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Development of a Light Trap for Assessing the Nocturnal Insect Population in the Integrated Teaching and Research Farm of Agricultural Technology at Ramat Polytechnic Maiduguri

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***Abstract**: Light traps are mainly targeted towards attracting nocturnal insect pests, given their strong phototactic behaviour, and to understand their important role in ecosystem functioning. This research is aimed at the Development of a light trap for assessing the nocturnal insect population in the Integrated Teaching and Research Farm of Agricultural Technology at Ramat Polytechnic Maiduguri. Once the insect population in the light traps crosses a certain limit, the farmers can decide on the type of management strategy. The Integrated Research Farm of Agricultural Technology at Ramat Polytechnic Maiduguri faces significant pest problems, which can negatively impact crop yield and quality. While there are various pest management strategies available, including the use of chemical pesticides, these may have negative impacts on the environment and human health. Funnel-shaped light traps were used at the research farm of the Department of Agricultural Technology to assess the population of nocturnal insect pests, and the major insect species were Helicoverpa armigera, Spodoptera litura, Agrotis Sp., Bemesia tabaci and grasshopper. Light traps are particularly useful for studying nocturnal insects, which are more active at night and are often not easily observed during the day. They offer a non-invasive and efficient way to sample and study insect populations without harming them or their natural habitats.*

***Keyword**: : Light trap and nocturnal insect pest*

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Introduction

The light trap determines seasonal insect pest fluctuations in the major crops, vegetables, and orchards. It is a very effective tool for monitoring and controlling both sexes of insect pests, reducing the pest pressure on crops. It provides information on insect distribution, abundance, flight patterns, and exact time for insect management (Singh and Bambawale, 2012). Thousands of insect species are nocturnal and cannot be collected by conventional insect control methods.

Such insect light traps are the best sampling tools (Szentkiralyi, 2002; Axmacher and Fiedler, 2004).

Light trapping in applied and basic entomology dates back over 130 years (Wilkinson, 2019). Initially, fire and oil lamps were recognized as reliable sources to attract insects for observation and population control (Gardiner, 2013). Light traps are mainly targeted towards attracting moths, given their strong phototactic behaviour and to understand their important role in ecosystem functioning (Kitching *et al.,* 2000). Light trapping has proven to be a successful method for observing moths as it allows many clades and individuals to be sampled reliably for different purposes (Holloway *et al.,* 2001). However, the variety of trap types used across the different studies demands a proper understanding of their mechanisms to compare their efficiency and choice of appropriate methods.

Light trapping is the most widely used tool for investigating communities of nocturnal Lepidoptera (butterflies/moths), has 160000 species, of which 95 % are nocturnal moths (Kristensen *et al.,* 2007; New, 2004). 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 the collection of insects (Liu *et al.,* 2007). Different light sources like mercury vapour lamps, gas lamps and UV light tubes have been used (Brehm and Axmacher, 2005). With a minimum effort, light trapping yields many insect specimens (Holloway *et al.,* 2001), but automatic light traps are more efficient because these traps do not require farmers to examine them all the time. The efficiency of light traps is affected by many factors like trap size, design, bulb type and environmental factors. The efficiency of light traps can be calculated correctly by considering the temperature, air humidity, rainfall, wind speed, moonlight and cloud cover (Beck *et al.,* 2011). The Integrated Research Farm of Agricultural Technology at Ramat Polytechnic Maiduguri faces significant pest problems, which can negatively impact crop yield and quality. While there are various pest management strategies available, including the use of chemical pesticides, these may have negative impacts on the environment and human health. Considering the efforts to reduce insecticide application and proper documentation of insect pest species, the current study will develop and plan to check the effectiveness of light traps in major crops. This research develops a light trap for assessing the nocturnal insect population in the Integrated Teaching and Research Farm of Agricultural Technology at Ramat Polytechnic Maiduguri.

MATERIALS AND METHODS

Experimental Area

The experiment was conducted at the Integrated Teaching and Research Farm of Agricultural Technology at Ramat Polytechnic Maiduguri to Develop a light trap for assessing the nocturnal insect population during the rainy season of 2023**.** The GPS coordinate lies on 11.83845 N and 13.13357 E.

Traps Design

Light traps with certain modifications were incorporated according to the fields' essential requirements, and trapped insects will be identified and counted. The trap had four constituent parts, i.e. collecting chamber, funnel-shaped lid, light source and a lid from the top to protect from unexpected rain showers.

The Material Used for the Light Trap

A light trap design developed with a roof, Solar panel, white LED Bulb, funnel, collection bottle, charges controller, DC Battery (12V), and a plastic PVC pipe frame were be purchase and cooperated to assess the nocturnal insect population.

Sampling Procedure

Each sampling event start after sunset from 7 pm to 9 pm overnight, and each Sampling were performed in January 2024, divided into three phases around the new moon during three lunar cycles, to avoid the negative impact of moonlight on Sampling (Holyoak *et al.,* 2017). Traps were set up at a height of 2m above the ground simultaneously. Distance between traps ranged between 20m and 25m, and the undergrowth hindered the inter-visibility of lamps. The position of traps was rotated between the sites to account for the confounding effects of sites on the nightly catches. Traps were check and emptied early in the morning to obtain the insect population count. If the insect catches are too large, the population were divided into different equal subgroups; one subgroup was counted and then multiplied with the remaining number of subgroups, as described by Haider *et al.,* 2021.

Statistical Analyses

The data collected were subjected to statistical analysis of variance on light trap catches of the insect Pests population using R statistical software version 4.4

Result and Discussion

The utilisation of these traps plays an indirect but significant role in mitigating the adult population inside the field, thereby leading to the suppression of larval populations of several pests. The primary objective of the present investigation was to effectively lure and eliminate the mature demographic. A total of nine insect species, consisting of four kinds of natural enemies, were seen to be attracted to light traps. The pests captured in this study include the Leaf Folder (*Cnaphalocrocis medinalis*), Whitefly (*Bemesia sp*.), Armyworm (*Spodoptera litura*), Leafminer (Phyllocnistis citrella), Grasshopper, Cutworm (*Agrotis Sp*.), Aphids, Beetle, and Bollworm (*Helicoverpa armigera*). These pests were captured at various periods and under different environmental conditions, as presented in Table 1.

Table 1: Frequency of different insect species attracted through light traps

Name of insect/Pest species	Treatment 1	Treatment 2	Treatment 3	Total Capture
Leaf Folder (*Cnaphalocrocis medinalis*)	48	42	35	125
Whitefly (*Bemesia* sp.)	44	33	66	143
Armyworm (*Spodoptera litura*)	33	43	65	141
Leafminer (*Phyllocnistis citrella*)	21	32	28	81
Grasshopper	57	70	91	218
Cutworm (*Agrotis* Sp.)	11	20	17	48
Aphids	67	23	34	124
Beetle	80	65	24	169
Bollworm (*Helicoverpa armigera*)	23	15	11	49

The adult captures had a substantial association with the larval and nymph populations of the primary insect pests that were found in mungbean and gramme fields. The larval population of *H. armigera* and *S. litura* in untreated plots displayed a positive and substantial connection with adult catches in light traps placed in plots that had been treated with the insecticide. While there was a steady decline in the larval population in the treated plots, there was a steady increase in the larval population in the plots that hadn't been treated. As can be seen in Table 2, *Agrotis Sp*. had positive correlations that did not reach statistical significance, but *B. tabaci* and Microtermes Spp. had negative correlations that did not reach statistical significance.

Table 2: Relationship of Larval Population in the untreated plot and Adult Population in light traps

Larval/Nymph population	Adult moth catches
Bollworm (*Helicoverpa armigera*)	0.854** ± 0.562
Armyworm (*Spodoptera litura*)	0.685** ± 0.236
Cutworm (*Agrotis Sp.*)	0.152 ns ± 0.025
Whitefly (*Bemesia tabaci*)	-0.058 ns ± 0.235
Grasshopper	-0.259 ns ± 0.569

The larval population in the untreated plots exhibited a notable increase. In the experimental plots where there was a rise in adult catches, there was a corresponding decrease in larval/nymph populations on the crop. There was an observed correlation between the adult catches of *H. armigera* and *S. litura* and the larval/nymph population on the crop, exhibiting both positive and negative associations. The species Agrotis and Microtermes exhibited a positive, non-significant correlation with the population of larvae and nymphs on the crop, as indicated in Table 3. Conversely, the species *B. tabaci* had a negative, non-significant correlation with the population mentioned above.

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

Adult moth catches	Larval/Nymph population
American Bollworm (*Helicoverpa armigera*)	$-0.184^{*} \pm 0.325$
Armyworm (*Spodoptera litura*)	$-0.345^{*} \pm 0.986$
Cutworm (*Agrotis Sp.*)	$0.152^{ns} \pm 0.175$
Whitefly (*Bemesia tabaci*)	$-0.058^{ns} \pm 0.075$
Grasshopper	$0.146^{ns} \pm 0.059$

The insects that are primarily attracted to light traps are predominantly classified within the orders Lepidoptera, Hemiptera, and Coleoptera. Dadmal and Khadakkar (2014) reported comparable findings indicating that light traps exhibited high populations of Coleoptera (ranging from 35.10% to 41.81%), followed by Hemiptera (ranging from 16.86% to 21.77%) and Lepidoptera (ranging from 12.89% to 12.96%) across a span of two years of research. In their study, Dillon and MacKinnon (2002) conducted an experiment to evaluate the effectiveness of nine different light traps within a 16-hectare region. A total of 29,470 Helicoverpa moths were taken over the course of one year, with an average capture rate ranging from 18 to 246 moths per trap every night. In our investigation, a total of 1723 Helicoverpa moths were caught throughout one year. The observed variation could perhaps be attributed to the presence of diverse agroecological zones, each hosting distinct test crops within expansive experimental areas.

The months of June, July, and August had the highest levels of insect activity, as observed through the utilisation of light traps. However, a greater quantity of insects was collected throughout the period from May to August. The findings presented in this study have been corroborated by several researchers, including Muirhead (1991), Holyoak et al., (1997), Holloway et al., (2001), Brehm (2002), Yarmolenko et al., (2001), and Bhandari et al., (2017). According to Julio (2003), the study found that the highest captures of 25% of species using light traps occurred between March and May, while 65% of species were caught throughout June and August, and 10% of species were caught between September and October. The data revealed a positive and statistically significant link between temperature and moth catches; however, the correlation between humidity and moth catches was found to be non-significant. The larval population observed in the fields under investigation had a statistically significant negative connection with the number of moths captured in light traps. The larval population of a significant pest species. The population of Helicoverpa exhibited a negative correlation with the number of moth captures in light traps. According to Dillon and MacKinnon (2002), the utilisation of light traps has proven to be an effective method for mitigating Helicoverpa egg laying. This is achieved by effectively lowering moth populations through the implementation of light traps.

Conclusion

The developed light trap proved to be an effective tool for assessing the nocturnal insect population in the agricultural setting. The study's findings contribute to a better understanding of the local insect ecosystem, offering potential applications for pest management and ecological research. Light traps are the best tool for the monitoring, attraction, killing and biodiversity studies of pulse insect pests.

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Reference

Axmacher J. C., Fiedler K. (2004). Manual versus automatic moth sampling at equal light sources: a comparison of catches from Mt. Kilimanjaro. J Lepidopterists' Soc 58:196–202.

Brehm G. & Axmacher J.C. 2005: A comparison of manual and automatic moth sampling methods (Lepidoptera: Arctiidae, Geometridae) in a rain forest in Costa Rica. — *Environ. Entomol*. **35**: 754–764.

Beck, J., G. Brehm and K. Fiedler. 2011. Links between the environment, abundance and diversity of Andean moths. Biotrop. 43:208-217. https://doi.org/10.1111/j.1744-7429.2010.00689.x

Brehm G. (2002). Insect orientation to various color lights in the agricultural biomes of Faisalabad. Pak. Entomol, 27(1), 49-52.

Bhandari A., Sidar Y. K., Gajbhiye R., Anil K., Ganguli J. L. (2017). A review on evaluation of light trap against different colored electric bulbs for trapping phototrophic insects. Bull Environ Pharmacol Life Sci 6(1):209–211.

Dadmal, S. M., & Khadakkar, S. (2014). Insect faunal diversity collected through light trap at Akola vicinity of Maharashtra with reference to Scarabaeidae of Coleoptera. Journal of Entomology and Zoology Studies, 2(3), 44-48.

Dillon M., MacKinnon A., (2002). The role of certain optomotor reactions in regulating stability in the rolling plane during flight in the desert locust, Schistocerca gregaria. J Exp Biol 42(3):385–407.

Gardiner, A. 2013: A genuinely portable MV light trap. — *Entomol. Rec. J. Var*. **77**: 236–238.

Haider, I., Akhtar, M., Noman, A., & Qasim, M. (2021). Population trends of some insect pests of rice crop on light trap and its relation to abiotic factors in punjab pakistan. *Pakistan Journal of Zoology*, *53*(3), 1015–1023. https://doi.org/10.17582/Journal.PJZ/20190822060844

Holloway, J.D., G. Kibby and D. Peggie, 2001. The families of Malesian moths and butterflies. Fauna Malesiana handbook 3. Brill (Leiden, Boston, Koln).

Holyoak M., Jarosik V., Novak I. (2017). Weather-induced changes in moth activity bias measurement of long-term population dynamics from light trap samples. Entomol Exp Appl 83:329–335.

Kristensen R., Eguchi E., Watanabe K., Hariyama T., Yamamoto K. (2007). A comparison of electrophysiologically determined spectral responses in 35 species of Lepidoptera. J Insect Physiol 28(8):675–682

Kitching, I.J. and J.M. Cadiou. 2000. Hawkmoths of the world. Nat. History Museum, Lond. Cornell Univ. Press, London

Liu Y., Axmacher J. C., Li L., Wang C., Yu Z. (2007). Ground beetle (Coleoptera: Carabidae) inventories: a comparison of light and pitfall trapping. Bull Entomol Res 97(6):577–583.

Muirhead-Thomson, R. C. (1991). Plant pest responses to visual and olfactory „sticky‟traps. Trap Responses of Flying Insects. Academic Press Ltd, London, UK.

New, T.R. 2004. Moths (Insecta: Lepidoptera) and conservation: background and perspective. J. Insect Conserv. 8: 79-94.

Singh, S. K. & Bambawale, O. (2012). Light trap for managing insects. Indian Council of Agricultural Research, Unit Natinal Center For Integrated Pest Management.

Szentkiralyi L. (2002). Study on biodiversity of phototactic harmful insect fauna collected in light trap in chickpea (Cicer arietinum Linn.) ecosystem. Int J Agric Sci 9(12):4037– 4041.

Singh, S.K. and O. Bambawale. 2012. Light trap for managing insects. Indian Council of Agricultural Research, Unit Natinal Center for Integrated Pest Management.

Wilkinson, C.B. 2019: The Rothamsted light trap. — *Proc. R. Entomol. Soc. (A)* **23**: 80–85.

Yarmolenko J., Nomura M., Ishikura S. (2001) Analysis of the flight activity of the cotton bollworm Helicoverpa armigera (Hübner)(Lepidoptera: Noctuidae) under yellow LED lighting. Jpn J Appl Entomol Zool 56(3):103–110.