# Evaluating the Influence of Different Colors on Nocturnal Insects Attraction: Behavioral and Ecological Implications

**Pawan Kumbhar[1], A. R. Bhusnar[2]**

[1,2]Department of Zoology, Yashwantrao Chavan Warana Mahavidyalaya, Warananagar.

**Abstract**

This study investigates the phototactic behavior of insects in response to different wavelengths of light, specifically red, blue, and white light. Phototaxis, the movement of organisms toward or away from light, plays a crucial role in insect navigation, foraging, mating, and migration. The experiment involved using light traps exposed to the three light colors from 7:00 PM to 10:00 PM over a 15-day period to assess insect attraction. Due to the sensitivity of insect compound eyes to shorter wavelengths, nocturnal species were hypothesized to be most attracted to blue light, which resembles natural twilight and serves as a navigational cue. In contrast, red light was expected to elicit minimal attraction due to its longer wavelength, which many insects cannot detect effectively. White light, containing a broad range of wavelengths, was anticipated to produce a mixed response depending on species-specific visual sensitivity. The findings provide insight into how light wavelength influences insect phototaxis, with potential applications in ecological research and pest management strategies.

**Keywords:** Phototactic, Light colors, Insect, Attraction.

## Introduction

Insects exhibit a strong responsiveness to light, a behavior known as phototaxis. This behavior is essential for their navigation, foraging, mating, and migration. Phototaxis can be classified as positive, where insects move toward light, or negative, where they move away from it. Additionally, different wavelengths of light can influence their orientation in various ways.

This study examines the orientation of insects toward different wavelengths of light, specifically red, blue, and white light. Variations in light color (wavelength) can have distinct effects on insects due to the unique characteristics of their visual systems. For example, many insects are highly sensitive to ultraviolet (UV) and blue light, while red light tends to be less effective in attracting them. Understanding how insects respond to these light sources provides valuable insights into their behavior, ecological interactions, and the physiological mechanisms underlying phototaxis.

This research aims to investigate how insects orient themselves under the influence of different colored lights. By analyzing their responses to red, blue, and white light, the study seeks to deepen our understanding of the role light plays in insect orientation. The findings could have practical applications in fields such as pest control, conservation, and the development of insect-attracting technologies.

A thorough understanding of light and its interaction with insects is crucial for the framework of this experiment. The light spectrum comprises seven colors: red, orange, yellow, green, blue, indigo, and violet. This study focuses on three colors—red, white, and blue. Each color in the spectrum has a distinct wavelength and frequency, with red light characterized by the longest wavelength and the lowest frequency.

**Material**

Light Traps: For the present experiment, three distinct light traps were designed to capture insects. Each light trap was equipped with a specific colored light source: red, blue, or white.

Light Sources: LED lights emitting red, blue, and white light were installed in the traps. The light intensity was standardized at 7 watts for all traps to ensure uniform brightness.

Collection bags/containers: Transparent bags were affixed to each trap to collect and temporarily store insects for subsequent analysis.

Timer: A watch was used to precisely monitor the timing for switching the lights on and off daily, between 7:00 PM and 10:00 PM.

Location Setup: The traps were positioned at equidistant points in an open field or an area with minimal external light interference. This arrangement ensured that the traps did not compete for insect attraction.

Notebook: A notebook was used to record data, such as the number and types of insects caught in each trap.

Identification Tools: Magnifying glass, insect identification guidebook.

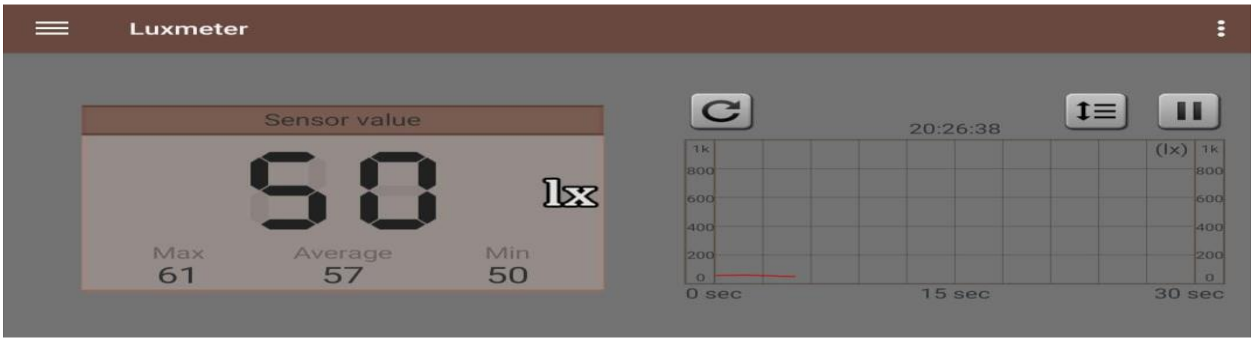
Data Tools: Lux Meter app is used to measure the brightness of light.

Red Light : Intensity of Red light at ground near the trap

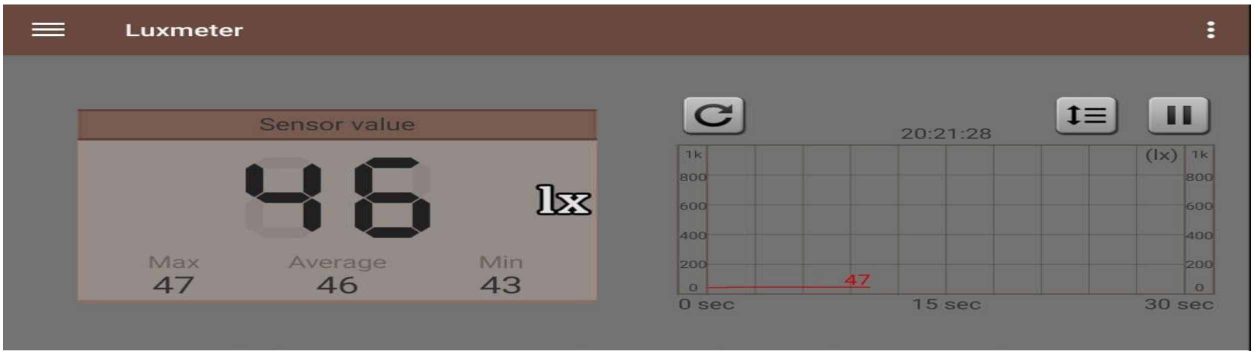
Light Trap

blue light at night trap

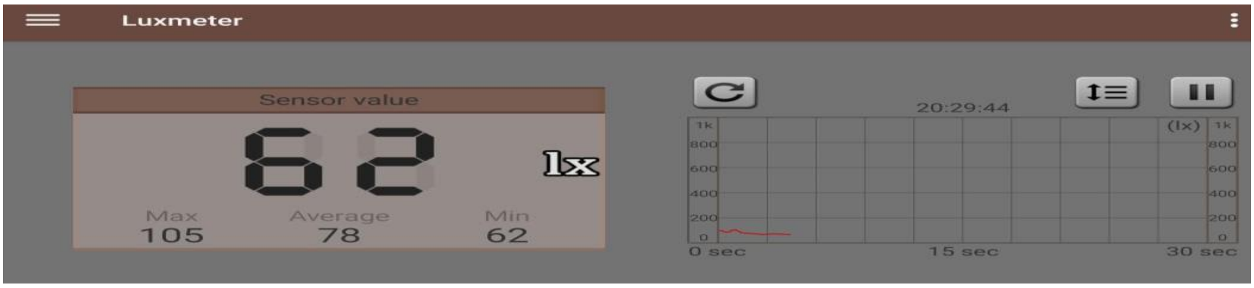
Coloured Light Sources




- Blue Light : Intensity of blue light at ground near the trap




- White Light :Intensity of white light at ground near the trap




**Method**

The methodology used to study insect attraction towards different light colors involved the use of light traps and controlled exposure to red, blue, and white light. The experiment was conducted during year 2023-2024, over a 15-day period, with the lights being switched on daily from 7:00 PM to 10:00 PM to attract insects. The study sites were selected for its ecological diversity and its relative lack of artificial light sources, which could potentially interfere with the results. The traps were placed at equal distances of 6 meters apart to avoid light overlap or competition. Three light traps were set up, each equipped with one of the three light colors: red, blue, and white. The collection containers for each trap were securely fastened to ensure proper insect capture while preventing escape. The lights were switched on from 7:00 PM to 10:00 PM for a duration of 15 days. This time frame was selected to align with peak nocturnal insect activity, ensuring optimal capture rates. At the end of each session, the insects trapped in the containers were collected, counted, and temporarily stored for analysis. Precautions were taken to prevent contamination or mixing of insects from different traps. The collected insects were identified and classified according to their taxonomic orders. The counts for each trap were recorded to determine the number and diversity of insects attracted to each light colour. To eliminate potential biases, the positions of the light traps were rotated every few days. This ensured that any differences in insect orientation were attributed to the light colour rather than the trap location. The data from all 15 days were compiled, and the total number of insects attracted to each light color was calculated. The results were then analyzed to determine which light colour was most effective in attracting insects and to assess any significant variations among species.

**Results Table-Experiments were conducted on nocturnal insects during year 2023-2024.**

| Sr. No | Orders | Blue | | | | White | | | | Red | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Rainy | Winter | summer | Mean | Rainy | Winter | summer | Mean | Rainy | Winter | summer | Mean |
| 1. | Lepidoptera | 22 | 30 | 13 | 21.66 | 18 | 29 | 09 | 18.66 | 00 | 2 | 01 | 01 |
| 2. | Diptera | 186 | 239 | 109 | 178 | 163 | 216 | 146 | 175 | 43 | 60 | 18 | 40.33 |
| 3. | Coleoptera | 78 | 119 | 23 | 73.33 | 26 | 40 | 14 | 26.66 | 01 | 3 | 00 | 1.33 |
| 4. | Hemiptera | 27 | 64 | 11 | 34 | 06 | 28 | 03 | 12.33 | 07 | 22 | 06 | 11.66 |
| 5. | Orthoptera | 16 | 20 | 09 | 15 | 04 | 06 | 02 | 04 | 00 | 0 | 00 | 00 |
| 6. | Isoptera | 10 | 00 | 00 | 3.33 | 08 | 02 | 00 | 3.33 | 00 | 00 | 00 | 00 |
| 7. | Blattodea | 14 | 21 | 00 | 11.66 | 00 | 05 | 00 | 1.66 | 10 | 29 | 04 | 14.33 |

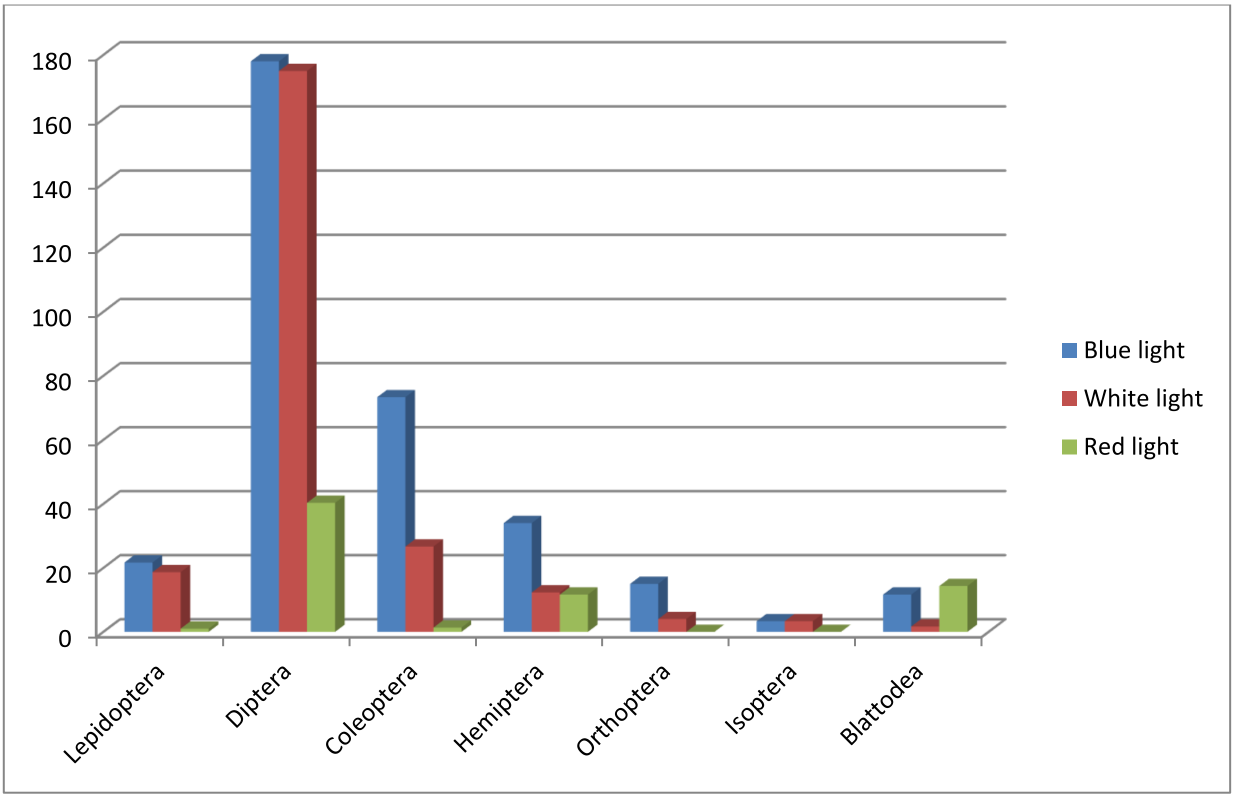



**Fig.- Influence of Different Colors on Nocturnal Insects Attraction.**

Insects, especially nocturnal species, are generally more attracted to blue light than red light. This is because blue light resembles natural twilight and is more easily detected by the compound eyes of many insects, which are sensitive to shorter wavelengths. As a result, insects are likely to be drawn toward blue light, using it as a navigational cue. Insects are expected to exhibit less attraction, or even repulsion, to red light. This is because many insects, particularly nocturnal species, have limited sensitivity to longer wavelengths like red light. Consequently, red light is less effective at attracting them compared to blue or white light, which fall within their visual spectrum. Insects are expected to show a neutral or mixed response to white light, which contains a full spectrum of wavelengths. Their reaction may vary depending on their sensitivity to specific wavelengths within the white light. While some insects may be attracted to the broader spectrum, others might prefer certain wavelengths present in the white light.

It was observed that different insect species respond uniquely to the same light colors due to their visual adaptations and ecological behaviors. For example, moths and flies may react differently to blue or red light because of differences in their photoreceptor structures and specific ecological needs.

**Discussion**

The orientation of insects toward light, referred to as phototaxis, has been a focal point of scientific investigation for decades. Numerous studies have examined the influence of light wavelength, intensity, and environmental variables on insect behavior. This review synthesizes key findings from prior research relevant to the current study on insect orientation in response to red, blue, and white light.

Phototactic behavior in insects is a well-documented phenomenon, characterized by either positive or negative phototaxis, depending on whether the insect moves toward or away from a light source. Positive phototaxis is notably prevalent in nocturnal species, such as moths and certain beetles, which are often observed aggregating around artificial light sources during nighttime hours. Papi (1955) proposed that insects utilize light as a key navigational cue, particularly under conditions of low ambient illumination, where the presence of light can significantly influence their orientation and movement. This phototactic response is influenced by several factors, including the type of light source, its intensity, and the specific wavelength of light emitted. The interaction between these variables can affect the strength and directionality of the insect's movement, with some species exhibiting a stronger attraction to specific wavelengths or intensities.

Insects exhibit visual systems that are specifically adapted to detect light within certain wavelength ranges. Chapman *et al.* (2013) described the structure of insect compound eyes, which are equipped with photoreceptor cells that are particularly sensitive to ultraviolet (UV), blue, and green wavelengths. Blue light, with its shorter wavelength range (450–495 nm), is especially attractive to many insect species due to its resemblance to the natural twilight spectrum. Research by Eguchi *et al*. (1982) further elucidated that blue and UV light are highly effective in attracting species such as flies and moths, which are particularly responsive to these wavelengths. In contrast, red light, with its longer wavelengths (620–750 nm), typically falls outside the visual sensitivity range of many insects, resulting in minimal attraction to such light sources.

White light, which consists of a combination of all visible wavelengths, tends to attract a wide range of insect species. Longcore and Rich (2004) reported that artificial white light sources, such as streetlights, have significant ecological consequences by altering insect behavior and disrupting natural ecosystems. Their study highlighted the importance of both the intensity and spectral composition of white light in influencing the diversity and abundance of insects attracted to these light sources. The findings underscored that variations in the light's intensity and spectral characteristics can modulate the extent of attraction, affecting not only the quantity but also the diversity of insect species drawn to artificial lighting.

Yoshida *et al.* (1978) demonstrated that insects exhibit a reduced responsiveness to red light, primarily due to the limitations of their visual systems in detecting longer wavelengths. This characteristic has led to the use of red light in various research and pest control applications, where minimal disruption of insect activity is desired. Studies conducted in agricultural settings have further corroborated that red light attracts fewer insects compared to other wavelengths, positioning it as a potentially effective tool for mitigating pest disturbances. This selective response to red light highlights it's utility in managing insect populations in environments where light-induced behavior must be minimized.

The effectiveness of light in attracting insects is influenced by various environmental factors, including temperature, humidity, and moonlight. Bowden and Church (1973) found that light traps were most effective on warm, humid nights with minimal moonlight, as these conditions tend to enhance insect activity. These findings emphasize the necessity of conducting experiments under controlled and consistent environmental conditions to accurately assess the role of light in insect attraction.

Light traps have been extensively utilized in pest control and ecological monitoring. Sudheendrakumar *et al.* (1996) demonstrated that blue light traps are highly effective for managing pest populations in agricultural settings. In contrast, other studies have suggested the use of red or low-intensity light in areas where minimizing insect attraction is desirable, such as in urban environments or wildlife conservation areas, where the presence of excessive light may disrupt local ecosystems or cause nuisance to both insects and humans.

## Conclusion

The investigation into insect orientation toward different light colors demonstrated that light type significantly affects insect attraction. Blue light elicited the highest attraction, followed by white light, while red light attracted the fewest insects. These findings indicate that insects exhibit greater sensitivity to shorter wavelengths of light (blue) and reduced responsiveness to longer wavelengths (red). The pronounced attraction to blue light can be attributed to the sensitivity of insect photoreceptors, which are adapted to detect shorter wavelengths. White light, comprising a broad spectrum of wavelengths, elicited moderate attraction due to its ability to stimulate multiple photoreceptor types across various insect species. In contrast, red light, characterized by its longer wavelength, likely falls outside the visual sensitivity range of most insects, resulting in minimal attraction.

These findings underscore the critical role of light wavelength in shaping insect behavior. An understanding of these wavelength-specific preferences has practical implications for pest management strategies. For instance, blue light could be effectively utilized in light traps to enhance pest control efforts, while red light may be applied in environments where minimal insect attraction is desired, reducing unwanted insect presence. In conclusion, the study confirms that insect orientation is significantly influenced by light color, with blue light demonstrating the highest attraction, followed by white light, while red light elicited the least response. Future research could focus on species-specific responses and the influence of environmental factors to further elucidate the mechanisms underlying these behavioral patterns.

## Reference

1. Ashfaq, Rashid A. Khan*, M. Ahsan Khan, Fahad Rasheed* and Shahid Hafeez* . Insect orientation

to various colour lights in the agri-cultural biomes of Faisalabadm. Department of Agri Entomology, University of Agriculture, Faisalabad. Department of Forestry, Range Management and Wildlife, University of Agricutlure, Faisalabad.
2. Bowden, J., & Church, B. M. (1973). "The influence of moonlight on catches of insects in light-traps in Africa. Part II: The effect of moon phase on light-trap catches." Bulletin of Entomological Research, 63(1), 129-142.
3. Chapman, J. W., Reynolds, D. R., & Wilson, K. (2013). "Long-range seasonal migration in insects: Mechanisms, evolutionary drivers, and ecological consequences." Ecology Letters, 16(1), 60-71.
4. Eguchi, E., Watanabe, K., Hariyama, T., & Yamamoto, K. (1982). "A comparative study on spectral sensitivity curves in insects." Comparative Biochemistry and Physiology Part A: Physiology, 73(1), 141-146.
5. Longcore, T., & Rich, C. (2004). "Ecological light pollution." Frontiers in Ecology and the Environment, 2(4), 191-198.
6. Papi, F. (1955). Phototactic behavior in insects and its ecological significance. *Journal of Insect Physiology*, 1(4), 201-210.
7. Sudheendrakumar, V. V., Mathew, G., & Varma, R. V. (1996). "Blue light traps for the management of tea mosquito bug, Helopeltistheivora Waterhouse." Pest Management in Horticultural Ecosystems, 2(1), 49-55.
8. Yoshida, M., Takeda, M., & Tada, Y. (1978). Behavioral responses of insects to different light wavelengths: A study on the attraction to red and other light sources. *Journal of Insect Behavior*, 21(3), 195-204.