Effect of Differing Electromagnetic Radiation (light) Wavelengths on Attracting Different Nocturnal Insect Species

ABSTRACT

This experiment researched the impacts that different wavelengths of light had on the attraction of various insect species and how many of each species was present depending on the light type. The experiment studied the effect that the different wavelengths had on insect behavior in the hopes of better understanding what light types are most attractive to insects and to what types of insects. This question has not yet been adequately answered, despite various studies researching the wavelength preference of different insect species but not of the insect family in general. An experiment was created to adequately answer this question and was tested on insects present in southern Arizona during early winter months (January). The experiment studied how three different wavelengths of light (white, green and UV LED lights) affected the number of insects present as well as the variety of species present using a light trap made from a white sheet that was hung over a metal stand with a lamp containing the one of the previously mentioned lights shining on it. The experiment found that green LED light was the most attractive to insects with 35 insects being recorded and that UV LED light attracted the greatest variety of insects, with white LED light attracting the least amount of insects with only 25 being present during the white light trial. The UV light likely attracted the highest variety of species due to the reliance that many nocturnal insects have on moonlight for navigation, the green light likely attracted the most insects because it falls within the light spectrum which insects can perceive and white light likely attracted the least amount of insects due to its closeness to wavelengths of light that they don't use for navigation. This research can be helpful in better understanding the different impacts that light can have on insects and help in capturing insects for scientific and agricultural purposes.

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QUESTIONS AND VARIABLES

Research Question:
How does the wavelength of white light, green light, and UV light in a light trap affect the species of insects captured, and the number of total insects?

Independent Variable:
Color of light measured in wavelengths.

Dependent variable:
Insect biodiversity and total insect count in the insect light traps.

The lights that were chosen for this experiment were a green light, a white light, and an ultraviolet light.

- the green light was chosen, because it was speculated that the green light would mimic natural light that shines through foliage in an insects' natural habitat.
- White light was used because it is the wavelength of light that is commonly emitted from streetlamps and other artificial sources of light.
- The ultraviolet light was chosen because ultraviolet light is commonly used in insect attracting, since many insects can see ultra violet light.

Hypothesis:
UV light will be most effective at attracting insects due to its already widespread use in insect traps. Most insects regardless of species will be attracted to UV light.

BACKGROUND RESEARCH

Insects are a vital part of the ecosystem, however certain insects have presented numerous issues to humans and their civilization. Finding a way to properly control invasive or damaging insect populations, while balancing the ecosystem roles played by beneficial insects has been a scientific question for decades. With research showing chemical pesticides have deadly effects on our health and the ecosystem, it is important to find a cost-effective and safe solution to pest insects soon. Certain insects such as the Hessian fly can cause damage to crops in agricultural fields, causing farmers to lose profits, and possibly damage the environment using chemical pesticides. Other insects like biting midges can be vectors of disease, and cause illness or even death in livestock or humans. The study, "Key Elements of Photo Attraction Bioassay for Insect Studies or Monitoring Programs" Uses light based traps operating at different wavelengths, in order to record the amount and diversity of insects caught by the trap. According to the study, "Bioassays are used to develop accurate and effective insect traps to guide the development and optimization of insect traps used to monitor pest population fluctuations for disease vector risk assessments, the introduction of invasive species, and/or be used for population suppression." The method that was used in this study was a bioassay, which is a method to determine the effect of a condition, by observing the reaction of a living organism to its stimuli. Another study that measured the effects of wavelengths like a bioassay on insects was, "Attractiveness of light-emitting diodes (LEDs) of different wavelengths to the South American rice water weevil". The results of this study were, "These authors found out that light in the UV spectrum was more attractive to adults of *O. -oryzae*, but they also obtained some attractiveness for blue and green fluorescent lamps." This study also had the intent to increase the effectiveness of light traps against pest insects. These studies provide knowledge on how certain pest and

vector insects react to light traps that may help farmers or cities properly manage these insect populations in a more efficient way.

Pg 3: Background research

Many insects have adapted to different environments and resource partitioning in order to survive. Some insects are diurnal, while other insects are nocturnal, some insects live in the canopies, while other insects live in or under the ground, and some insects eat certain diets or live in certain conditions that other insects do not. It is important to know the behavior of insects, so that humans can adjust insect traps in order to catch specific insects rather than others. For example, the study, “Optimizing light trap height and installation timing for effective monitoring of insect pests in rice fields”. This study measured different heights and active times for a group of light traps, and how they affected specific species of insects and the amount caught. The results of this study were as follows, “Early-night trapping recorded the highest captures of green leafhoppers (96.67 individuals) and rice bugs (39.67 individuals), while late-night trapping was most effective for stem borers (577.00 individuals) and rice leaf folders (35.33 individuals). The height of trap installation also influenced pest captures, with canopy-level traps (1.0 m) proving most effective for pests such as green leafhoppers and caseworms. Beneficial insects, including carabid beetles and earwigs, similarly exhibited a preference for traps set at higher positions.” These results prove that certain insects reside in higher areas or are awake at earlier times than other insects. Another study, “Efficiency of different light sources in light traps in monitoring insect diversity” focused on mainly beneficial insects, and tried to measure diversity with traps containing different types of light bulbs, and certain weather parameters. The results of this study discovered, “ The mercury light was more efficient for Lepidoptera, Hemiptera, Hymenoptera, Odonata, and Diptera and while black light was more efficient for Coleoptera, Orthoptera,

Isoptera, and Dictyoptera. Similar attractiveness to the mercury and black light sources were found for coleopterans. Coleopterans were equally attracted to mercury and black light sources. Average temperature showed a significant relationship with coleopterans, lepidopterans and hemipterans when all insect traps were considered together" Showing that individual insect species could have preferences that distinguish them from other insect species. These studies may be helpful at calibrating traps to catch specific harmful insects, while leaving beneficial insects for the environment.

Pg 4: Background research

Another study, "Shedding Light on Moths: Shorter Wavelengths Attract Noctuids More than Geometrids" studied the effects of light wavelengths on moth populations in the United Kingdom and how if at all different wavelengths of light and further urbanization effect moth populations. The study found that moths in general are more attracted to light with shorter wavelengths, but the results were unable to prove whether or not artificial light affects moth populations. The researchers concluded that the main cause for the decline in populations of moths across Europe was most likely due to a different factor attributed to urban areas other than artificial light, but that artificial light might still have effects on the mortality of certain species of moths such as noctuids (owlet moths) seeing as they were the main species most attracted to a certain wavelength of light. "...the two most commonly caught moth families responded to lighting differently; significantly more noctuids were attracted to the SW lighting than the LW lighting, but geometrids showed no significant difference."- *Somers-Yeates, 2013.* Despite the mostly inconclusive results of this study in terms of the effects of artificial light on moth populations, the information gathered from this research could potentially help people to control moth populations specifically around their homes (for instance using porch lights with longer

wavelengths in order to attract less moths to their homes at night) and promote further research on why there was a difference in the preference of light between different moth species, and how changes in wavelengths of light could affect different species of moths.

MATERIALS LIST

- LED UV light (attract insects)
- White LED light (attract insects)
- Green LED light (attract insects)
- light trap: rope (to secure sheet)
- lights(to attract insects)
- white sheet(for observation and amplification of light)
- heavy object (to secure sheet)
- trees (for securing rope)
- phone camera (to record amount of insects and provide identification of insect species)
- extension cords(to power the light)
- nearby outlet with electricity(to power the extension cords)
- lamp stand (to secure the light source).

EXPERIMENTAL PROCEDURES/METHODS

Procedures

Step 1: A rope was tied between two stands, a white sheet was placed over them, and a lamp stand was placed facing one side of the sheet. A brick was placed on the corners of the sheet to ensure that the sheet did not blow away. An extension cord was plugged into a nearby outlet and brought to the lamp stand.

Step 2: LED UV light, White LED light, and Green LED light were used which were swapped out every 30 minutes, 3 times in total. In between each tested light, 3 minutes were spent without light, which ensured no bugs remained to altered data.

Step 3: The light trap was placed outside for 99 minutes and the number of insects and insect species attracted to the light were recorded visually and photographed/ videotaped. The test lasted a total of 99 minutes and took place at night.

Data Analysis

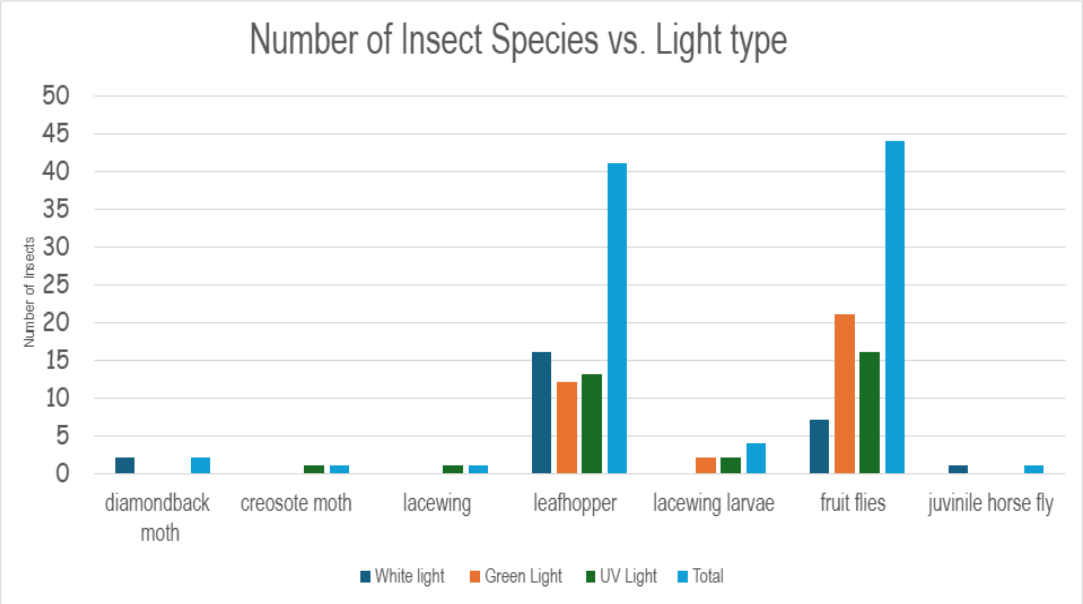
The number of insects was recorded after each light was placed in the light trap, as well as the number of different species present at each light. The insects were counted by observing the number of insects recorded in photos/videos.

DATA ANALYSIS AND DISCUSSION

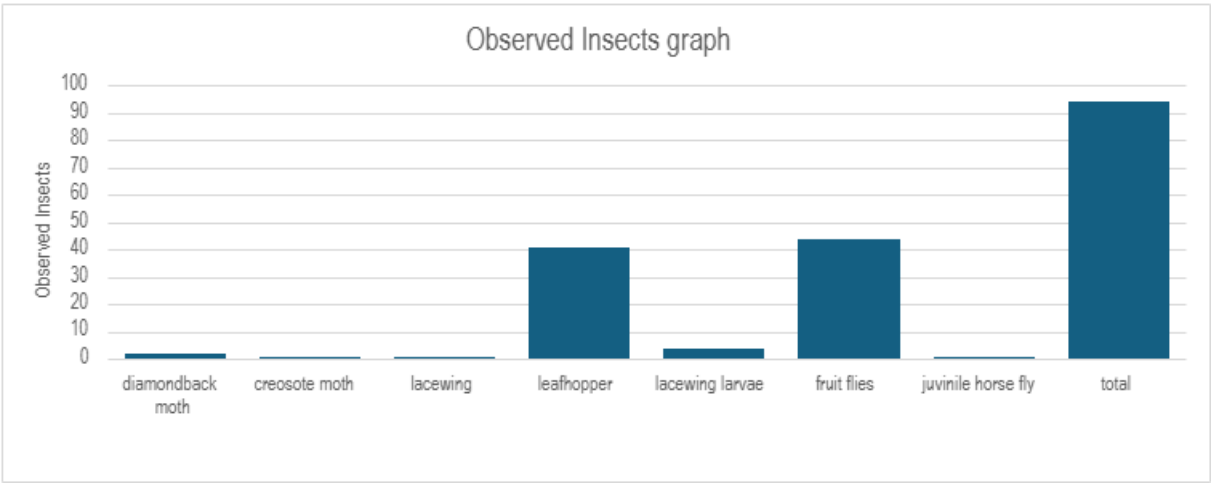
- Green LED light is the most attractive to insects.
- UV LED light attracted the highest variety of insects.
- White LED light was the least attractive of the three light types used.

- The data reported 35 insects were present at the green LED light, 33 insects were present at the UV LED light, and 25 insects were present at the white LED light.
- The variety of insect species present rapidly increased when the UV LED light trial began.
- White LED light attracted 25 insects while LED green light attracted 35 and LED UV light attracted 33 insects.

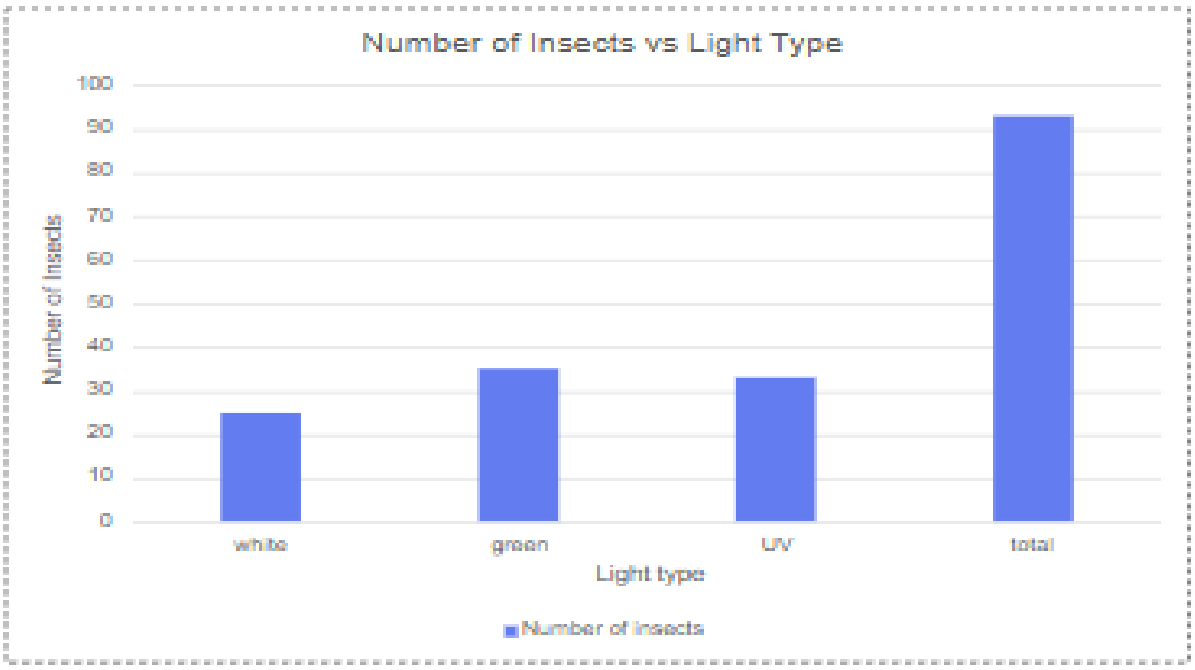
- UV LED lights most likely attracted the highest variety of insects, due to some insects' reliance on seeing UV wavelengths for navigation.
- White LED likely attracted the least insects because it is outside of the spectrum of light that they use for navigation,and therefore likely making it the least attractive.
- Green LED likely attracted the most insects because the green light falls within the spectrum of light that insects use for navigation.



This graph shows the quantity of insect species that were observed to be attracted to each type of light trial. The graph has a peaking trend among all insects (except fruit flies), with a sharp increase in all insects (except for fruit flies) during the Ultra-violet trial. Fruit fly observations spiked during the green light trial with a little over 20 observed, then fruit flies decreased during the ultraviolet trial. Leaf hoppers were most attracted to white light, with almost 20 observed in the white light trial, decreasing o the green light trial, and increasing slightly during the UV trial.



This graph shows the total number of each insect species that were observed. The majority of the insect species had numbers below 10. Leafhoppers and Fruit flies were most common, around 40 and 50 insects.



The graph showed the number of insects in total that were present at a specific light type as well as the total number of insects present throughout the entirety of the experiment. The green light attracted 35 insects, the white light attracted 25 insects, and the UV light attracted 33 insects, with the green light attracting the most insects and the white light attracting the least insects. A total of 93 insects where present throughout the duration of the experiment.

CONCLUSION

In conclusion, our project found that LED green light was the most attractive to insects and that LED UV light attracted the widest variety of insect species native to Tucson Arizona and that LED white light was the least attractive. These findings may be helpful in better understanding the impacts on different light wavelengths on the navigation abilities of nocturnal insects and may help designers of lighting facilities such as street lamps to design the light emitted to have minimal impacts on nocturnal insect species. This research may also be helpful for agricultural uses, such as light traps for pest control and in further scientific research about the behavior of insects and why moonlight is so important to their navigation strategies.

IDEAS FOR FUTURE RESEARCH

- Future experimentation could verify results and possibly test more variables for accurate data that is more applicable to the real world.

- Errors in the counting of insects are possible due to each insect being recorded visually. The same insect could have moved and been counted twice during the counting process.
- The time without any light could have not been enough time for all the insects previously present to leave the data collection area.
- Many insects had similar appearances and could have been mistaken for the wrong species of insect.

- These errors could have caused incorrect counts of insects during each trial.
- Due to how close the data was in each trial, certain variables may have been shown to be more effective than others, which could be false.
- These errors could have also caused mis-identification of insects, leading to a misunderstanding in the behavior of a specific species.

In a future experiment, it would be good to find ways to collect data more accurately by removing the errors found in this experiment. In a future experiment, after redesigned the way to attract insects, in a way that keeps insects confined to a specific area, it could prevent mis-counting insects. A future experiment could increase the amount of time with darkness before each trial, or could purposefully remove each insect in the data collection area, in order to ensure that the insects do not stay between each trial, skewing data. In a future experiment, it would be good to ask for the help of a licensed entomologist to thoroughly identify each inset, to ensure species are not mis-identified.

ACKNOWLEDGEMENTS

We would like to thank our teachers, and parents for helping us to accomplish this project and for providing us with the resources that made this project possible. Despite the many light trap failures (falling and trapping humans rather than insects), and thinking this project wouldn't have been possible, without the help of these people we wouldn't have been able to do this project. We would also like to thank the parents for being our chauffeurs during this project and for providing moral support throughout the process. Your immaculate driving skills will forever be appreciated.

BIBLIOGRAPHY

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2. The article Optimizing light trap height and installation timing for effective monitoring of insect pests in rice fields, tests the effectiveness of light traps placed at different heights and times in catching insects. The goal of this article is to find a way to increase the efficiency of light traps as a more environmentally sustainable integrated pest management. In this study light traps were placed at different heights and timed, after the study each trap was counted for insects. This study found that the most effective height was 1 meter from ground level, and that the time the light was active changed the species caught in each trap.

Uddin, ABM Anwar, et al. “Optimizing Light Trap Height and Installation Timing for Effective Monitoring of Insect Pests in Rice Field.” *Nova Geodesia*, vol. 5, no. 1, Mar. 2025, pp. 322–322. *novageodesia.ro*, https://doi.org/10.55779/ng51322.

3. The article efficiency of different light sources in light traps in monitoring insect diversity, tested the species of insects and quantity of insects caught in traps using different light sources throughout the year. The goal of this study was to find in any one light source is most efficient at catching certain types of bugs as a sustainable pest management usage. In this study, over the course of 2 years, different light traps were monitored and calculated for number of insects caught and insect species. The results of this study were that mercury lights attracted the most bugs, and that 2008 there were more caught insects than 2007,, also that the middle of the year most bugs were caught, and finally that the weather and temperature affected the amount and species of insects being caught in the traps.

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4. The article “Key Elements of Photo Attraction Bioassay for Insect Studies or Monitoring Programs” studied the effectiveness of different wavelengths of light (colors) to attract insects and lure them into monitoring traps. The goal of the study was to increase the effectiveness of trapping insects using a visual attractant (in this case light) in order to manage and/or control population sizes of nocturnal insects. The study used a “cloverleaf bioassay arena” which is a clover-shaped arena with four different areas containing four different wavelengths of light. The different wavelengths of light were moved around the arena in order to measure if the insects were attracted to a specific light source or area of the arena and the experiment was recorded using an infrared camera. The result of the study showed that red flour beetles were most attracted to UV LED (390nm) lights, Hessian flies were most attracted to green light (502-525nm), and biting midges were most attracted to UV light as well, but at a lower wavelength (355-365nm), concluding that the insects in the study were more attracted to light sources with shorter wavelengths.

Cohnstaedt, Lee W., et al. “Key Elements of Photo Attraction Bioassay for Insect Studies or Monitoring Programs.” *Journal of Visualized Experiments*, no. 137, 26 July 2018, https://doi.org/10.3791/57445. Accessed 12 Sept. 2025.

5. The article “Shedding Light on Moths: Shorter Wavelengths Attract Noctuids More than Geometrids” studied how artificial light has affected moth populations in the United Kingdom. The goal of the study was to understand the reason for a decline in moth populations across Europe and to see if an increase in artificial light was the cause. The study was performed between June 26th and October 10th 2012 in Walled Garden, Tremough Campus, and Penryn UK. Various lamp pole structures were set up around the areas being studied with two different adjacent lights with different wavelengths. The lights with shorter wavelengths attracted significantly more moths than the lights with longer wavelengths, but different species of moths responded differently with the species that were most commonly more attracted to shorter wavelength light being noctuids (owlet moths) and geometrids (geometer moths) showing no specific preference.

Somers-Yeates, Robin, et al. “Shedding Light on Moths: Shorter Wavelengths Attract Noctuids More than Geometrids.” *Biology Letters*, vol. 9, no. 4, 23 Aug. 2013,

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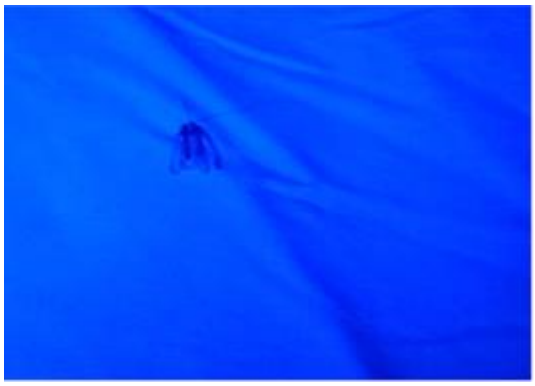
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