131 adults during the trapping period of 30 June -15 October 2013 using light trap. Likewise, Dadmal & Khadakkar (2014) reported that in total 19 species of scarab beetles belonging to 10 genera were the prominent visitors of BLT. The highest number of adult insects trapped in case of black light trap was chaffer beetle (405= 66.83%), where as it was only 22 (3.36%) from an ordinary light trap (Thapa, 2007).

Total order and families

Among various insects collected in the traps, the major contributors were Coleopterans, followed by Lepidopterans, Hemipterans, Orthopterans, Dipterans and Hymenopterans. The result showed that the highest number of catches per family falls under Coleoptera followed by Lepidoptera and Hemiptra respectively (Fig. 7). Dadmal and Khadakkar (2014) observations revealed that Coleopterans followed by Hemipterans and Lepidopterans were the dominating orders caught. Similarly, (Ashfaq et al., 2005) observed the highest number of insects in container placed under the black light (UV light) and the lowest under red light trap.

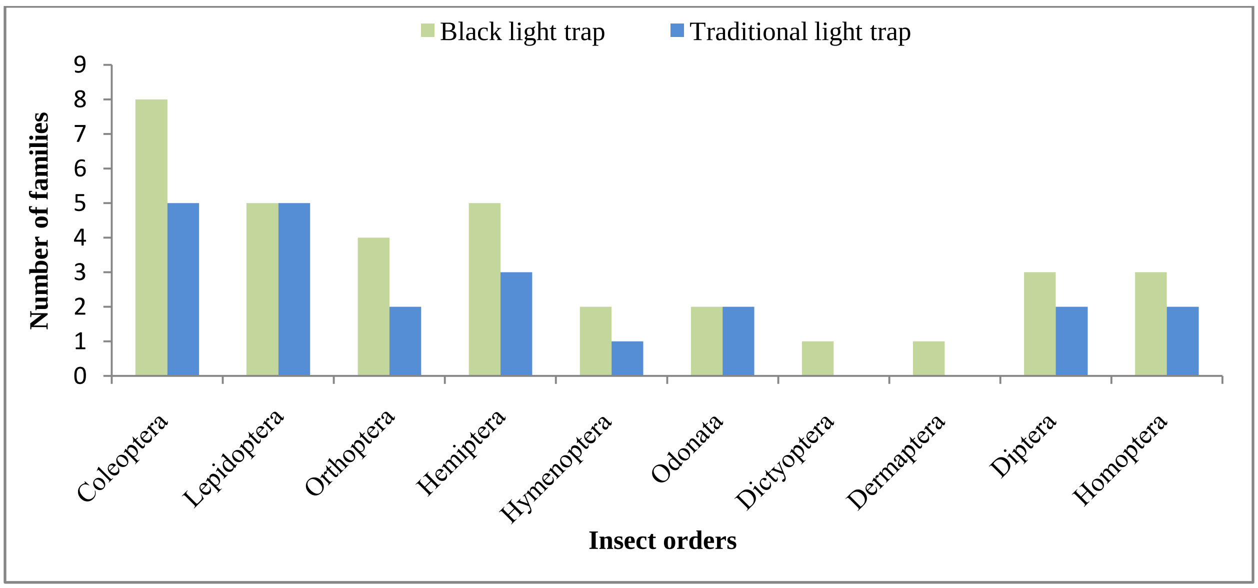

Fig. 7 Insect orders and families trapped through different light traps at NMRP, Chitwan during 2017

Detail cost estimation of black light trap

The detail estimate of all the parts of black light trap is presented in table 3. The cost of all the materials used is as actual rate of local market price in 2016.

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Table 3 Estimated cost of black light trap (BLT)

Items	Quantity	Unit	Specification	Cost (NRs.)
Rain shelter, funnel	1	No	GI sheet (20 gauge)	2000.00
Baffles	4	No	Fibers sheet	2150.00
Iron Frame	1	Set	Iron rod	4000.00
Base frame for tube holder	2	No	Wood	500.00
Black light tube	1	No	F10T8/BL (350 mn wavelength)	2000.00
Electric wire, Chock, two pin, holder, screw etc all complete	1	Set	22/7 mm wire, chock-10 watt, plastic holder	500.00
Insect collection chamber with led	1	Set	GI sheet	2000.00
Sieve	2	No	GI sheet	800.00
Fitting charge				500.00
Miscellaneous				550.00
Total cost				**15000.00**

CONCLUSION

Many drawbacks of TLPs have recovered through this study on BLT. The absence of striking and sieving mechanism in TLP has been fulfilled in BLT which helps for catching and instant sorting of trapped insects there by facilitating easy identification of specimens. The insect attracting capacity of BLT (350 ηm wavelength; visible light) was found significantly higher than that of TLP. In same environmental condition and same interval of time, BLT has trapped large number of insect species, families and orders. It is of international standard, durable, portable and having wide range of insects trapping capacity from different habitats. Thus, it can be concluded that monitoring of insect species with BLT can provide thorough knowledge of the insect arthropod composition of an agro-ecosystem, there by identification of pest species, their economic level to start a management strategy. However, further evaluations of BLT in regard to the effect of altitude, crop height, information requirement and subsequent trap designs are required before its commercial branding.

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AUTHOR CONTRIBUTIONS

G.S.B. designed and performed experiments, analyzed data and wrote the paper; S.K.J. designed the light trap; R.B.T., H.K.M., Y.P.G., N.D., P.K.J. and P.T. revised the article for final approval of the version to be published.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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