Research Article

Role of Light Traps in Attracting, Killing and Biodiversity Studies of Insect Pests in Thal

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Abstract | Light traps play important role in field sampling, monitoring, capturing, killing and biodiversity studies of nocturnal insect population. Funnel shaped light traps were used in mungbean and gram crops throughout the year. Effects of light traps were assessed by daily night collections in relation with abiotic factors based on marginal cost benefit ratio. Results indicated that total 32415 insect's captures were made with >26 insect species including 4 species of bio control agents. *Helicoverpa armigera*, *Spodoptera litura*, *Agrotis* Sp., *Bemesia tabaci* and *Microtermes* Spp. were major pests of gram and mungbean attracted in light traps. May, June and July were hottest months of the year with highest population captures of 2892, 2789 and 2475, respectively. Temperature had significant impact of 80.7 % on per unit population attraction (r=0.807). However, humidity had no significant impact (2.9 %) on per unit population attraction in light traps (r=0.029). Increasing adult catches trends of *H. armigera* and *S. litura* had significantly reduced larval populations in the field. Temperature had 12.3, 11.3, 10.5, 7.1 and 6.3 % impact on per unit population change of *Agrotis* Sp., *Microtermes* Spp., *H. armigera*, *S. litura* and *B. tabaci* respectively. While humidity had 25.6, 6.3, 1.6, 0.9 and 0.7 % impact on population change of *Microtermes* Spp., *S. litura*, *H. armigera*, *Agrotis* Sp. and *B. tabaci* respectively. MCBR indicated light traps as least cost tool and gave maximum yield having MCBR ratio 1:8.93 in comparison with farmer field (1:2.85).

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Introduction

Light trap is used to determine seasonal pattern of insect pest fluctuations in the all major crops, vegetables and orchards. It is very effective tool for the monitoring and controlling of both sexes insect pests which resultantly reduces the pest pressure on crop. It provides information related to insect distribution, abundance, flight patterns and exact time for insect management (Singh and Bambawale, 2012). There are thousands of insect species which are nocturnal and cannot be collected by conventional methods of insect control. For such insect's light traps are best sampling tools (Szentkiralyi, 2002; Axmacher and Fiedler, 2004). For example, largest order Lepidoptera (butterflies/moths) has 160000 species of which 95 % are nocturnal moths (Kristensen et al., 2007; New, 2004). So, the proper documentation is important to study diversity and population dynamics. This method is also effective for attracting insect species of order Coleoptera, Diptera, Hymenoptera and Neuroptera. Light traps are effective to collect the insects like moths, beetles, bugs and some flies etc. Some nocturnal insects can only be attracted during particular point of night (Kitching and Cadiou, 2000). Farmers must be aware that by attracting and killing one adult moth they can control around 300-400 insect progenies. Recently declines of moth populations have been observed. For instance, in Great Britain the abundance of moths was decreased by 28 % from 1968-2007 (Fox et al., 2013) and similar declining trends were found in Sweden (Franze and Johannesson, 2007) and the Netherlands (Groenendijk and Ellis, 2011). Once the insect population in the light traps crosses a certain limit, the farmers can decide on the type of management strategy. Light traps are expensive but very efficient for collection of insects (Liu et al., 2007). Different light sources like mercury vapour lamps, gas lamps and UV light tubes are been used (Brehm and Axmacher, 2006). With a minimum effort light trapping yields large number of insect specimens (Holloway et al., 2001) but automatic light traps are more efficient because these traps do not require farmer to examine all the time. Efficiency of light traps is affected by many factors like trap size, design, bulb type and environmental factors. Efficiency of light traps can be calculated correctly by keeping in mind the temperature, air humidity, rainfall, wind speed, moonlight and cloud cover (Beck et al., 2011). Keeping in view the efforts to reduce insecticides application and proper documentation of insect pest species, the current study was planned to check the effectiveness of light traps in major pulses of Thal crops. Efficacy of light traps were assessed by computing Marginal Cost Benefit Ratio of major pulses crops i.e. gram, mungbean.

Materials and Methods

Experiment was conducted at Arid Zone Research Institute, Bhakkar to evaluate the efficacy of light traps in gram and mungbean crops under irrigated conditions during 2017-18. Treatment consists of 1 hectare area, same variety and sowing date with control plot. Local made funnel shaped light traps @ 2/ha were installed throughout the year. Light traps were installed 30 days before sowing till 30 days after harvesting. Trap was hanged 1.5 m above the ground. The light source was provided by alternate current with LED 24 watts from dawn to dusk. At the base of trap a poison bottle having potassium cyanide with a layer of plaster of parris was hanged for the killing purpose. Adult catches were recorded on daily basis. Dead insect were identified and pinned in the collection boxes. Collections of natural enemies were maintained separately from other insect pests. Effects of moth catches were evaluated on the bases of larval population of major insect pests in the treated as well as the control plot. In addition to major pests of gram and mungbean, many other species of various pests were also attracted. Regression and correlation studies of only major pests of gram and mungbean were calculated by Minitab 17. Marginal Cost Benefit Ratio was calculated separately for both crops by using following mathematical equation.

$$\text{Yield increase (\%)} = \frac{\text{Yield gain} - \text{Yield of control}}{\text{Yield of control}} \times 100$$

$$\text{Marginal CBR} = \frac{\text{Net Income (Rs)}}{\text{Cost of treatment (Rs)}}$$

Results and Discussion

Light traps are the important component of Integrated Pest Management against various crop pests.

Table 1: *Frequency of different insect species attracted through light traps/ha during 2017-18.*

Sr. No.	Name of insect/Pest species	Total captures /ha	Crop specific pest
1	American Bollworm (*Helicoverpa armigera*)	1723	Mungbean, Gram, Wheat, Vegetables, Cotton, Maize etc
2	Armyworm (*Spodoptera litura*)	3955	Mungbean, Gram, Wheat, Vegetables, Cotton etc
3	Cutworm (*Agrotis* Sp.)	1725	Seedlings of Mungbean, Gram, Wheat, Vegetables, Cotton etc.
4	Whitefly (*Bemesia* sp.)	2875	Mungbean, Cotton etc
5	Termites (*Microtermes* Spp.)	1681	All crops, vegetables and ornamentals
6	Field Crickets (*Gryllus* Spp.)	124	-
7	Leaf Folder (*Cnaphalocrocis medinalis*)	495	-
8	Hairy Catterpiller (*Euproctis lunata*)	186	Oilseed and fodder crops
9	Aphids (*R. padi, S. graminum, S. avenae, M. rosae*)	12854	Wheat, Ornamentals
10	Leafminer (*Phyllocnistis citrella*)	394	Citrus, Vegetables
11	Till hawk moth (*Acherontia* Spp.)	79	Weeds, Ornamentals
12	Dung Beetle (*Onthophagus gazelle*)	728	-
13	Ground Beetle (*Calosoma* Spp.)	673	-
14	Green Bug (*Chinavia hilaris*)	349	Mungbean, Gram, Vegetables, Cotton
15	Stink Bug (*Halyomorpha halys*)	291	Mungbean, Gram, Vegetables, Cotton
16	Grey weevil (*Myllocerus virdidanus*)	112	Mungbean, Cotton
17	Others (ants, grasshopper, cockroach, damselfly, click beetle, earwig, water beetle etc)	3375	-
Some Beneficial Fauna			
18	Lady Bird Beetle (*Coccinella septempunctata*)	174	-
19	Lacewing (*Chrysoperla Carnea*)	529	-
20	Preying mantis (*Mantis religiosa*)	55	-
21	Honey Bees (*Apis mallifera*)	38	-

These traps only attract the adult stage of different insects. So, these traps are indirectly important to reduce adult population in the field thus suppresses the larval population of various pests. During current studies main focus was to attract and kill adult population of mungbean, gram and wheat pests. More than 26 insect species including 4 species of natural enemies were attracted through light traps. 32415 adult catches of insects were made during 2017-18 of which 16086 were important pests of gram, mungbean and other pulses. These pests were *Helicoverpa armigera*, *Spodoptera litura*, *Agrotis* Sp., *Bemesia tabaci*, *Microtermes* Spp., *Chinavia hilaris*, *Halyomorpha halys* and *Myllocerus virdidanus* with 1723, 3955, 1725, 6250, 1681, 349, 291, and 112 captures respectively, during different time periods and environmental conditions as shown in Table 1. Four natural enemies of different pests were attracted of which *Chrysoperla Carnea* had maximum 529 captures during study years. Population captures of different pests were increased by increasing the environmental temperature. More hot temperature had attracted more populations. Population captures were decreased during cold months as shown in Figure 1.

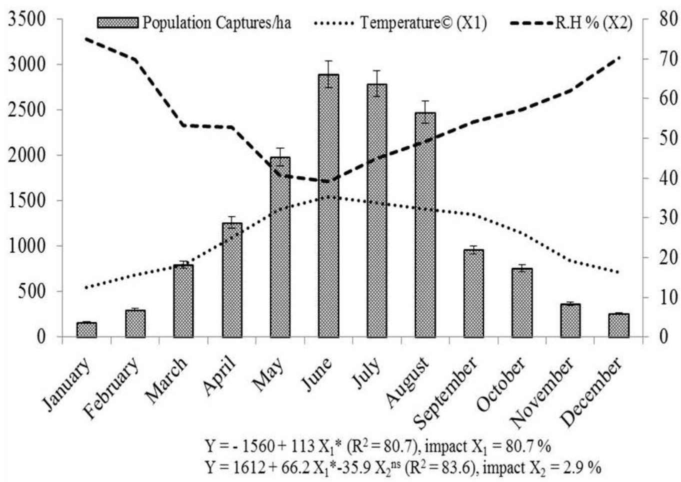

Figure 1: *Total adult moth population captures/hactare/year.*

May, June and July were hottest months of the year with high population captures of 2892, 2789 and 2475, respectively. Temperature had significant impact of 80.7 % on per unit population attraction (r=0.807). However, humidity had no significant impact (2.9 %) on per unit population attraction in light traps (r=0.029). Adult captures had significant relation with the larval/nymph population of major insect pests in mungbean and gram fields. In untreated plots larval population of *H. armigera* and *S. litura* had positive and significant correlation with adult catches in the light traps of treated plots. Larval populations in the untreated plots were increasing while decreasing trends of larval population was found in the treated plots. *Agrotis* Sp. had positive but non-significant while *B. tabaci* and *Microtermes* Spp. had negative and non-significant correlation as shown in Table 2.

Table 2: *Relationship of larval population in the untreated plot and adult population in light traps.*

Sr. No.	Larval/Nymph population	Adult moth catches
1	American Bollworm (*Helicoverpa armigera*)	0.854** ± 0.562
2	Armyworm (*Spodoptera litura*)	0.685** ± 0.236
3	Cutworm (*Agrotis* Sp.)	0.152 ns ± 0.025
4	Whitefly (*Bemesia tabaci*)	-0.058 ns ± 0.235
5	Termites (*Microtermes* Spp.)	-0.259 ns ± 0.569

Table 3: *Relationship of larval and adult population in the plots treated with light traps.*

Sr. No.	Adult moth catches	Larval/Nymph population
1	American Bollworm (*Helicoverpa armigera*)	-0.184* ±0.325
2	Armyworm (*Spodoptera litura*)	-0.345* ±0.986
3	Cutworm (*Agrotis* Sp.)	0.152 ns ±0.175
4	Whitefly (*Bemesia tabaci*)	-0.058 ns ±0.075
5	Termites (*Microtermes* Spp.)	0.146 ns ± 0.059

So, the larval population in the untreated plots was increasing. In the treated plots when adult catches increased, it decreased larval/nymph populations on the crop. Adult catches of *H. armigera* and *S. litura* had negative but positive correlation with larval/nymph population on the crop. *Agrotis* Sp. and *Microtermes* Spp. had positive non-significant while *B. tabaci* negative non-significant corealtion with larval/nymph population on the crop as shown in Table 3. Regression studies of adult catches in the light traps were carried in relation with temperature and humidity. Where temperature had 12.3, 11.3, 10.5, 7.1 and 6.3 % impact on per unit population change of *Agrotis* Sp., *Microtermes* Spp., *H. armigera*, *S. litura* and *B. tabaci* respectively. While humidity had 25.6, 6.3, 1.6, 0.9 and 0.7 % impact on population change of *Microtermes* Spp., *S. litura*, *H. armigera*, *Agrotis* Sp. and *B. tabaci* respectively, as shown in Table 4. Marginal Cost Benefit Ratio (MCBR) was calculated to check the cost effectiveness of light traps. MCBR was calculated in comparison with farmer field and a control treatment having no application either insecticides or light traps. Light traps were proved least cost and gave maximum yield having MCBR ratio 1:8.93 in comparison with farmer field having MCBR ratio 1:2.85.875, 770 and 587 kg/ha grain yield of gram was obtained in light traps field, farmer field and control plot respectively. Similarly, for Mungbean crop MCBR ratio was 1:5.92 in comparison with farmer field having MCBR ratio 1:1.26. 1056, 952 and 805 kg/ha grain yield was obtained in light traps field, farmer field and control plot respectively. Insects attracted through light traps mainly belong to order Lepidoptera, Hemiptra and Coleoptera. Dadmal and Khadakkar (2014) find similar results that revealed light traps had rich populations of Coleoptera (35.10-41.81 %) followed by Hemiptera (16.86-21.77 %) and Lepidoptera (12.89-12.96 %) during two years of investigations. Ramamurthy et al. (2010) also reported similar results. Dillon and MacKinnon (2002) tested nine light traps in 16 hectare area. Total 29470 *Helicoverpa* moths were captured in a year with 18-246/trap/night. While in our study only 1723 *Helicoverpa* moths were captured in year. This difference may be due different agro ecological zone with different test crop with large experimental area. June, July and August were the most active periods of insects attracted through light traps. However larger amounts of insects were captured from May-August. These results were confirmed by Muirhead-Thomson (1991), Holyoak et al. (1997), Holloway et al. (2001), Brehm (2002), Ullah et al. (2015) and Bhandari et al. (2017). Jonson et al. (2014) reported that light traps catches of 25 % species peaked during March-May, 65 % during June-August and 10 % during September-October. Temperature had positive and significant correlation with moth catches while humidity had non-significant correlation. Larval population in the tested fields had negative and significant correlation with moth catches in light traps. Larval population of major pest *Helicoverpa* was decreased when moth catches in light traps was increased. Dillon and MacKinnon (2002) reported

Table 4: *Regression studies of adult catches in the light traps with environmental conditions.*

Parameters	Regression equation	Impact (%)	
		Temperature °C	Humidity %
American bollworm (*Helicoverpa armigera*)	$= -10.1+0.422\ X_1^{*}+ 0.346\ X_2^{ns}$	10.5	1.6
Armyworm (*Spodoptera litura*)	$= -15.6+0.022\ X_1^{ns} + 0.143\ X_2^{ns}$	7.1	6.3
Cutworm (*Agrotis* Sp.)	$= -8.4+0.182\ X_1^{*}+ 0.083\ X_2^{ns}$	12.3	0.9
Whitefly (*Bemesia tabaci*)	$= -5.93+0.0126\ X_1^{ns}+0.0954\ X_2^{ns}$	6.3	0.7
Termites (*Microtermes* Spp.)	$= -6.13+0.125\ X_1^{*}+0.0369\ X_2^{*}$	11.3	25.6

X_1: Temperature °C X_2: Humidity %.

Table 5: *Effect of Light Traps on Net income and Marginal benefit cost ratio.*

Treatments	Yield (kg/ha)	Additional yield over control (kg/ha)	Additional income (Rs/ha)	Treatment Cost (Rs/ha)	Net income (Rs/ha)	Marginal BCR ratio
Gram/Chickpea						
Control	587					
Light trap	875	288	28800	2900	25900	8.93
Farmer field	770	183	18300	4750	13550	2.85
Mungbean						
Control	805					
Light trap	1056	251	20080	2900	17180	5.92
Farmer field	952	147	11760	5126	6634	1.29

Average market rates: Mungbean Rs.80/kg; Gram/Chickpea Rs.100/kg.

light traps a successful tool to reduce egg laying of *Helicoverpa* by suppressing their moth populations through light traps. Van Langevelde (2011) reported positive correlation with ambient temperature and negative with air humidity in contrast with Holyoak et al. (1997) who reported positive correlation of humidity and moth catches. Gullan and Cranston (2010) observed that species richness and abundance were affected by the temperature and light source while moth abundance decreased by increase in air humidity. Ramamurthy et al. (2010) reported that temperature had most significant relationship with total insect catch (r=0.36) followed by rainfall (r=0.24). These findings are somewhat agreement with our study where temperature had significant relationship while humidity had positive relationship only in case of termites (r=0.25). No reports were found regarding Marginal Cost Benefit Ratio of light traps. Different scientists have used light traps in various IPM techniques and calculated MCBR in combination with other treatments. Rahman et al. (2016) studied different IPM approaches against *Helicoverpa* on tomato crop. He reported 0.69-3.41 Marginal BCR in different IPM approaches. Mahmudunnabi et al. (2013) concluded cost benefit ratio 0.64-2.11 under different treatments. Suganthy and Kumar (2000) concluded that IPM was best treatment with ideal cost benefit ratio (1:6.3) as compared to other treatments.

Conclusions and Recommendations

Light traps are the best tool for the monitoring, attraction, killing and biodiversity studies of pulses insect pest of Thal regions. This is best insect population controlling tool which can easily be manufactured at homes or small markets with idea Marginal Cost Benefit Ratio.

Author's Contributions

Muneer Abbas: Conducted research, data collection, species identification and manuscript writing.
Muhammad Ramzan: Layout experiment and species identification.
Niaz Hussain: Analysis of results and proof read.
Abdul Ghaffar: Layout of experiment and analysis of results.
Khalid Hussain: Proof read.
Sohail Abbas: Data collection and species identification.
Ali Raza: Data collection.

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