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***Research Paper :***

# Performance evaluation of SPV light trap cum lantern

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## ABSTRACT

Presently light traps are working on conventional A.C. electricity which is not economical with respect to depleting conventional energy sources and it is also difficult to operate in agriculture fields as supply of electricity is not available everywhere. Also lanterns are used everywhere in rural sectors as well as during the load shading time in the urban sector. In present era of energy crisis, solar energy is abundantly available. Considering the demands, a light trapper cum lantern, working on the SPV technology was developed and tested for its performance. The developed light trapper cum lantern consisted of a solar array panel of 1058cm$^2$ to recharge the battery in the day time from 8.00am to 6.00pm and its performance was tested by using a 9 watt lamp. A battery of 6 volt; 4.5 amp-hr was used. The SPV panel had 18V; 1.5A voltage and current. An average working hours was 5. It collected maximum insects in the range of 40-60 at temperature range of 27-30$^0$C. Also as wind speed increased above 5kmph the number insects collected were observed to be decreased.

**Key words :** SPV light trap cum lantern, Performance evaluation, Lantern

Energy is the one of the important inputs to agriculture as well as the industries. Demand for the energy from both the sections is constantly increasing with rate of development in either field. Solar photovoltaic is a technology that directly converts the sun's radiations into electricity based on the physical processes that requires no moving parts. It is possible to generate about 120 W of electrical power form a 10 ft$^2$ area of SPV panel on sunny days. SPV is reliable in different scale applications. India is endowed with very good solar energy resource. The average intensity of solar radiation received by India is 200 MW/km$^2$. Even if 10% of available area can be used, the available solar energy would be 8 million MW, which is equivalent of 5909 (million tones of oil equivalent) m toe per year.

Now days, SPV technology is being efficiently used for lightening of streets, residences, hotels, schools, clinics etc. It is used for running electro-mechanical equipments like radio, fan, T.V., refrigerator, pump sets etc. Also SPV supplies electrical power to operate poultry incubators, rice mills, cinemas, telecommunication equipments and charging Ni-Cd batteries.

Presently light traps are working on conventional, A/C electricity which is not economical with respect to depleting conventional energy sources and it is also difficult to operate in agricultural fields as a supply of electricity is not available everywhere.

Also, lanterns are operated on kerosene/LPG, dry batteries or batteries charged on electricity. Lantern is used in field as well as home during time of load shading. The insect light trap could be used as lantern if its design is modified to some extent.

An attempt /study was made to control the insects causing agricultural economic losses by developing a light trapper cum lantern which would attract and kill the insects as well as can be used as lantern as and when required.

## METHODOLOGY

Funnel type SPV trapper cum lantern: This solar photovoltaic operated insect light trap cum lantern (Fig. 1) worked on the SPV technology. The performance was evaluated by using 9W lamp. It used a battery of 6V; 4.5 Amp-hr. The SPV panel had 18V; 1.5A voltage and current. The working hours of the battery were 5 hrs. All the set up was shown in Fig. 1.The battery was charged on solar panel of 1058cm$^2$ size from 8.00am to 6.00pm. Also wind speed was noted to know the velocity of wind, which would affect during performance evaluation of the insect collection. The details regarding the solar photovoltaic operated insect light trap cum lantern are presented in Table 1.

### *Components of light trap cum lantern:*

*Solar array*-It was used for converting the sunlight into D.C. electricity to charge the battery.

*Lantern*-It makes provision for placement of inverter circuit and battery box and it was used for lighting purpose.

*Hopper*- Hoper was used for collecting insects. As

**Table 1 : Design dimensions of solar photovoltaic operated insect light trap cum lantern**

| Sr. No. | Specifications | Dimensions |
|---|---|---|
| 1. | Hopper | |
| | Height | 53cm |
| | Diameter | 35cm |
| | Slope | |
| 2. | Lantern | |
| | Height | 33cm |
| | Diameter | 21cm |
| | Weight | 1568cm |
| 3. | Top cover of hopper | |
| | Height | 18cm |
| | Diameter | 40cm |
| | Space for tube | 17x4cm |
| 4. | Stand for trap | |
| | Height of leg | 130cm |
| | Width of stand | 46cm |
| 5. | Battery | |
| | Voltage | 6V |
| | Current | 4.5amp-hr |
| 6. | Bulb(CFL) | 9watt |
| 7. | Insect collector | |
| | Diameter | 10cm |
| | Height | 12cm |
| 8. | Total weight of the light trap cum lantern | 10kg |

**Fig. 1 : SPV light trap cum lantern**

soon as the insects fall into the hoppers inclined surface they gets slide down to insect collecting container.

*Insect collecting container*- The dead insects were collected in the insect collecting container. Insecticide like water kerosene mixture was filed in this container.

*Stand*- The stand holds the trap and also allows the adjustment for height to the trap.

*Inverter circuit*- It converted D.C. from battery to A. C. It was designed especially for required wattage.

*Bulb*- 9W, CFL was provided for this trap.

***Conversion efficiency :***

It is the ratio of voltage and current developed by solar array system to the input of array.

$$\text{C.E.} = \frac{\text{Array output (Watt)}}{\text{Input to array (Watt)}} \times 100$$

***Overall efficiency:***

It is the ratio of energy actually used for bulb to the incoming energy from the sun and is expressed as percentage.

$$\text{O.F.} = \frac{\text{Bulb wattage}}{\text{Input energy (watt)}} \times 100$$

## RESULTS AND DISCUSSION

The findings of the present study as well as relevant discussion have been summarized under following heads:

***Temperature:***

The sample observation for the panel (7.5W) was recorded. It was observed that, temperature was maximum at 14:00 hrs and it varied from 33.10 to 38.92$^0$C from 9.00 to 18.00 hrs with mean of 37.19$^0$C.

***Solar insolation:***

The average value of solar insolation at various times in a day was recorded with the help of insollorimeter (suryamapi) and performance of the panel was worked out. It was observed that maximum solar insolation of 80mW/cm$^2$ at 12.00hrs and minimum of 45 mW/cm$^2$ at 18.00 hrs with the mean of 63.40 mW/cm$^2$.

Also it was observed that, even if the incoming solar increases, the solar cell could not convert all incoming solar insolation over 77mW/cm$^2$ into the electrical energy.

***Energy input and output of solar array:***

**Table 2 : Specifications of the array**

| Sr. No. | Specification | Dimensions |
|---|---|---|
| 1. | Size of array | 45x23.5cm |
| 2. | Peak power | 7.5W |
| 3. | Open circuit voltage | 15V |
| 4. | Short circuit voltage | 0.5Amp |
| 5. | Cell conversion efficiency | 10% |
| 6. | Number of cells | 32 |
| 7. | One cell generator | 0.46V |
| 8. | Total cell area | 560 $cm^2$ |

The SPV array under the study had one array with total area of 1058$cm^{2.}$ The maximum mean daily input energy of 35.48 watt was recorded. Also maximum daily input energy of 44.80 watt was recorded at 12 hrs and minimum daily input of 25.20 watt at 18.00 hrs.

Energy output is useful conversion of solar cells into electrical energy. The average values of output were found in between 6.34 to 2.84 watt. The maximum value was observed at 11.00hrs and minimum value at 18.00hrs with the mean value of 4.94 watt and is presented in Table 3.

***Conversion efficiency:***

It decides the capacity of solar cell to convert incoming solar insolation into electrical energy. The conversion efficiency was observed to be varied between 18.24 to 18.21% with mean of 13.72%.

***Overall efficiency:***

The average value of over all efficiency of the panel was varied between 35.71 to 20.08% with mean value of 25.69%.

Performance evaluation of SPV light trap cum lantern: In order to evaluate the performance of SPV insect light trap cum lantern(Fig. 1), one bulb of 9W was used with charged battery (6V; 4.5Amp) on solar photo voltaic panel. The light intensity and working time of bulb was recorded. The working time of the bulb was found to be 6 hrs and observations for the wind speed, temperature, number of insects collected and the type of insect were recorded for a week (Table 4 and 5).

It was seen that the temperature from 7.00pm to 1.00am varied from $31^0$C to $27^0$C and the wind speed observed to be 1.5 to 7.8 km/hr. The insects collected were maximum *i.e.* 40 to 60 in the maize crop (Table 4)

**Table 3: Average values of performance of the panel**

| Time (hrs) | Avg. tempt. ($^0$C) | Solar insolation (mW/$cm^2$) | Array voltage (V) | Array current (Amp.) | Array input (W) | Array output (W) | Conversion efficiency (%) | Overall efficiency (%) |
|---|---|---|---|---|---|---|---|---|
| 08-09 | 33.10 | 50 | 15.70 | 0.2 | 28.00 | 3.14 | 11.21 | 32.14 |
| 09-10 | 36.50 | 72 | 15.79 | 0.3 | 40.32 | 4.73 | 11.73 | 22.32 |
| 10-11 | 37.17 | 76 | 15.86 | 0.4 | 42.56 | 6.34 | 14.89 | 21.14 |
| 11-12 | 38.40 | 80 | 15.67 | 0.4 | 44.80 | 6.26 | 13.97 | 20.08 |
| 12-13 | 38.70 | 76 | 15.61 | 0.4 | 42.56 | 6.24 | 14.66 | 21.14 |
| 13-14 | 38.92 | 72 | 15.50 | 0.4 | 40.32 | 6.20 | 15.37 | 22.32 |
| 14-15 | 38.00 | 60 | 15.34 | 0.4 | 33.60 | 6.13 | 18.24 | 26.78 |
| 15-16 | 37.50 | 54 | 15.10 | 0.3 | 30.24 | 4.53 | 14.98 | 29.76 |
| 16-17 | 37.00 | 49 | 15.00 | 0.2 | 27.44 | 3.00 | 10.93 | 32.79 |
| 17-18 | 36.70 | 45 | 14.20 | 0.2 | 25.20 | 2.84 | 11.26 | 3.71 |
| Mean | 37.19 | 63.4 | 15.30 | 0.3 | 35.48 | 4.94 | 13.72 | 26.10 |

**Table 4 : Average values recorded for the insects collected in the SPV insect light trap cum lantern with liquid insecticide in maize crop**

| Time (hr) | Wind speed (km/hr) | Tempt. ($^0$C) | Lux meter reading from 1m. | No. of insects collected | Type of insect and % of insect |
|---|---|---|---|---|---|
| 19-20 | 10.20 | 32.20 | 9 | 54 | Moths (65%) |
| 20-21 | 10.80 | 31.80 | 8 | 71 | Aphids (11%) |
| 21-22 | 12.40 | 31.60 | 7 | 50 | White grub (05%) |
| 22-23 | 14.60 | 29.50 | 6 | 30 | Mosquitoes (03%) |
| 23-00 | 14.70 | 29.40 | 4 | 26 | White fly (15%) |
| 00-01 | 8.40 | 28.80 | 4 | 46 | Grass hopper(02%) |
| Mean | 13.43 | 29.21 | 6.3 | Total=277 | |

**Table 5: Average values recorded when blue light used in ladies fingure vegetable**

| Time (hr) | Wind speed (km/hr) | Tempt. ($^0$C) | Lux meter reading from 1m. | No. of insects collected | Type of insect and % of insect |
|---|---|---|---|---|---|
| 19-20 | 11.4 | 34.8 | 4 | 40 | Moths (34%) |
| 20-21 | 12.7 | 33.4 | 4 | 55 | Aphids (24%) |
| 21-22 | 10.5 | 32.8 | 4 | 28 | White Grub (20%) |
| 22-23 | 10.9 | 31.7 | 4 | 20 | Mosquitoes (02%) |
| 23-00 | 12.3 | 31.4 | 3 | 24 | White fly (17%) |
| 00-01 | 10.7 | 28.7 | 3 | 28 | Grass hopper(03%) |
| Mean | 11.41 | ---- | 3.6 | 195 | |

and 30 to 35 for ladies fingure vegetable (Table 5) in temperature range of 27 to 30$^0$C. During these hours the wind velocity was below 5km/hr and afterwards as it increases the collection of insect was decreased.

In this solar insect light trap cum lantern, energy was stored in a battery in the day time and stored energy was used for glowing the bulb at night time. On an average of 5 hrs, bulb was observed to be glowed, and hence the removable unit *i.e.* lantern was used for lighting purpose in the night time.

Similarly type of investigations have been carried out by Rathi (2002) and Pampattiwar *et al.*, 1999 in the past.

***Conclusion:***

– The maximum insects were collected in the temperature range of 27 to 30$^0$C for the wind velocity less than 5km/hr, in the 20.00 to 21.00hrs.

– The majority insects collected were moths.

– The maximum working hours of SPV light trap cum lantern was 6 hours

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