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# Study the relative efficacy of new designs of light trap using UV and UV-LED light source in attracting and trapping insect pests

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**Abstract**
The experiment was conducted behind the biotechnology center, JNKVV campus, Jabalpur (MP) during the period between third week of October 2019 to third week of March 2020. Comparative studies of trap catches revealed that UV 15 watt (model SMV-4) has given better response than UV LED 7 watt solar trap (model Rakshak) in following species – *Gryllus bimaculatus* and unidentified Lepidoptera moths, But, there is no significant difference between the catches of UV 15 W and 7W UV LED light sources. UV15 w has given better response than UV LED 7 watt in case of *Helicoverpa armigera*, *Gryllotalpa orientalis*, *Plusia orichalcea*, *Agrotis ipsilon*, *Creatonotos gangis* with significant difference between the catches of SMV-4 UV 15 watt and SOLAR UV LED 7watt. Taking into consideration the total wattage of consumption i.e. UV 15watt (electric powered) v/s UV-LED 07 watt (solar powered) the UV 07 watt seems to a much cheaper & economic light source than 15 watt. Therefore, solar light source (07 watt UV) seems to be very good alternative source to 15watt for operation of light trap as pest control device. But cost wise compared the both models the solar powered light trap is much costlier.

**Keywords:** Light trap, UV, UV-LED, IPM, solar trap

## Introduction
Traps are used for general survey of insect diversity and usually are simple interception devices that attracts and capture insects moving through an area. Traps also are used for detection of new invasions of insect pest in time and/or space, for delimitation of area of infestation, and for monitoring population levels of established pests. Use of light trap gained a wide spread importance in IPM strategies all over the world.
Vaishampayan and his associates did extensive work on light trap studies with support of ICAR during the period 1973-2001 at JNKVV Jabalpur. Mercury vapour lamp (125 Watt and 160 Watt) proved the best light source against many crop pest species, while 15Watt UV Black light lamp 18’’ tube length was the next better source (Vaishampayan 2007) [7]. Many insects are positively phototrophic in nature and use of light traps for insect catches produces valuable faunistic data. This data can be seen as a parameter of health of biodiversity of the concerned vicinity. The data provided by light trap catches could throw light on period of maximum activity of insects Dadmal and Khadakkar, (2014) [2]
The solar light trap may be considered as the alternate solution that has several advantages over the electrical light trap. To fulfill the purpose, a suitable model of solar light trap was selected considering the following characteristics i.e. portable in nature, easily fixed at any place in the field.

## Material and Method
The experiment was conducted behind the biotechnology center, JNKVV campus, Jabalpur (MP) during the period between third week of October to third week of March, (2019 -2020). Light Trap model SMV- 4 developed by Dr. S. M. Vaishampayan in 2014, was used in the present study as 1st treatment. The details of light trap design are published in book “Light Trap: an eco-friendly IPM tool” written by Vaishampayan & Vaishampayan (2016) [6]. Trap is suitable to use MV and UV lamps as light source. In this experiment UV 15watt 18” tube light was used as a light source. (The light trap unit is comprised of two components (a) Trapping unit with funnel baffle plates and (b) a Collection unit. As a 2nd treatment, solar powered light trap model Rakshak was used for the monitoring of insect pest. As per the objectives of the study experiment was conducted in the field. Light traps were operated every night and collection was being observed next morning. Observations were recorded every day throughout the *rabi* season. Total insects fauna was observed and sorted out on the basis of major species. Data of daily trap catch was maintained.

In all, two light traps were installed in the experimental area. This area was covered mainly by a gram in around 5 hectors of crop area. Spacing between two traps was approximately 100 meter. The insects collected in the collection bag were killed by the exposure of Dichlorvos 76 EC vapours (as fumigating agent) released in a dispenser with scrubber, placed in a collection tray for instant killing of trapped insects. Insects were collected from the collection bag every morning.

**Comparative efficacy of two light sources:** It includes two treatments to compare the relative efficiency of SMV-4 model over solar light as light source in a light trap in trapping and collecting insects of various crop pest species.
T1 –15 watt UV tube light 18" (SMV-4 Model)
T2 –7 watt UV LED tube (Solar light trap) model Rakshak

**Results**

Results of experiment on comparative responses of insect pest species towards light sources are described in brief below. Comparative efficacy of SMV-4 UV and SOLAR LED light sources based on response of seven insect pest species namely Gram pod borer *Helicoverpa armigera*, Black cutworm *Agrotis ipsilon*, Tiger moth *Creatonotos gangis*, Field cricket *Gryllus bimaculatus*, Mole cricket *Gryllotalpa orientalis*, Cabbage semilooper *Plusia orichalcea*, Unidentified Lepidoptera moth were identified as important positively phototropic insect pest in rabi crops because they occoured regularly and significantly high in traps catches. Name of major species observed in trap catches and species wise description is given in Table No.1 and the comparative response of the insect pest towards the light sources is described in detail in following Table No.1:

**Table 1:** List of insect pests attracted in light traps

| S. N | Common name | Scientific name | Order | Family |
|---|---|---|---|---|
| 1. | Gram pod borer | *Helicoverpa armigera* | Lepidoptera | Noctuidae |
| 2. | Black cutworm | *Agrotis ipsilon* | Lepidoptera | Noctuidae |
| 3. | Tiger moth | *Creatonotos gangis* | Lepidoptera | Noctuidae |
| 4 | Cabbage semilooper | *Plusia orichalcea* | Lepidoptera | Noctuidae |
| 5 | Feild cricket | *Gryllus bimaculatus* | Orthoptera | Gryllidae |
| 6 | Mole cricket | *Gryllotalpa oreintalis* | Orthoptera | Gryllotalpidae |
| 7 | Unidentified Lepidoptera moth | Miscellaneous species | Lepidoptera | ----- |

**Table 2:** Comparative response of insect pest species towards light sources. T1-SMV-4 UV 15 watt, T2- SOLAR UV LED 7 watt

| S. No. | Observation period weekly | Species wise mean per day per trap | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | *Helicoverpa armigera* | | *Agrotis ipsilon* | | *Creatonotos gangis* | | *Plusia orichalcea* | |
| | | T1 | T2 | T1 | T2 | T1 | T2 | T1 | T2 |
| | | SMV 4 UV 15W | Solar UV LED 7W | SMV 4 UV 15 W | Solar UV LED 7W | SMV 4 UV15 W | Solar UV LED 7 W | SMV-4 UV15 W | Solar UV LED 7 W |
| 1 | Oct III wk | 0 | 0 | 0 | 0 | 31.75 | 6.25 | 0 | 0 |
| 2 | Oct IV wk | 0 | 0 | 0 | 0 | 27.66 | 4.44 | 0 | 0 |
| 3 | Nov I wk | 0 | 0 | 0 | 0 | 11.71 | 1.28 | 0 | 0 |
| 4 | Nov I wk | 0 | 0 | 0 | 0 | 7.28 | 1.57 | 0 | 0 |
| 5 | Nov III wk | 0 | 0 | 0 | 0 | 12 | 3.37 | 0 | 0 |
| 6 | Nov IV wk | 0 | 0 | 0 | 0 | 8.57 | 4.75 | 0 | 0 |
| 7 | Dec I wk | 0 | 0 | 0 | 0 | 8.42 | 5.14 | 0 | 0 |
| 8 | Dec II wk | 0 | 0 | 0 | 0 | 4.42 | 3.71 | 0 | 0 |
| 9 | Dec III wk | 0 | 0 | 0 | 0 | 3 | 2.875 | 0 | 0 |
| 10 | Dec IV wk | 0.25 | .142 | 0 | 0 | 1.125 | 1.71 | 0 | 0 |
| 11 | Jan I wk | 0.142 | 0.142 | 0 | 0 | 1.57 | 1.141 | 1.142 | 0.428 |
| 12 | Jan II wk | 0 | 0 | 0 | 0 | 1.57 | 1.141 | 1.142 | 0.142 |
| 13 | Jan III wk | 0 | 0 | 0 | 0 | 2.375 | 1 | 1.857 | 0.857 |
| 14 | Jan IV wk | 0.142 | 0.142 | 0.714 | 0.428 | 1.5 | 0.625 | 1.125 | 0.500 |
| 15 | Feb I wk | 0.142 | 0.142 | 0.428 | 0.142 | 1.57 | 1.142 | 0.285 | 0.142 |
| 16 | Feb II wk | 0.285 | 0.142 | 1 | 0.571 | 1.57 | 1 | 0.571 | 0.285 |
| 17 | Feb III wk | 0.285 | .285 | 0.714 | 0.714 | 0.42 | 1.28 | 1.857 | 0.428 |
| 18 | Feb IV wk | 0.875 | .428 | 1.142 | 0.875 | 3.85 | 2 | 3.625 | 2.285 |
| 19 | Mar I wk | 1.142 | 0.285 | 2.428 | 1.428 | 10.71 | 2.71 | 3.857 | 1.428 |
| 20 | Mar II wk | 1 | 0.714 | 2.28 | 0.714 | 11.57 | 2.28 | 2.714 | 1.428 |
| 21 | Mar III wk | 1.428 | 0.66 | 1.833 | 1 | 12 | 2.28 | 2.00 | 0.571 |

| S. No. | Observation period weekly | Species wise weekly mean per day per trap | | | | | |
|---|---|---|---|---|---|---|---|
| | | *Gryllus bimaculatus* | | *Gryllotalpa oreintalis* | | Unidentified Lepidoptera moth | |
| | | T1 | T2 | T1 | T2 | T1 | T2 |
| | | SMV 4 UV 15W | Solar UV LED 7W | SMV 4 UV 15 W | Solar UV LED 7W | SMV 4 UV15 W | Solar UV LED 7 W |
| 1 | Oct III wk | 22.5 | 3.125 | 1 | 0 | 8.75 | 3.125 |
| 2 | Oct IV wk | 12.625 | 2.28 | 0 | 0.22 | 9.33 | 2.88 |
| 3 | Nov I wk | 5.28 | 1 | 1 | 0.571 | 2.85 | 1.714 |
| 4 | Nov I wk | 3.57 | 0.57 | 2.857 | 1 | 1.71 | 0.57 |
| 5 | Nov III wk | 1 | 2.142 | 4.125 | 3.142 | 4.42 | 1.857 |
| 6 | Nov IV wk | 1.14 | 0.857 | 2.75 | 3.66 | 7.25 | 3.25 |
| 7 | Dec I wk | 0.85 | 0.857 | 2.428 | 2 | 9.425 | 5 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 8 | Dec II wk | 1 | 0.285 | 2.714 | 1.85 | 6.285 | 3.142 |
| 9 | Dec III wk | 0 | 0 | 1.714 | 1.428 | 4 | 5 |
| 10 | Dec IV wk | 0.14 | 0.571 | 0.857 | 0.625 | 4.42 | 2.875 |
| 11 | Jan I wk | 1 | 0.428 | 0.714 | 0.428 | 2.85 | 2.571 |
| 12 | Jan II wk | 0.428 | 1 | 0.571 | 0.142 | 1.425 | 1.142 |
| 13 | Jan III wk | 0.285 | 0.571 | 0.428 | 0.75 | 2.25 | 1.285 |
| 14 | Jan IV wk | 1.285 | 0.75 | 0.875 | 1 | 5.77 | 5.125 |
| 15 | Feb I wk | 0.428 | 0.428 | 1 | 0.142 | 6 | 1.42 |
| 16 | Feb II wk | 1 | 0.714 | 0.142 | 0.142 | 4.42 | 1.285 |
| 17 | Feb III wk | 0.571 | 0.285 | 0.571 | 0.25 | 4.857 | 2 |
| 18 | Feb IV wk | 0.285 | 0.285 | 0.714 | 0.571 | 7.285 | 6.375 |
| 19 | Mar I wk | 2 | 0.285 | 1.428 | 0.714 | 11.142 | 6.857 |
| 20 | Mar II wk | 2.285 | 0.571 | 2.00 | 1.285 | 9.00 | 6.71 |
| 21 | Mar III wk | 2.285 | 1.428 | 1.571 | 0.428 | 12.00 | 5.83 |

**Species wise comparative response given below**

Gram pod borer *Helicoverpa armigera* (Hubner)

| **Details of statistics with light sources SMV- 4 UV and SOLAR UV** | ***Helicoverpa armigera*** | |
|---|---|---|
| | **T1** | **T2** |
| | **SMV- 4 UV 15 watt** | **SOLAR UV LED 7 watt** |
| No. of Observation | 10 | 10 |
| Total mean | 0.308 | 0.573 |
| Variance | 0.049 | 0.248 |
| d.f | 9 | 9 |
| $t_{cal}$ | 2.264 * | |
| $t_{tab\ (0.05)}$ | 2.262 | |

(*significant at 5%)

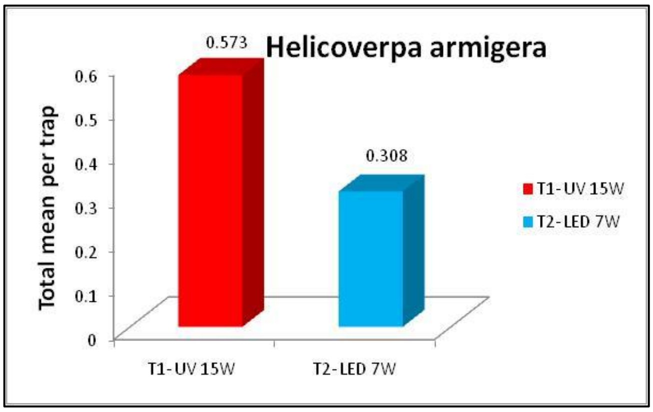


**Fig 1:** Response of Gram pod borer

- The calculated value of t (2.264) is found to be greater than the tabulated value (2.262) of T1- 9(df) and T2- 9(df) at 5% level of significance. Hence, we reject the null hypothesis and conclude that there is significant difference between SMV-4 UV 15 Watt and SOLAR UV LED 7 Watt.
- Numerically trap catch was higher in SMV-4 UV than SOLAR UV LED

Field cricket *Gryllus bimaculatus* (De Geer)

| **Details of statistics with light sources SMV- 4 UV and SOLAR UV** | ***Gryllus bimaculatus*** | |
|---|---|---|
| | **T1** | **T2** |
| | **SMV-4 UV 15 watt** | **Solar LED UV 7 watt** |
| No. of Observation | 20 | 20 |
| Total mean | 2.998 | 0.900 |
| Variance | 28.922 | 0.618 |
| d.f | 19 | |
| $t_{cal}$ | 1.967NS | |
| $t_{tab\ (0.05)}$ | 2.093 | |

NS (non significant)

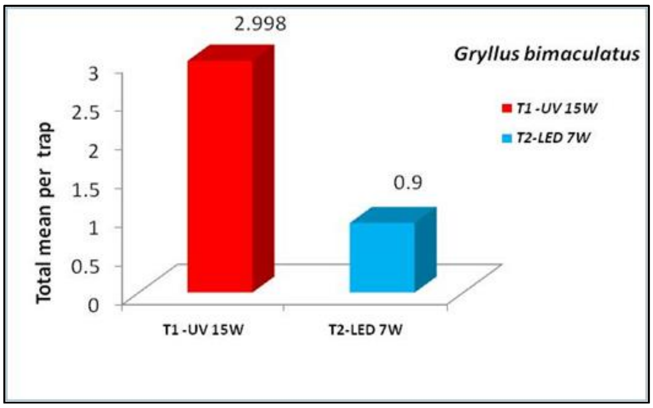


**Fig 2:** Response of field cricket (*Gryllus bimaculatus)*

- The calculated value of t (1.967) is found to be less than the tabulated value (2.093) of t (19df) at 5% level of significance. Hence, we accept the null hypothesis and conclude that there is no significant difference between mean of SMV-415 Watt and SOLAR UV 7 Watt.
- Numerically trap catch was higher in SMV-4 than SOLAR UV LED.

Mole cricket *Gryllotalpa orientalis* (Burmeister)

| **Details of statistics with light sources SMV-4 and SOLAR UV** | ***Gryllotalpa orientalis*** | |
|---|---|---|
| | **T1** | **T2** |
| | **SMV- 4UV 15 watt** | **Solar LED UV7watt** |
| No. of Observation | 20 | 20 |
| Total mean | 1.473 | 1.017 |
| Variance | 1.075 | 0.964 |
| d.f | 19 | |
| $t_{cal}$ | 3.477* | |
| $t_{tab\ (0.05)}$ | 2.093 | |
| $t_{tab\ (0.01)}$ | 2.861 | |

Significant at 5% and 1%

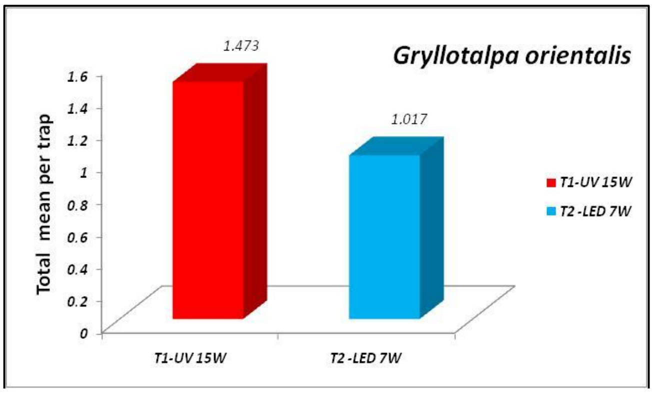


**Fig 3:** Response of mole cricket (*Gryllotalpa orientalis)*

- The calculated value of t (3.477) is found to be greater than the tabulated value (2.093) of t (16df) at 5% level of significance. Hence, we reject the null hypothesis and conclude that there is significant difference between mean of SMV-4UV 15 Watt and SOLAR UV 7 Watt.
- Numerically trap catch was higher in SMV-4UV than SOLAR UV LED

Tiger moth *Creatonotos gangis* (Linnaeus)

| Details of statistics with light sources MV and UV | ***Creatonotos gangis*** | |
|---|---|---|
| | **T1** | **T2** |
| | **SMV- 4 UV 15watt** | **SOLAR LED UV 7watt** |
| No. of Observation | 21 | 21 |
| Total mean | 7.842 | 2.461 |
| Variance | 70.768 | 2.529 |
| d.f | 20 | |
| $t_{cal}$ | 3.362* | |
| $t_{tab\ (0.05)}$ | 2.845 | |

Significant at 5% and 1%

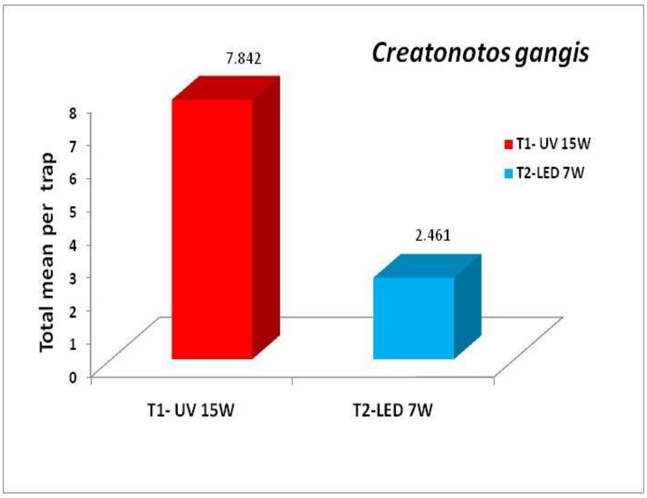


**Fig 4:** Response of tiger moth (*Creatonotos gangis)*

- The calculated value of t (3.362) is found to be greater than the tabulated value (2.845) of t (20 df) at 5% and 1% level of significance. Hence, we reject the null hypothesis and conclude that there is significant difference between mean of SMV-4 UV 15 Watt and SOLAR UV 7 Watt.
- Numerically trap catch was higher in SMV-4UV than SOLAR UV LED.

Cabbage semilooper *Plusia orichalcea*

| Details of statistics with light sources SMV-4 and SOLAR UV | ***Plusia orichalcea*** | |
|---|---|---|
| | **T1** | **T2** |
| | **SMV-4UV 15 watt** | **SOLAR UV LED 7watt** |
| No. of Observation | 11 | 11 |
| Total mean | 1.833 | 0.772 |
| Variance | 1.353 | 0.454 |
| d.f | 10 | |
| $t_{cal}$ | 5.556* | |
| $t_{tab\ (0.05)}$ | 2.228 | |
| $t_{tab\ (0.01)}$ | 3.169 | |

*Significant at 5% and 1%

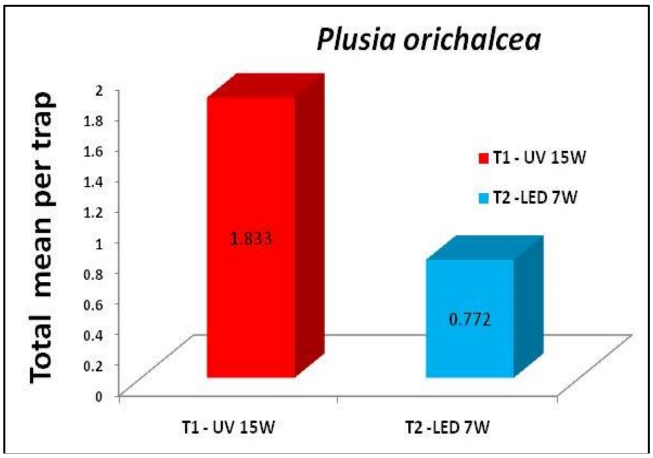


**Fig 5:** Response of cabbage semilooper (*Plusia orichalcea)*

- The calculated value of t (5.556) is found to be greater than the tabulated value (2.228) of t (10df) at 5% level of significance. Hence, we reject the null hypothesis and conclude that there is significant difference between mean of SMV-4UV 15 Watt and SOLAR UV 7 Watt.
- Numerically trap catch was higher in SMV-4UV than SOLAR UV LED.

Cutworm *Agrotis ipsilon* (Hufnagel)

| Details of statistics with light sources SMV-4 and SOLAR UV | ***Agrotis ipsilon*** | |
|---|---|---|
| | **T1** | **T2** |
| | **SMV – 4 UV 15watt** | **SOLAR UV LED 7watt** |
| No. of Observation | 8 | 8 |
| Total mean | 1.318 | 0.734 |
| Variance | 0.584 | 0.149 |
| d.f | 7 | |
| $t_{cal}$ | 3.211* | |
| $t_{tab\ (0.05)}$ | 2.365 | |

*Significant at 5

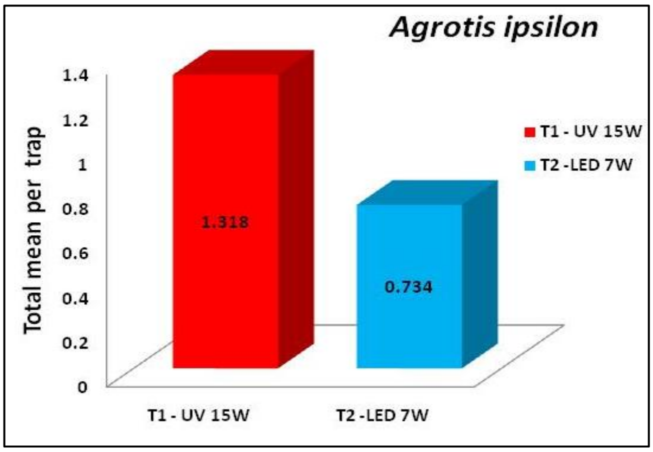


**Fig 6:** Response of cutworm (*Agrotis ipsilon)*

The calculated value of t (3.211) is found to be greater than the tabulated value (2.365) of t (7df) at 5% level of significance. Hence, we reject the null hypothesis and conclude that there is significant difference between mean of SMV-4UV Watt and SOLAR UV 7 Watt.
Numerically trap catch was higher in SMV-4UV than SOLAR UV LED.

Unidentified Lepidoptera moth

| Details of statistics with light sources SMV-4 and SOLAR UV | *Unidentified lepidoptera moth* | |
|---|---|---|
| | **T1** | **T2** |
| | **SMV 4 UV 15watt** | **SOLAR UV LED 7watt** |
| No. of Observation | 21 | 21 |
| Total mean | 4.319 | 3.920 |
| Variance | 5.483 | 6.797 |
| d.f | 20 | |
| $t_{cal}$ | 1.958 NS | |
| $t_{tab\ (0.05)}$ | 2.845 | |
| $t_{tab\ (0.01)}$ | 3.169 | |

NS (non-significant)

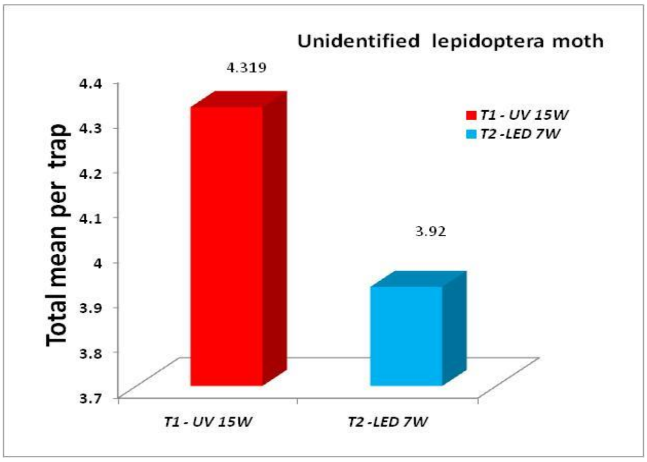


**Fig 7:** Response of Unidentified Lepidoptera moth

- The calculated value of t (1.958) is found to be less than the tabulated value (2.086) of t (20df) at 5% level of significance. Hence, we accept the null hypothesis and conclude that there is no significant difference between mean of SMV-4UV 15 Watt and SOLAR UV 7 Watt.
- Numerically trap catch was higherinSMV-4UV than SOLAR UV LED.

## Discussion

Comparison is based on the relative response of the insect pest species (trap catch per week) in two light sources i.e.SMV-4 UV 15 watt and SOLAR UV LED 7watt. Statistically analyzed by Paired t-test. Results are summarized in two head as given below:

### 1. Higher response in SMV-4 UV 15 watt compared to SOLAR UV LED 7 watt.

The species show higher response in SMV-4 UV 15 watt is listed below:

1. Gram pod borer *Helicoverpa armigera* (Hubner)
2. Field cricket *Gryllus bimaculatus* (De Geer)
3. Unidentified Lepidoptera moth

In above three species numerically (by number of trap catch) UV 15 watt has given higher response i.e. better than UV LED 7 watt, but statistically, differences were non-significant in the trap catch of these three species.

### 2. Higher response in SMV-4 UV compared to SOLER UV LED (Statistically significant):

The species show higher response in SMV-4 UV 15 watt is listed below:

1. Mole cricket *Gryllotalpa orientalis* (Burmeister)
2. Tiger moth *Creatonotos gangis* (Linnaeus)
3. Cabbage semilooper *Plusia orichalcea*
4. Cutworm *Agrotis ipsilon* (Hufnagel)

In above four species numerically (by number of trap catch) SMV-4 UV 15 watt has given higher response i.e. better than SOLER UV LED 7 watt, but statistically, differences were significant in the trap catch of these four species.

Therefore, taking into consideration the relative higher response, trap catches etc UV 15watt light source seem to be much cheaper and economic light source and a very good substitute to SOLER UV LED 7 watt as a pest control, survey and monitoring device.

Results of experimental work done on light trap studies earlier (Since 1935) in many parts of USA and other countries, support the importance of Ultra violet light, specially the 15 watt black light (UV) lamp (18'' tube) as a light source for its use in light trap as survey and pest control tool.

An experiment on comparative efficiency of different light sources used in light trap against insect-pest of *Kharif* crop was conducted by Band *et al.* (2019) [1]. Comparative studies of trap catches revealed that ultraviolet 16 watt (8+8 watt) has given better response than mercury lamp 160 watt in some species.

Shrikant *et al.* (2019a) [5] conducted the experiment to compare 125watt mercury lamp and 15watt ultraviolet tube are in light trap in the paddy ecosystem. Comparative studies revealed that UV 15 watt has given a higher response than MV 125 watt in some species and in some species MV has given higher response. They observed that ultraviolet light sources (15 watt) seems to be a very good alternative source to MV 125 watt.

As reported by Vaishampayan and Verma (1983) [8] the efficiency of various light sources in attracting night-flying adults of *Heliothis armigera* (Hubner), *Spodoptera litura* (Boisd) and *Agrotis ipsilon* was tested in the field during 1977-1978 in paired tests. Mercury vapor followed by UV proved the best light sources.

Dalvaniya (2010) [3] tested the response of white grubs towards various coloured light sources. Black light (UV) attracted the highest number of insects (42.1per cent) Blue light was next attractant source (22.4per cent) followed by white (18per cent) in both the experiments conducted at different sites.

Sermsri Nichanant and Chonmapat Torasa (2015) [4] proposed Solar Energy-Based Insect Pests Trap has an automatic control system to lure insect pests when there is no sunlight and the system will be stop when the sun shines. The results of the system installation test showed that this proposed Solar Energy-Based Insect Pests Trap could lure several types of insect pests in vegetable and coconut plantations including Brotispa, Elephus beetles, and Aphis, etc.

## Conclusion

Our observations showed that SMV-4 Ultraviolet light is a very good light source for its use in light trap for insect pest survey and control compared to SOLER UV LED light source due to higher response The Ultra Violet light seems to be much cheaper and economic light source.

Results of our studies in conclusion, supported by work done in the past as discussed above showed that Ultra violet light source i.e. UV 15 watt (18'' tube length) is the best light source for operation of light trap. Taking into consideration the total wattage of consumption i.e. UV 15watt (electric powered) v/s UV LED 07 watt (solar powered), the UV LED 07 watt seems to a much cheaper & economic light source than 15watt. Therefore, solar light source (07watt LED UV) seems to be very good alternative source to 15watt for operation of light trap as pest control device. But cost wise compared the both models the solar powered light trap is much costlier.

**Acknowledgement**
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