Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2019; 7(1): 532-537

Received: 11-11-2018
Accepted: 15-12-2018

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Comparative efficiency of ultra violet black light lamp and mercury vapour lamp as a light source in light trap against major insect pest of *Kharif* crops

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Abstract
The experiment was conducted at JNKVV Jabalpur (M.P.) during June to October 2017. Comparative studies of trap catches revealed that Ultraviolet 16 watt (8+8) watt has given higher response than MV 160 watt in following species -*Holotrichia consanguinea, Hyblaea puera* While, Mercury vapour has given higher response than Ultraviolet in following species-*Gryllus bimaculatus, Spilosoma obliqua.* MV has given better response than Ultraviolet in case of *Gryllotalpa orientalis, Plusia chalcites, Spodoptera litura w*ith significant difference between the catches of MV and Ultraviolet. Since, all these four species differences in trap catches were statistically non-significant shows that trapping efficiency of UV was at par with MV light source. In another words Ultraviolet light source can be successfully used for operation of light trap as survey and pest control tool. Taking into consideration the total wattage of electricity consumption of 160 watt in MV v/s 16 watt in Ultraviolet, the Ultraviolet 16 watt (8+8 watt) seems to a much cheaper & economic light source than MV. Besides the economy, the trapping efficiency of Ultraviolet light source is also at par with MV in majority of the species as stated above. In view of these observations, Ultraviolet light source (16 watt) seems to be very good alternative source to MV 160 watt for operation of light traps for monitoring activity and pest control device.

Keywords: light trap, mercury vapour, ultraviolet, insect pest

Introduction
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 as per Dadmal and Khadakkar (2014) [2]. The forecasting and predication of insect occurrence or outbreak can be made by using light trap Singh *et al*. (2007) [9]. Low wattage of ultra violet (Black light) lamps 8/10 and 15 watt with low electricity consumption, maintaining high trapping efficiency, makes these lamps most convenient to operate the light traps with solar electric panel or a set of dry recharging batteries, in the farmer's field or even in remote areas where electricity is not available. Ashfaq *et al*. (2005) [1] studied the effect of different colours on light trap catches and the lights of six different colours were blue, green, yellow, red, black and white. The highest number of insects was observed in container placed under the black light (UV light), while the lowest in that of red light. The common insect orders frequented among all color lights were, Dipteral, Coleoptera, and Lepidoptera. Mercury light was more effective for Lepidoptera, Hemiptera, Hymenoptera, Odonata and Diptera while black light was more efficient for Coleoptera, Orthoptera, Isoptera and Dictyoptera. As reported by Vaishampayan and Verma (1983) [11] the efficiency of various light sources in attracting night-flying adults of *Heliothis armigera* (Hubner), *Spodoptera litura* (Boisd) and *Agrotis ipsilon* (Hufn) was tested in the field during 1977-1978 in paired tests. The light sources were mercury vapor lamps of 125 and 250 watt, UV 15 Watt, Tube light and fluorescent tube light of 40 watt, in shades of white, blue, green, yellow and red, incandescent tungsten lamp of 150 and 300 watt and petromax lamp of 400 candle power. Mercury vapor and UV proved the best light sources while, Incandescent tungsten was the least effective. Blue light radiation in 450-480nm wavelength band proved a more attractive source than green, yellow and red. Mercury vapor lamp of 125 watt was as good as that of 250 watts. Trap catches in petromax light were higher than catches in incandescent light.

The response to ultra violet light was higher in October and November than in February and March. The Mercury vapour lamp and Ultraviolet light are the well-known light sources used in light trap for survey and monitoring of insect pest. Mercury vapour lamp, because of its high wattage (power consumption) and difficulties in installation, heavy weight of chock and expenses in fitting etc. UV light seems to be much cheaper and economic light source than MV source. Present investigations were carried out to keep in mind to test our hypothesis if MV can be replaced satisfactorily by UV (15 to 16) watt light source, maintaining the trapping efficiency almost at same level in majority of insect pest species. In view of above it is proposed to test the practical use of UV light source in light traps as a substitute to MV 160 watt lamp, compared with efficiency of 8+8 watt (16 watt) UV BL lamp 12" in length as a light sources for its use in light trap.

Materials and Methods

The experiment was conducted in JNKVV Jabalpur (MP) during the period from last week of June to last week of October, 2017. The experiment was conducted by using SMV-4 light trap model with Ultraviolet light 8+8 watt (12" tubes each of 8 watt) and Mercury Vapour 160 watt was used as light source. Comparison of Ultraviolet Black light lamp and Mercury Vapour lamp against major insect pest of Kharif crops was based on catches obtained on daily basis by operating the light trap throughout the kharif season and were converted into standard weekly averages. As per the objectives of the study experiments were conducted in the field. Light traps were operated every night and collection was being observed next morning. Observations were recorded every day throughout the *Kharif* season. Total insects fauna was observed and sorted out on the basis of major species and order groups. 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 soybean crop in around 30 ha of crop area. Spacing between each trap 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. It includes two treatments to compare the relative efficiency of Ultraviolet lamp over mercury vapour lamp as light source in a light trap in trapping and collecting insects of various crop pest species. The data so obtained were analyzed by using paired t-test.

T1 - MV (Mercury Vapor) lamp 160 watt

T2 - UV (Ultra Violet) tube 8+8 watt

Results

Comparative efficiency of ultraviolet and Mercury vapour light sources based on response of seven insect pest species namely White grub *H. consanguinea* Field cricket *G. bimaculatus* Mole cricket *G. orientalis* Teak defoliator *H. puera* Soybean Semilooper *P. chalcites* Tobacco caterpillar *S. litura and* Bihar hairy caterpillar *S. obliqua* were identified as important positively phototropic insect pests in the kharif crops because they occoured regularly and significantly high number in trap catches. Species wise description of comparative response to the light sources as follows. (Table No.1).

Table 1 (a): Observations on comparative response of insect pest species towards light sources

Sr. No.	Observation period weekly	Species wise mean per day catch per trap							
		Holotrichia consanguinea		*Gryllus bimaculatus*		*Gryllotalpa orientalis*		*Hyblaea puera*	
		T1	**T2**	**T1**	**T2**	**T1**	**T2**	**T1**	**T2**
		MV	**UV**	**MV**	**UV**	**MV**	**UV**	**MV**	**UV**
1	Jun IV wk	1.57	2.85	165.71	254.86	2.43	2.14	0	0
2	Jul I wk	5.71	5.29	76.43	90.29	3.57	2.85	10.14	13.43
3	Jul II wk	4	5.5	142.63	208.75	6.75	2.25	36	43.5
4	Jul III wk	0	0	1401.67	459	10	3	89.5	70.33
5	Jul IV wk	0	0	193.29	213.86	2.57	3.14	38.57	69.71
6	Aug I wk	0	0	103.83	26.33	3.17	2.5	3.5	3
7	Aug II wk	0	0	100.43	100.28	4.57	6	12.14	12.14
8	Aug III wk	0	0	94.71	58.42	3.86	3.43	9.14	7.29
9	Aug IV wk	0	0	94.14	69.71	3.29	3.14	0	0
10	Sept I wk	0	0	84.17	79.33	10.33	6.83	0	0
11	Sept II wk	0	0	106.29	53.29	19.71	5.71	0	0
12	Sept III wk	0	0	122	109.83	4.33	5.33	0	0
13	Sept IV wk	0	0	122.5	62.25	40.75	13.75	0	0
14	Oct I wk	0	0	76.57	124.29	13.71	9	0	0
15	Oct II wk	0	0	100.13	89.25	18.5	9.25	0	0
16	Oct III wk	0	0	108.57	84.57	11.14	9.71	0	0
17	Oct IV wk	0	0	77	73.11	9.78	12.22	0	0

Table 1(b): Observations on comparative response of insect pest species towards light sources

Sr. No.	Observation period weekly	Species wise mean per day catch per trap					
		Plusia chalcites		*Spodoptera litura*		*Spilosoma obliqua*	
		T1	**T2**	**T1**	**T2**	**T1**	**T2**
		MV	**UV**	**MV**	**UV**	**MV**	**UV**
1	Jun IV wk	0	0	0	0	0	0
2	Jul I wk	0	0	0	0	0	0
3	Jul II wk	0	0	0	0	0	0
4	Jul III wk	0	0	3.33	4.5	0	0

5	Jul IV wk	0	0	9.43	5.57	0	0
6	Aug I wk	17.83	18	4.17	3.17	5.67	6.0
7	Aug II wk	21.71	19.29	4.57	2	4.57	3.14
8	Aug III wk	27	21.42	3.57	4	6.14	3.57
9	Aug IV wk	24.14	20.43	9	6.29	4.14	3.28
10	Sept I wk	31	13.83	9.33	3.67	11.0	10.67
11	Sept II wk	19.86	11.86	15.86	8.71	15.0	6.43
12	Sept III wk	27.17	16.83	9.5	7.67	10.17	11.16
13	Sept IV wk	24.62	12.13	8.38	4.5	5.13	5.25
14	Oct I wk	5.29	6.71	7.57	3.57	5.86	4.57
15	Oct II wk	11.63	8.13	6.88	5.13	2.13	3.50
16	Oct III wk	3.71	4.85	4.14	6.85	1.71	2.57
17	Oct IV wk	4.56	5.56	6.89	4.89	3.22	3.44

1. **White grub *Holotrichia consanguinea* (Hope)**

Table 2: Details of statistics with light sources MV and UV Holotrichia *consanguinea*

Details of statistics with light sources MV and UV	***Holotrichia consanguinea***	
	T1	**T2**
	MV 160 watt	**UV 8+8 watt**
No. of Observation	3	3
Total mean	3.76	4.54
Variance	4.33	2.17
d.f	2	
t_{cal}	1.297 (NS)	
$t_{tab (0.05)}$	4.303	

The calculated value of t (1.297) is found to be less than the tabulated value (4.303) of t (2 df) at 5% level of significance. Hence, we accept the null hypothesis and conclude that there is no significant difference between mean of MV 160 Watt and UV 8+8 Watt. Numerically trap catch was higher in UV than MV. (Fig. No. 1)

2. **Field cricket *Gryllus bimaculatus* (De Geer)**

Table 3: Details of statistics with light sources MV and UV *Gryllus bimaculatus*

Details of statistics with light sources MV and UV	***Gryllus bimaculatus***	
	T1	**T2**
	MV 160 watt	**UV 8+8 watt**
No. of Observation	17	17
Total mean	186.48	126.91
Variance	99070.23	11206.94
d.f	16	
t_{cal}	1.060 (NS)	
$t_{tab (0.05)}$	2.12	

The calculated value of t (1.060) is found to be less than the tabulated value (2.12) of t (16 df) at 5% level of significance. Hence, we accept the null hypothesis and conclude that there is no significant difference between mean of MV 160 Watt and UV 8+8 Watt. Numerically trap catch was higher in MV than UV.(Fig. No. 2)

3. **Mole cricket *Gryllotalpa orientalis* (Burmeister)**

Table 4: Details of statistics with light sources MV and UV *Gryllotalpa orientalis*

Details of statistics with light sources MV and UV	***Gryllotalpa orientalis***	
	T1	**T2**
	MV 160 watt	**UV 8+8 watt**
No. of Observation	17	17
Total mean	9.91	5.90
Variance	92.66	13.51
d.f	16	
t_{cal}	2.265*	
$t_{tab (0.05)}$	2.12	
$t_{tab (0.01)}$	2.921	

The calculated value of t (2.265) is found to be greater than the tabulated value (2.12) of t (16 df) at 5% level of significance. Hence, we reject the null hypothesis and conclude that there is significant difference between mean of MV 160 Watt and UV 8+8 Watt. Numerically trap catch was higher in MV than UV. (Fig. No.3)

4. **Teak defoliator *Hyblaea puera* (Cramer)**

Table 5: Details of statistics with light sources MV and UV *Hyblaea puera*

Details of statistics with light sources MV and UV	***Hyblaea puera***	
	T1	**T2**
	MV 160 watt	**UV 8+8 watt**
No. of Observation	7	7
Total mean	28.43	31.34
Variance	913.86	868.55
d.f	6	
t_{cal}	0.515 (NS)	
$t_{tab (0.05)}$	2.447	

The calculated value of t (0.515) is found to be less than the tabulated value (2.447) of t (6 df) at 5% level of significance. Hence, we accept the null hypothesis and conclude that there is no significant difference between mean of MV 160 Watt and UV 8+8 Watt. Numerically trap catch was higher in UV than MV (Fig. No. 4)

5. **Soybean semilooper *Plusia chalcites* (Esper)**

Table 6: Details of statistics with light sources MV and UV Plusia chalcites

Details of statistics with light sources MV and UV	***Plusia chalcites***	
	T1	**T2**
	MV 160 watt	**UV 8+8 watt**
No. of Observation	12	12
Total mean	18.21	13.25
Variance	92.66	35.67
d.f	11	
t_{cal}	2.868*	
$t_{tab (0.05)}$	2.201	
$t_{tab (0.01)}$	3.106	

The calculated value of t (2.868) is found to be greater than the tabulated value (2.201) of t (11 df) at 5% level of significance. Hence, we reject the null hypothesis and conclude that there is significant difference between mean of MV 160 Watt and UV 8+8 Watt. Numerically trap catch was higher in MV than UV. (Fig. No. 5).

6. Tobacco caterpillar *Spodoptera litura* (Fabricius)

Table 7: Details of statistics with light sources MV and UV *Spodoptera litura*

Details of statistics with light sources MV and UV	*Spodoptera litura*	
	T1	T2
	MV 160 watt	UV 8+8 watt
No. of Observation	14	14
Total mean	7.33	5.04
Variance	11.396	3.38
d.f	13	
t_{cal}	3.265**	
$t_{tab\ (0.05)}$	2.16	
$t_{tab\ (0.01)}$	3.012	

The calculated value of t (3.265) is found to be greater than the tabulated value (2.16) of t (13 df) at 5% level of significance. Hence, we reject the null hypothesis and conclude that there is significant difference between mean of MV 160 Watt and UV 8+8 Watt. Numerically trap catch was higher in MV than UV. (Fig. No. 6)

7. Bihar Hairy caterpillar *Spilosoma obliqua* (Walker)

Table 8: Details of statistics with light sources MV and UV *Spilosoma oblique*

Details of statistics with light sources MV and UV	*Spilosoma obliqua*	
	T1	T2
	MV 160 watt	UV 8+8 watt
No. of Observation	12	12
Total mean	6.29	5.30
Variance	15.48	8.30
d.f	11	
t_{cal}	1.210 (NS)	
$t_{tab\ (0.05)}$	2.201	

The calculated value of t (1.210) is found to be less than the tabulated value (2.201) of t (11 df) at 5% level of significance. Hence, we accept the null hypothesis and conclude that there is no significant difference between mean of MV 160 Watt and UV 8+8 Watt. Numerically trap catch was higher in MV than UV. (Fig. No. 7)

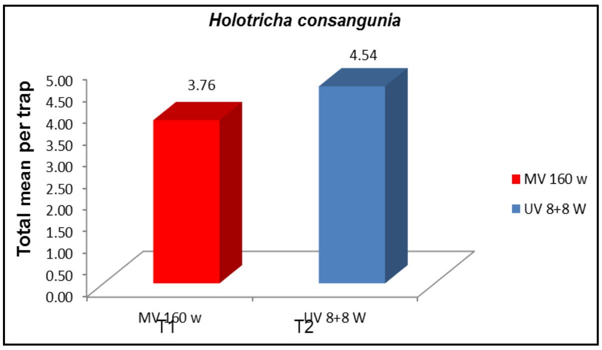

Fig 1: Response of white grub (*Holotrichia consanguinea)*

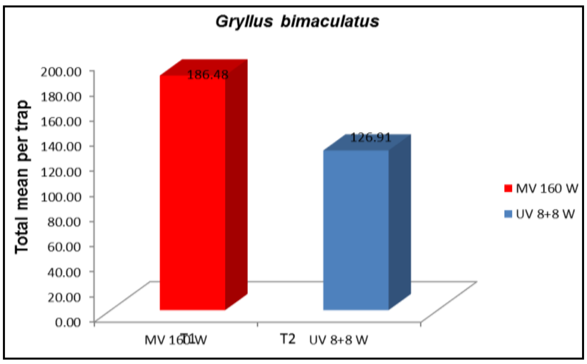

Fig 2: Response of field cricket (*Gryllus bimaculatus*)

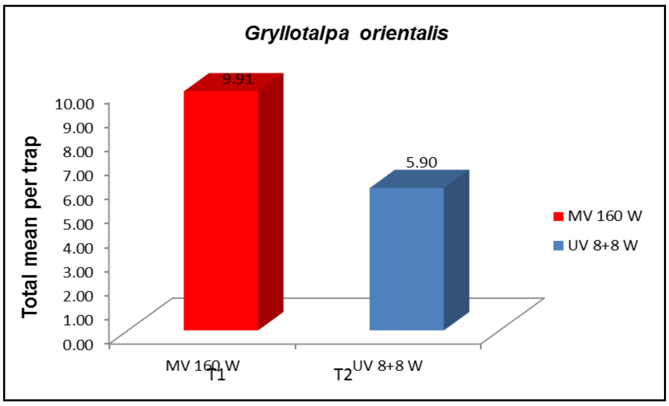

Fig 3: Response of mole cricket (*Gryllotalpa orientalis)*

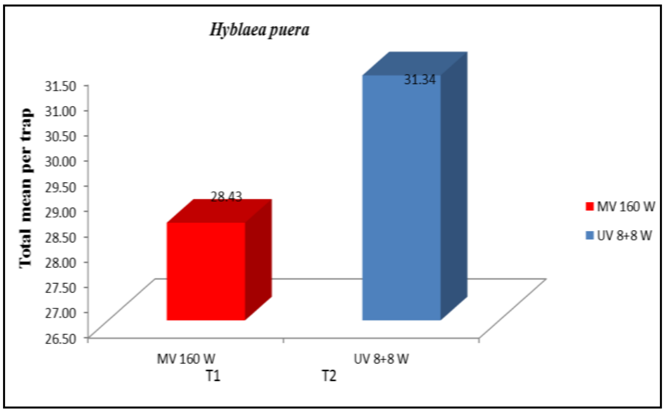

Fig 4: Response of teak defoliator (*Hyblaea puera)*

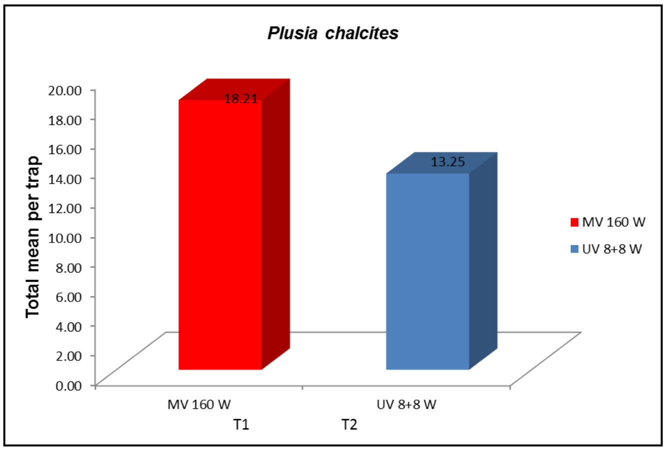

Fig 5: Response of soybean semilooper (*Plusia chalcites)*

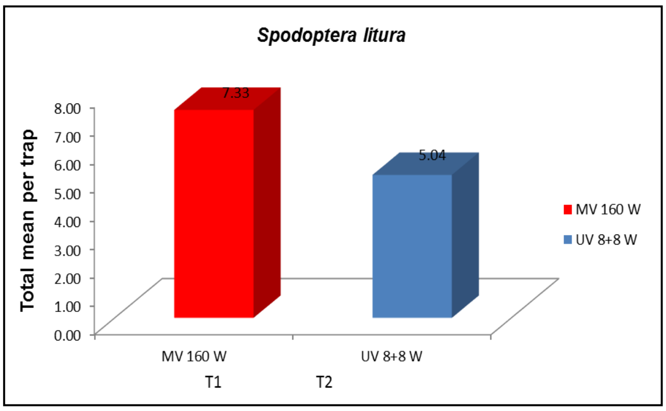

Fig 6: Response of tobacco caterpillar (*Spodoptera litura)*

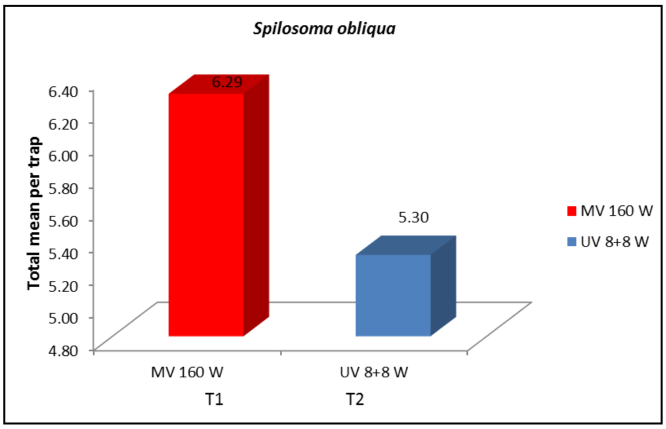

Fig 7: Response of Bihar hairy caterpillar (*Spilosoma obliqua*)

Discussion

Comparison is based on the relative response of the insect pest species (mean per day catch per trap) in UV and MV light source. The discussion was summarized in three head as given below:

Higher response in UV compared to MV: (Statistically non-significant)

1. White grub, *Holotrichia consanguinea* (Coleoptera)
2. Teak defoliator, *Hyblea puera* (Lepidoptera)

In above two species numerically (by number of trap catch), UV 8+8 watt (16 watt) has given higher response i.e better than MV 160 watt, but statistically, differences were non-significant in the trap catch of these two species. Similarly, Dalvaniya (2010) tested the response of white grubs towards various coloured light sources. Black light (UV) attracted the highest number of insects (42.1 per cent) Blue light was next attractant source (22.4 per cent) followed by white (18 per cent) in both the experiments conducted at different sites.

Lower response in UV compared to MV: (Statistically non-significant)

1. Field cricket, *Gryllus bimaculatus* (Coleoptera)
2. Bihar hairy caterpillar, *Spilosoma obliqua* (Lepidoptera)

In above two species numerically (by number of trap catch), MV 160 watt has given higher response than UV 8+8 watt, but statistically, differences were non-significant in the trap catch of these two species.

Lower response in UV compared to MV: (Statistically significant)

1. Mole cricket, *Gryllotalpa orientalis* (Orthoptera)
2. Soybean semilooper, *Plusia chalcites* (Lepidoptera)
3. Tobacco caterpillar, *Spodoptera litura* (Lepidoptera)

In above species numericallay (by number of trap catch), UV 8+8 watt has given lower response than MV 160 watt. Statistically their differences were significant at 5% level of significance in all the three species. Therefore, taking into consideration the relative response, lower wattage consumption, trap catches. UV 8+8 light source seem to be much cheaper and economic light source and a very good substitute to MV 160 watt as a pest control, survey and monitoring device. In contrast Vaishampayan and Verma (1983) [11] reported that the efficiency of various light sources in attracting night-flying adults of *Heliothis armigera* (Hubner), *Spodoptera litura* (Boisd) and *Agrotis ipsilon* (Hufn) was tested in the field during 1977-1978 in paired tests. Mercury vapor followed by UV proved the best light sources. Pfrimmer (1957) observed the response of cabbage looper to different sources of black light i.e.15-watt BL and 15-watt BLB lamps compared with a 100-w mercury vapor lamp. During the years, (1955 & 1956), the BL lamp attracted the greatest number of moths. Catch in Mercury vapor lamp was second highest in 1955 and lowest in 1956. Falcon *et al*. (1967) [4] observed that in black light insect trap effectively trapped moths of cabbage lopper and bollworm in a Fresno county cotton field. Increased collections of moths in the traps were followed by a rise in egg and larva populations in the field. Marshall and Hienton (1935) [6] studied that attraction of codling moths to a wide variety of lamps radiating energy in the visible and ultraviolet regions. Results indicated the most attractive region of the spectrum was between 300 nm and 400 nm, or near ultraviolet and violet. Glick *et al*. (1956) [5] studied on the attraction of pink bollworm moths and verified the greater response to lamp that radiated in the near ultraviolet (black light) region. Otman and Brook (1961) [7] reported that the BL trap proved to be several times more effective than the regular type incandescent light trap for surveying European corn borer. Tashiro and Tuttle (1959) [10] experimented with omnidirectional light trap with 4 baffles using 15 watt BL lamps. Trap captured upto 70 times as many beetles as the most attractive chemically baited traps.

Conclusion

Comparative studies of trap catches revealed that UV 16 watt (8+8) watt has given higher response than MV 160 watt in following species -*Holotrichia consanguinea*, *Hyblaea puera* While, MV has given higher response than UV in following species –*Gryllus bimaculatus*, *Spilosoma obliqua*. MV has given better response than UV in case of *Gryllotalpa orientalis*, *Plusia chalcites*, *Spodoptera litura* with significant difference between the catches of MV and UV. Since, all these four species differences in trap catches were statistically non-significant shows that trapping efficiency of UV was at par with MV light source. In another words UV light source can be successfully used for operation of light trap as survey and pest control tool. Taking into consideration the total wattage of electricity consumption i.e 160 watt in MV v/s 16 watt in UV, the UV 16 watt (8+8 watt) seems to a much cheaper & economic light source than MV. Besides the economy, the trapping efficiency of UV light source is also at par with MV in majority of the species as stated above. In view of these observations, UV light source (16 watt) seems to be very good alternative source to MV 160 watt for operation of light traps for monitoring activity and pest control device. Seasonal activity trends in population graphs in all the species in UV light were quite comparable with MV light source.

Acknowledgement

In presenting this text, I feel highly privileged to Dr. Sanjay Vaishampayan, Senior Scientist, Department of Entomology as the Chairman of my advisory committee, I avail this unique opportunity to express my heartfelt indebtedness for his able guidance, keen interest and inferential criticism during the course of study and preparation of this manuscript. I would like to express my heartfelt thanks to Dr. S.M. Vaishampayan Retired Professor JNKVV Jabalpur for his effective guidance and providing the SMV-4 light trap models for conducting my experimental trials. I am deeply obliged Dr. A.K. Bhowmick, Professor and Head; Dr. A. Shukla, Associate Professor, Department of Entomology and Dr. R. B. Singh, Professor Department of Agricultural Statistics, JNKVV, Jabalpur for their valuable guidance, noble advice and timely suggestions.

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