EFFECT OF LIGHT EMITTING DIODE ON VEGETABLE PLANTS GROWTH AND DEVELOPMENT

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ABSTRACT

Natural disasters like droughts, floods, and climate change are becoming more frequent, posing a growing threat to traditional agriculture. People are committed to expanding the greenhouse sector in order to help plants grow safely and productively while also meeting human needs. Because indoor planting can provide larger yields all year round, it has become a more popular technique. The scarcity of food resulting from growing populations, restricted arable land, severe droughts, floods, and storms, together with pest and disease outbreaks and climate shifts, is compelling people to farm plants indoors and in cities. Plant photosynthesis, substance metabolism, and gene expression are all regulated by light, which is an important environmental influence. The most promising artificial light source for plant lighting is the light-emitting diode (LED). This technology uses LEDs to simulate sunlight in an indoor environment. In his study, three different LED colors lights such as red, green and blue were used. The height and growth of Capsicum annum (Chili) plant was taken for 4 weeks period. At the end of study, the height of the Chili plant in blue light is as high as 4.5 inches, followed by the red light (3.8 inches), green light (3.5 inches) and natural light (1.3).

From the studies it shows different color lights create an impact on the height, growth and development of a plant. The lack of awareness and availability of sustainable alternatives has led to several reports demonstrating that farmers inadvertently spray pesticides in their vegetable fields every other day, or even every day. There are major health issues when fresh fruits and vegetables include pesticide residues. Many vegetables are grown in extremely contaminated water that has high concentrations of one or more heavy metals. These metals are absorbed by plants and eventually have detrimental effects on a variety of metabolic activities, including respiration, nitrogen metabolism, photosynthesis, and transportation. This study is very useful for cultivation of vegetable plants using artificial lightning is ecofriendly this range of light is harmless and production of organic vegetables.

Keywords: Indoor farming; LED light; growth and development; artificial light

INTRODUCTION

In today's era, indoor farming is proving to be very useful for the food need of growing population, and therefore it is attracting the attention of modern researchers, and industrialist. When growing plants indoors, artificial light is crucial. Phosphor- converted light-emitting diode (pc-LED) systems that offer artificial lighting for indoor plant growth have made extensive use of red and far-red emitting phosphors. It is very important that phosphorus emission must precisely align with the plant pigment- absorbing zones. Plant factory artificial light allows for premium quality crops and large yields per area. It is a closed plant production system that produces a clean and highly chemical-safe crop without pesticides. Along with controlling temperature, relative humidity, CO2 and artificial light in accordance with the stage of the plant's growth, the system may also manage other environmental factors (Kozai and Niu 2020; Kim et al, 2021).

The scarcity of food resulting from growing populations, restricted arable land, severe droughts, floods, and storms, together with pest and disease outbreaks and climate shifts, is compelling people to farm plants indoors and in cities (Sabzalian et al., 2014). Traditional agriculture is experiencing an increasing number of hazards and challenges, such as climate change, drought, flooding, and so on, as natural disasters become more common. People are committed to expanding the greenhouse sector in order to help plants grow safely and productively while also meeting human needs (Shiet al., 2020). A key element in the growth and development of plants is light. An artificial light source is added in controlled facility cultivation to encourage high yields and high-quality products (Manivannan et al., 2017; Wang et al., 2016). The light sources employed in recent times were incandescent and fluorescent bulbs; nevertheless, these lights have several drawbacks, such as low luminous efficiency, high power consumption, and inadequate spectrum distribution (Peng et al., 2017; Silva etal., 2017). Subsequently, Lighting Emitting Diodes (LEDs) lights were implemented into agricultural production, and LEDs are more environmentally beneficial due to their low power consumption, high light efficiency, and low heat emission (Gupta and Sahoo, 2015). LED lighting generates the least amount of heat, it releases less carbon dioxide into the atmosphere.

The industry has manufactured a large variety of lamps with various light kinds, which have been used in indoor plants but are not known to be effective for plant growth. In order to create artificial light in indoor spaces, this study primarily focuses on introducing a light source other than sunlight. Specifically, it compares natural light toward vegetable growth in red, blue, and green LED lights with fluorescent lamps that use LED light (light-emitting diode). Thus, this study was conducted in a dark room.

AIMS AND OBJECTIVES OF THE WORK

1. In the proposed work, we will synthesize rare earth doped inorganic phosphor and characterize their spectroscopic properties according to vegetable plant cultivation.
2. To study the effects of various light sources on plant growth and the performance of plants in relation to those light sources.
3. To provide a revolutionary indoor plant design that enables individuals to cultivate plants even in the absence of sunlight.

SCOPE OF VEGETABLE PLANT CULTIVATION

1. Artificial light source is considered innovative, economical and environmentally compatible solution for cultivation of plants. The innovative study examined the effects of artificial light such as LEDs and natural light on the growth of indoor chilli plants.
2. This artificial lightning process is Low cost-thousand-fold cheaper than other process.
3. Due to their inherent qualities, which include greater disease resistance, increased adaptability to a harsh climate, and less intense cultivation, these underutilized vegetables could be regarded new food crops that could increase the variety of foods that humans eat.
4. This kind of production will help small and marginal farmers. This helps address the issue of unemployment by keeping the farmer occupied throughout the entire year.

MATERIAL AND METHOD

In this proposed work, we are targeting to develop a series of Bi^{3+} activated Ca_2BO_3Cl phosphors was synthesized using the conventional high-temperature solid- state reaction method. The produced sample's crystal structure was found to be monoclinic, belonging to space group P21/c. The study of the surface morphology using aggregated particles and sizes in the nano range was revealed by scanning electron microscopy (SEM). Using Fourier transform infrared spectroscopy (FT-IR) and photoluminescence (PL) techniques, the presence of vibrational features and their luminescence characteristics were investigated. The results obtained indicated that the material disclosed would be a good option for use as a red-emitting phosphor for applications related to plant development and w-LEDs. Under this research work, the actual line of study is indicated by the corresponding proposed properties of the synthesized phosphors useful for development of artificial light sources (LEDs) with reference

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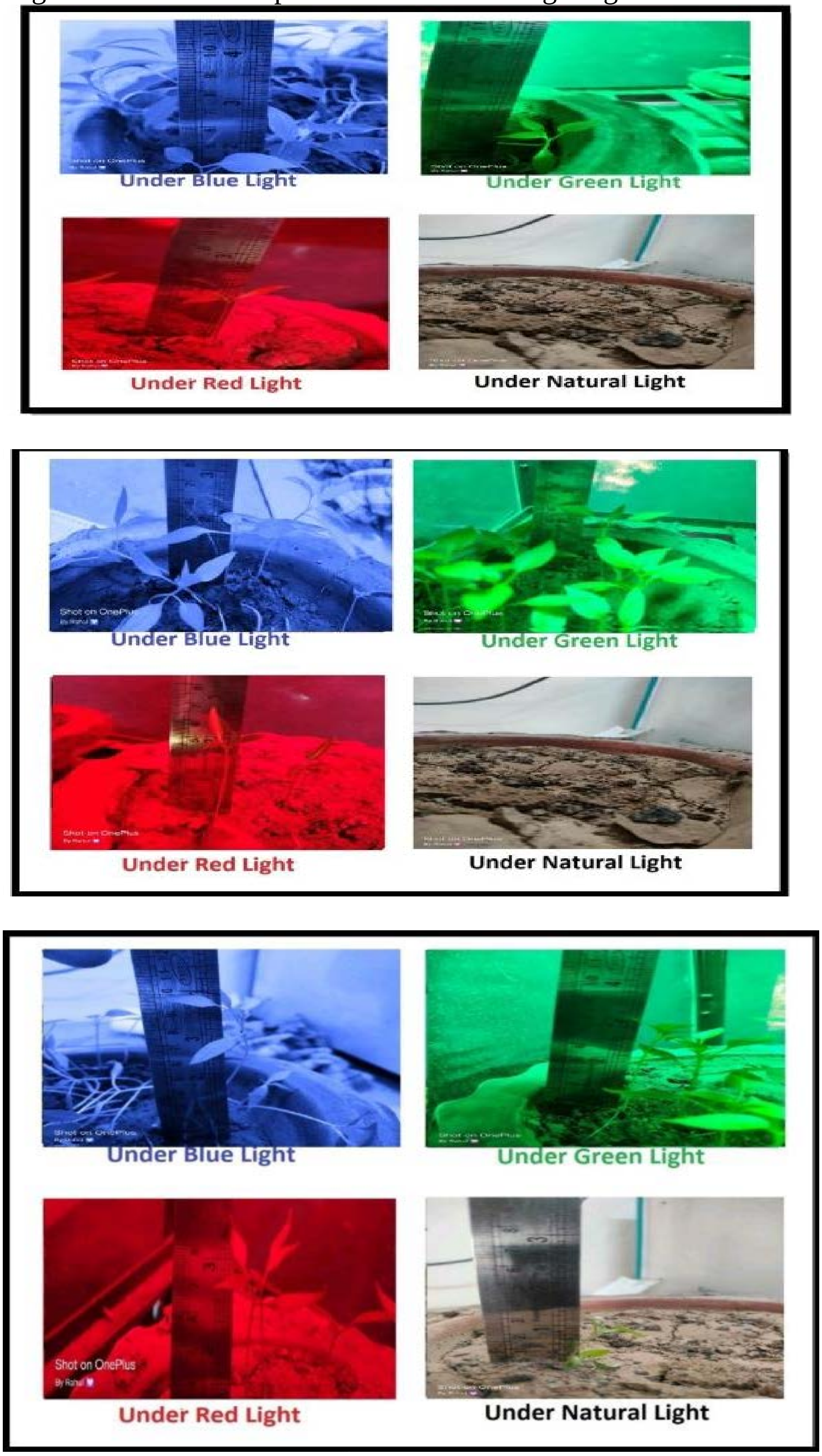
to the improvement of existing phosphors and the development of new phosphors. This investigation was carried out in a small, enclosed space to prevent light from leaking into other areas and to make data analysis on vegetable growth. To determine how artificial lighting affects the growth and development of cultivated vegetable plants i.e., Chili Plant (Capsicum annum L.).

RESULT AND DISCUSSION

The current study discovered that vegetable plants grew and flourished superbly when cultivated under light sources from LED lights of various colors and natural light.

The goal of this study is to understand how natural and LED lighting affects chili plants in order to maximize their growth indoors

.Fig. 1 Growth of chili plant under different lighting conditions:



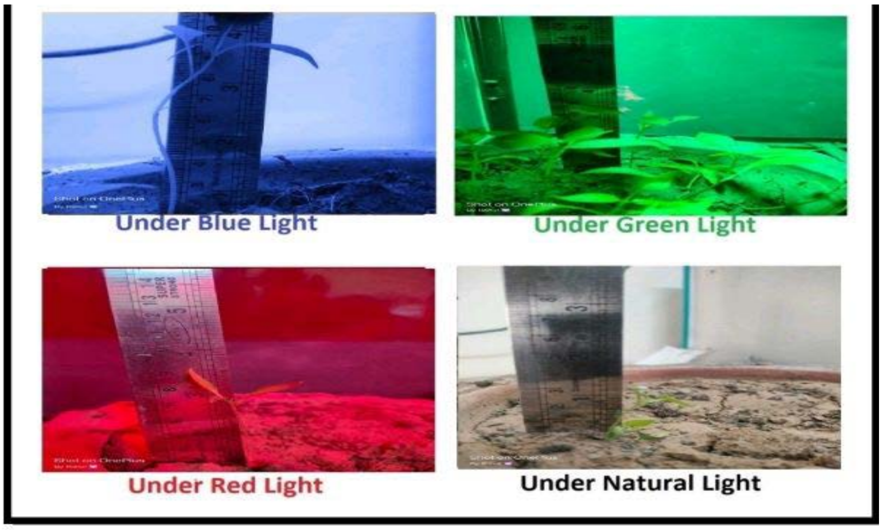


Fig 1: Growth of Chili Plant under various lighting conditions a) at the end of week 1 b) at the end of week 2 c) at the end of week 3 d) at the end of week 4.

The given figures represent the growth of chilli plant (Capsicum annum L.) when they are kept under red, blue, green and natural Sun lighting conditions at the end of week 1, week 2, week 3, and week 4 respectively shown in Fig 1. These plants were kept under different lighting conditions in a closed enclosure and were given water and adequate lighting for about 12 hours daily. The figures suggest the trends observed in the growth of the plant under different colored LEDs light. As can be seen from figures, one can easily observe that the plant grew a lot faster under the artificial color lights when compared to natural indoor lighting conditions. This suggests the theory of predominant growth of plants under certain lighting conditions. Furthermore, we can also observe that among the colored LEDs the plant grew at its fastest under blue colored light as compared to green and red colored lighting conditions. In contrast, the plant grown more steadily under the red lighting than it did under the other type. The c) d)plant in green light showed a good growth rate in the initial phase but the growth rate decreased after a few weeks. Even as the plants kept under artificial lighting conditions kept growing, the plants kept under control lighting (natural lighting conditions) showed no significant improvement in its growth. This clearly suggests that the plants growing in artificial lighting conditions deem to grow in a relatively faster rate when compared to natural lighting conditions shown in Fig 1.

The growth (in inches) of the plants under various conditions is displayed in table 1 below. These differences in the growth in plants can be easily studied based on the below table. The results show that there is a relative advantage in the area of plant growth when they are placed in specific lighting conditions when compared to ones in natural conditions.

Table 1: Chilli height (Inches) by different types of light sources

Time	Under Blue Light	Under Green Light	Under Red Light	Under Natural Light
Week 1	1.8 Inches	2 Inches	2.1 Inches	No Growth
Week 2	2.2 Inches	2.5 Inches	2.7 Inches	No Growth
Week 3	4 Inches	3.2 Inches	3.5 Inches	1.2 Inches
Week 4	4.5 Inches	3.5 Inches	3.8 Inches	1.3 Inches

Different plants respond differently to different LED light colours in terms of growth and development, with red and blue light receiving the majority of research attention (Li et al., 2017). For Example, exposure to blue light has been shown to decrease the leaf area and shoot dry weight of Asteraceae plants while increasing those of Solanaceae plants. (Sabzalian et al., 2014; Vu et al., 2014). Exposure to red light enhanced the stomatal conductance of plants in the Cucurbitaceae family, but it considerably decreased that of cruciferous plants. (Ye et al., 2014). Furthermore, some research suggests that the effects of LED lights vary depending on the stage of the plant & life cycle at the time the lights are applied (Hoffmann et al., 2015; Simlat et al., 2016). For instance, in certain annual plants, exposure to red light reduced the activity of catalase (CAT) and ascorbic acid peroxidase (APX); however, in certain perennial plants, this effect was notably greater (Baque et al., 2009; Li et al., 2010). Consensus regarding the relationship between light colour and certain plant species is hard to come by. The length of the light illumination period may also have an impact on the plants & growth and, eventually, size. The treatment, plant species, growth conditions, light spectrum, intensities, and other factors varying widely among independent experimental studies of the effects of LED light mean that there is no one systematic analysis covering all the data in the objective evaluation of the association between LED lights and effect on plant characteristics.

Artificial lighting is very useful for plants, Rahman et al., (2021) studied the, effect of artificial light on the potato plant growth and tuber formation and their results shows the, growth properties were enhanced by the red and far-red light spectra, whereas the development of tubers and the accumulation of primary metabolites were altered by the combination of red, blue, far-red, and white light. Sinha (2018) was evaluated the Nutritional analysis of few selected wild edible leafy vegetables of tribal of Jharkhand, India. She analyzed the moisture, ash, vitamin C, iron, calcium, protein content as 77.62+0.47, 13.44+0.03, 76.54+2.57, 45.83+0.381, 3590.5+66.89, 20.25+0.29 respectively its 40-45 % higher than other vegetables.

Sabzalian et. al., (2014) was studied plant growth and development supported by LED lighting regimes. In their studies, plants such as ornamentals, mint, lentils, and basil grew more quickly under this artificial lightning scenario. The study findings showed that LED lighting had positive effects on the vegetables and potted flowers under investigation, including dwarfism and enhanced production of essential oils. Red- blue illumination produced the majority of the advantageous advantages among the LED light characteristics. By analyzing the data of current study it shown that the plants growing in artificial lighting conditions deem to grow in a relatively faster rate when compared to natural lighting conditions. But when we compared result in between three lights maximum growth found in blue light as compared to red and green light.

Plants selectively absorb and use the light wavelengths that they can. Plants have two types of phytochromes that are sensitive to red light and far-red light, respectively: PFR and PR. In conclusion, the search for effective red/far-red emitting phosphors for use in plant culture LEDs is urgent. According to research, red light (600–700 nm) is crucial for plant stem growth and phototropism, blue light (400–500 nm) can encourage leaf growth and stomata opening, and far-red light (710–740 nm) can alter a plant & germination and flowering stage (Smith, 2000; Sankarasu bramanian et al., 2018).

CONCLUSION

Authors conclude from the above investigation to show environmental experts the many forms of indoor farming, delineate important research topics, and emphasize the potential environmental impacts of large-scale indoor farming. Peoples aware about excessive use of pesticides, insecticides and soil containing many heavy metals it adversely effect on heath create cancer like disease so peoples now a day prefer home gardening to grow vegetables at home so this artificial lightning technique both beneficial to farmers and peoples. In this technique use of artificial light for cultivation of vegetable plants in off season also, because some rare and wild vegetable grow only in particular seasons. It is always crucial to consider that the field of LED phosphors is one that is rapidly expanding. This study focuses on inorganic phosphors and how to use them for cultivating rare and wild edible plants. In the proposed work, we will synthesize rare earth activated inorganic phosphor and characterize their spectroscopic properties according to vegetable plant cultivation.

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