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Chromatic Wavelengths Luminescence: It's Impact to Growth Response of Tsitsirika (Catharanthus Roseus)

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Abstract: This study seeks to analyze the complex interactions between color psychology, lighting technology, and the cultivation of Tsitsirika (Catharanthus roseus) in the Philippine agricultural environment. The study is organized around three main goals: first, to investigate the effect of several LED wavelengths, specifically red, blue, and green, on the overall growth parameters of Tsitsirika. Second, it intends to conduct a rigorous comparative analysis, carefully comparing the development patterns shown by various colored LEDs to those detected in natural solar irradiation. This comprehensive analysis seeks to identify significant differences and explain potential benefits or drawbacks related with the use of artificial lighting. Ultimately, the study aims to explain the physiological characteristics induced by red, blue, and green LED wavelengths on Tsitsirika, revealing their subtle effects on the plant's physiological and morphological aspects, including leaf pigmentation and stomatal behavior. By thoroughly addressing these objectives, this study hopes to provide nuanced and academically valuable insights on the prudent application of color psychology and lighting technology, ultimately influencing optimal cultivation practices for Tsitsirika. This scholarly endeavor is positioned to support sustainable and efficient agricultural practices, not just in the Philippines but also with potential for broader application.

Keywords: Growth Parameters, Solar Irradiation, Optimal Cultivation, Efficient Agricultural Practices.

1. INTRODUCTION

Background of the Study

Over the past decades, studies involving the color spectrum and human behavior created a revolution in the field of psychology. (Kanagaraj et.al. 2020) This has raised researchers' interest on what other organisms other than human beings the psychology of color have an effect on has. (S. Gomez et.al 2022). As early as the 18th century, scientists have peaked an interest in plants' dependence on light after the discovery of photosynthesis by Joseph Priestley (O. Ptushenko et al., 2020). After the legalization of cultivating Cannabis Sativa in Canada, the government has limited options for cultivation.

The government has been firm about growing this plant indoors if it is for personal use. This led growers to innovate. The use of light-emitting diodes (LED) technology became an alternative. (Biloodeau et. al., 2019) It was deduced that using red and blue light is the most ideal for plant growth. (Johnson, 2020).The combination of color psychology and lighting technology has numerous advantages on plant production (D. Camejo et.al., 2020) This includes rapid plant growth, larger yield, and better plant physiology (E. Caunca et.al., 2021). However, this evidence only focuses on the mass production of foreign edible produce such as lettuce and tomatoes, which is the main intention of making this technology progress (I. Paucek et al., 2020). In a more localized setting, an emphasis on the study of common plants found in the Philippines has not yet been popularized.

Tsitsirika (Catharanthus roseus), a kind of periwinkle found in various regions of the Philippines, most typically on sandy coastlines, has physical features that allow it to grow using modern technologies (E. M. S. Nofal et al., 2021). An introduction to a variety of color spectrums will help to determine what color induces changes with its physiological characteristics (V. Kairiene et al., 2022).

Objectives of the Study

1. The use of different colored LED lights impacts the growth of the plant.
2. Compare the growth impact of different colored LEDs to natural sunlight, determining significant differences and potential advantages or drawbacks of artificial light.
3. Identify psychological characteristics induced by red, blue, and green LED wavelengths, unraveling their nuanced effects on Tsitsirika's physiological and morphological aspects.

Significance of the Study

The findings of this study help generate a better understanding of the following group of persons:

To the Researchers

Researchers may acquire specialized skills related to plant physiology.

To the People

The community may be informed about improvements in plant growth and lighting technologies by sharing the study's findings.

To the Future Researcher

Future researchers may benefit from additional data from this study. The results of this study may potentially offer preliminary information that other researchers might use in future

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research.

To the Environment
If the research leads to improved plant growth, it can reduce the need for chemicals.

To the Horticulturist
It is significant because it will benefit them if the study is successful in the future as it provides spectral effects of LEDs, revealing the primary roles of different light wavelengths on plant processes, and development.

Theoretical Framework
Light is the most important factor affecting plant growth and development, without light plants cannot produce food. There are two primary theories that guided this research. The first one is based on LED lightning and its effect on plants, Growers and the world theory by Kevin Wells (2015). Where he stated that “LEDs help create bigger, better plants, the horticultural led system and the spectral science they have made possible have already revealed some amazing effects (changing the wavelength of the light change the flavor of foods)”. On the other hand, Kevin Wells (2015) believes that LEDs produce plants that are more commercially viable than older lighting systems while consuming significantly less energy and covering the same area. They also state that according to certains studies, LEDs can minimize or even completely replace the need for pesticides, which is advantageous for both the environment and for growers who are no longer exposed to these dangerous chemicals.

Research Prototype

2. RELATED WORKS

Light is the primary source of energy required for the photosynthetic process and many other physiological processes related to plant growth and development (Bayat et al., 2018). Every plant goes through a natural growth process; however, light has immediate effects on a plant's vegetative and flowering phases. Year-round growth and rapid output are made possible by artificial lights, but the intensity and nutrients provided by natural sunlight are incomparably superior. Vegetable gardens wouldn't produce, flowers wouldn't appear, and we wouldn't have any green plant life. During photosynthesis, light provides nutrients and energy to plants, causing them to prosper. All life on Earth is dependent on it in some way (Stemstad, 2017).

Plant growth and physiology are influenced by light quantity (photoperiod and intensity) and quality (spectral composition), which also interact with other environmental variables and cultural factors to influence plant behavior. In addition to supplying the necessary energy for photosynthesis, light also determines certain signals that control plant growth, morphology,

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and metabolism in the sophisticated process known as photomorphogenesis (Paradiso, & Proietti, 2021). Quality and type of light, development, and the accumulation of phytochemicals all play important factors in influencing plant growth, especially in controlled circumstances.

Light is required for photosynthesis in higher plants, and light signaling is crucial for plant morphogenesis. Through the manipulation of light properties, the advancement of LED technology allows for the improvement of photosynthetic activities and the regulation of plant physiology (Paradiso, & Proietti, 2021). Because of their higher luminous efficiency, lower radiation, and lower power consumption than typical white, fluorescent lamp light, monochromatic Light Emitting Diode (LED) lights are commonly used in growing facilities to cultivate various plants, particularly horticulture crops (Yuanchun Ma, 2021).

Variations in light wavelengths exert distinct impacts on both plant growth and stress reactions. Whereas blue and orange light are associated with inducing stress and impeding growth. (Rehman et al., 2020). While far red light promotes blooming in long-day plants and the red/far red ratio controls stem elongation and branching, leaf expansion, and reproduction, blue light affects stomatal opening, plant height, and chlorophyll biosynthesis (Zheng et al. 2019). Lastly, green light acts from the chloroplast scale to the level of the entire plant, promoting both short-term adaptation to light circumstances and long-term development. As stated by Smith et al. (2017), green light does, in fact, penetrate deeply into the leaf mesophyll layers and reach the lower and inner canopy levels.

It does this by encouraging photosynthesis in the deepest chloroplasts and in the leaves that receive the least amount of light and by sending out signals to the leaves regarding how to respond to environmental irradiance. This emphasizes the significance of considering light quality when refining conditions for plant growth and addressing environmental stress within horticultural methodologies (Rehman et al., 2020).

Though many plant processes are known to be spectrally dependent, artificial lighting in horticulture is still primarily used for assimilative or photoperiodic purposes, and only recently has it become possible to take advantage of light's control function. Specifically, in the past few years, cutting-edge lighting solutions based on light-emitting diodes (LEDs) have been tested in plant cultivation. By utilizing various wavelength combinations, these lighting sources not only increase plant productivity and photosynthesis but also control photo morphogenetic responses, such as the synthesis of bioactive compounds (Bantis et al. 2018).

3. INSTRUMENTS AND METHODS

Shows the materials needed for the working lavatory prototype as well as the methods uses in conduction of the study for testing the efficiency of the LED Greenhouse.

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Controlled Output	**Uses**	**Pictures**
Gmelina Lumbers	Gmelina arborea timber serves as the foundational material for the prototype of an LED greenhouse, providing structural support and stability to the experimental structure.	
Black Tarp	The enclosure of the greenhouse incorporates black polyethylene tarpaulin as its walls, strategically selected for its light-blocking properties, preventing external light infiltration.	
Metal Screen	A metallic mesh screen is integrated into the ventilation infrastructure of the LED Greenhouse, facilitating internal air circulation and contributing to controlled environmental conditions.	
Led Bulb (red, blue, green)	Light-emitting diode (LED) bulbs function as the designated artificial radiation source within the experimental setup, providing targeted illumination for optimal plant growth.	
Black Electrical Wire	Utilizing black electrical wiring, the infrastructure is established for the requisite electrical connections, powering both the lamps and the ventilation fan in the designated experimental system.	
Omni Socket	The Omni socket serves as the interface in the lighting system, facilitating the connection between the LED bulb and the electrical wiring infrastructure within the experimental setup.	

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Omni Plug	The Omni plug functions as the interface between the electrical wiring system and the power source, ensuring the establishment of a secure and efficient connection within the experimental framework.	
Gang Outlet	The gang outlet serves as a consolidating interface, enabling the amalgamation of three individual bulb plugs into a unified extension, fostering streamlined connectivity within the experimental electrical network.	
Thumb Tacks	Thumb tacks are employed to secure the tarp in site, as an alternative to nails, mitigating potential structural damage in the process.	
Hinge	A hinge is employed as a pivotal component in the greenhouse entrance, facilitating controlled and articulated door movement within the structural configuration.	
Nail	Nails function as fundamental construction elements in establishing the foundation of the greenhouse structure.	

4. RESULTS AND DISCUSSION

Result

4.1 The Impact of Artificial Lighting on Tsitsirika's (*Catharanthus Roseus*) Growth Response: It would establish whether an artificial light source could sustain the growth of the plant through the artificial radiation of various colored LED lights. and can moreover give it the vital light it needs to thrive. After a month of conducting these experimental tests to gather

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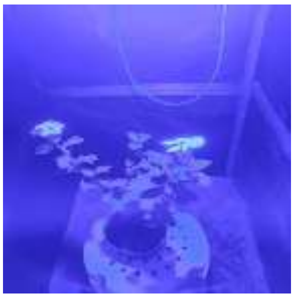
some significance, we were able to conclude that the plant's physiology and lifespan have been affected by the various artificial light spectrums.

4.2 The Monitoring of Plant Development in Response to Various Colored Light Spectrum.

On the first day, the plants are adjusting to their new surroundings gradually and are solely dependent on artificial light. The physical characteristics of the plants have changed over the processing days in response to certain physical traits. For example, some buds have begun to bloom and produce flowers; old leaves have started to wilt and fall while new ones are sprouting; during the observation period, the situation of two different colored plants—the red and blue—begins to show signs of deterioration while the green plant remains unchanged. After a month of observation, both blue and red plants have died. We could speculate that, of all the hues in the color spectrum, green light is one of the colors that is significant for sustaining a plant's life because it alone had allowed the plant to survive for a much longer period.

	Red	Blue	Green
WEEK 1	 - The plant has successfully adapted to its new environment after being repotted. - New buds formed on Day 3, indicating growth and adaptation. - The development of buds and blooming of some flowers on Day 6 indicate further growth and maturity. - Despite some flowers wilting on Day 5, the overall health of the plant appears to be good,	 - The plant showed signs of adjustment and adaptation to its new environment by Day 2. - On Day 3, buds began to swell, indicating impending blooming. - By Day 4, the buds had bloomed successfully. - Despite some wilting observed on Day 5, signs of growth persisted. - Day 6 saw the shedding of some flowers, alongside the	 - The plant initially showed signs of adapting to its new environment by Day 2. - By Day 3, new buds had started to form, but concurrently, the lower part of the leaves began to wilt and fall. - This trend persisted through Days 4 and 5, with continued wilting and falling of the lower leaves. - By Day 6, the wilting extended to more leaves,

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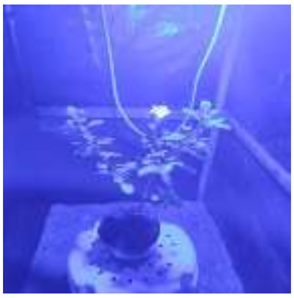
	with the stem and leaves remaining healthy throughout the observation period. - No new buds were observed on Day 7, suggesting a potential stabilization or pause in growth.	development of new buds. - By Day 7, new buds had started to bloom, suggesting a continuous cycle of growth. - Throughout the observation period, the stem and leaves of the plant remained healthy and showed no signs of distress.	although new buds were still developing. - On Day 7, new buds began to bloom, but the wilting and falling of leaves persisted, particularly in the lower part of the plant.
WEEK 2	 - The plant experienced a decline in flower health, with some flowers wilting and falling by Day 8. - This trend continued through Days 9 and 10, culminating in the loss of all flowers by Day 11. - However, from Day 12 onwards, the plant showed remarkable resilience and recovery, as it began to thrive once again.	 - The plant initially experienced a decline in flower health, with some flowers wilting and falling by Day 8. - However, simultaneously, new buds began to develop, indicating a cycle of growth and renewal. - By Day 10, buds continued to develop and grow, although some flowers started to wilt. - On Day 11, a new bud began to bloom, signifying the start of a	 - The plant demonstrated a cyclic pattern of blooming and wilting, indicating a natural progression in its growth cycle. - Initially, on Day 8, the plant displayed blooming flowers alongside some wilting and falling leaves. - By Day 9, buds began to bloom, but the wilting of leaves persisted. - Day 10 saw the blooming of new buds, yet both leaves and

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		new flowering cycle. - By Day 12, the flower had bloomed completely, but some older flowers were starting to wilt and fall. - This continued on Day 13, with some flowers falling from the plant. - By Day 14, the remaining flowers had bloomed completely, completing the flowering cycle.	flowers started to wilt, suggesting a possible decline in overall health. - On Day 11, some flowers fell, indicating a continuation of the natural lifecycle, while more buds developed. - By Day 12, new buds were actively growing, signaling potential for future blooms. - Day 13 marked the blooming of flowers, showcasing the plant's continued vitality. - However, by Day 14, the remaining bud began to wilt, suggesting the conclusion of the current flowering cycle.
WEEK 3	 - Initially, on Day 15, there were no noticeable changes in the plant's appearance. - Starting from Day 16, a consistent trend of leaf wrinkling was observed, indicating a potential issue with hydration or nutrient uptake.	 - The plant initially showed no physical changes on Day 15. - However, starting from Day 16, a consistent pattern of leaf wrinkling was observed. - This wrinkling persisted through Days 17, 18, and	 - On Day 15, all flowers have fallen from the plant, indicating the completion of the flowering cycle. - Starting from Day 16, a consistent pattern of leaf wrinkling was observed, suggesting potential stress or

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	- This wrinkling persisted through Days 17, 18, and 19, with an additional observation of leaves turning yellow by Day 19, suggesting possible stress or nutrient deficiency. - By Day 20, the wrinkling and yellowing of leaves continued, indicating a deterioration in the plant's health. - On Day 21, the plant showed clear signs of wilting, suggesting a significant decline in its overall vitality and potentially indicating severe stress or health issues.	19, indicating a potential issue with hydration, nutrient uptake, or environmental stress. - By Day 19, in addition to the wrinkling, some leaves began to turn yellow, suggesting possible nutrient deficiency or physiological stress. - Day 20 saw a continuation of leaf wrinkling and yellowing, indicating a progressive decline in the plant's health. - On Day 21, the plant exhibited clear signs of wilting, suggesting a significant decline in its overall vitality and health.	dehydration. - This wrinkling continued through Days 17, 18, and 19, accompanied by the onset of yellowing in some leaves, indicating potential nutrient deficiencies or environmental stressors. - By Day 20, the leaf wrinkling and yellowing persisted, indicating a progressive decline in the plant's health. - On Day 21, the plant exhibited a continuation of leaf wrinkling and yellowing, indicating further deterioration in its condition.
WEEK 4	 - The plant exhibited a persistent decline in health and vitality, as evidenced by the lack of improvement in its condition over several days. - Despite no signs of recovery or	 - The plant began to show signs of wilting on Day 22, indicating a decline in its health. - Despite efforts to monitor and potentially address the wilting, no improvement was observed over the	 - From Day 22 to Day 25, the plant exhibited signs of distress, with some leaves wrinkling and turning yellow. - This trend continued from Day 26 to Day 30, with the additional observation of some

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	improvement being observed, efforts to revive the plant were unsuccessful. - By Day 31, the plant had succumbed to its deteriorating condition and died.	subsequent days. - By Day 31, the plant had ultimately succumbed to its deteriorating condition and died.	leaves falling from the plant, indicating a worsening condition. - By Day 31, the plant's distress persisted, with ongoing leaf wrinkling, yellowing, and further leaf loss.

5. SUMMARY, CONCLUSION AND RECOMMENDATION

This chapter presents the summary of findings, conclusions, and recommendations drawn by the researcher from the results obtained in this study.

Summary of Findings

In order to improve crop production, the study looks into how different LED light spectra—Red, Blue, and Green—affect the growth parameters of tsitsirika plants. It hopes to provide insightful information about how to best optimize lighting in controlled environments. The following are the main issues the study addresses:

Impact of Led colors

The objective of the study is to determine how the growth characteristics of tsitsirika plants are impacted by the three different LED colors—Red, Blue, and Green. For each color spectrum, the effects on plant height, leaf area, leaf coloration, biomass accumulation, and blooming patterns must be evaluated.

Effects of Artificial Radiation

The study aims to examine the impact of artificial radiation on the tsitsirika plants' growth metrics. This involves being aware of the potential benefits and drawbacks of exposure to LED lights for different aspects of plant development.

Optimizing Lighting Conditions

The goal of the project is to provide insight on how to best light tsitsirika plants in controlled settings. The effects of this could be seen in indoor or greenhouse agriculture, where artificial light is frequently employed in place of or in addition to natural sunlight.

Enhancing Crop Production

The goal of the study is to make a positive impact on crop production by examining how LED lights impact growth metrics. To improve tsitsirika plant cultivation productivity and quality, farmers, researchers, and agricultural practitioners may find this material useful.

Conclusions

The purpose of the study is to search how the growth characteristics of tsitsirika plants are affected by the various colour spectrums of LED lights (Red, Blue, and Green). The effects of

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red, blue, and green LED light spectrums on tsitsirika plants, according to the researchers, provided important new information about how artificial radiation affects a variety of growth characteristics. Important factors such as plant height, leaf area and colouring were investigated in the study. The results offer useful insights into how to best optimise knowledge in controlled environments, potentially leading to improvements in agricultural yield. Differentiation in plant responses to distinct colour spectrums implies that specific growth characteristics can be improved by targeted light manipulation.

Recommendations
To ensure that Tsitsirika plants grow to their full potential, the cultivation environment needs to take a few important factors into account. The guidelines that follow are meant to improve the general health and vitality of the plants:

Ventilation System
The installation of an effective ventilation system is essential to guaranteeing sufficient air circulation and preserving the correct temperature for Tsitsirika plants. By offering a well-controlled development environment, this system will improve the general health of the plants.

Foundation
It is essential to use high-quality materials while building the foundation. A solid and well-constructed foundation creates the framework for a stable environment for growth. Using premium materials guarantees stability and longevity, giving the Tsitsirika plants a strong foundation.

Electrical System
For LED lighting and ventilation systems to function, a well-designed electrical system must be installed. This method helps to increase energy efficiency while also making the operation easier. An electrical system that is appropriately integrated improves the cultivation space's overall functionality.

Materials
It is crucial to choose the right materials for the foundation. Using well-fitting materials guarantees the foundation's strength and longevity, giving the Tsitsirika plants a safe and supportive growth environment. A solid foundation for cultivation requires careful evaluation of the ingredients.

Monitoring
It's essential to regularly observe the Tsitsirika plants in order to identify any alterations in their growth or general health. By putting in place a systematic monitoring system, problems can be quickly identified, allowing for timely intervention and modification of the growing environment to suit the unique needs of the plants.

Maintenance
The general quality and well-being of Tsitsirika plants depend on maintaining their structural integrity and diversity. The plants' long-term health and vitality are influenced by routine care

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procedures including pruning and making sure there is an adequate supply of nutrients. The plants are able to flourish and reach their maximum potential when their natural form is preserved.

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