Investigating Growing plants in Different Kinds of Light

Mobina Ebrahimi Fakhar Tehran / Iran

ARTICLE INFO

Participant in IYNT 2016 (Junior)

Selected by Ariaian Young Innovative Minds Institute , AYIMI

http://www.ayimi.org ,info@ayimi.org

ABSTRACT

The advantages and disadvantages of the artificial lightening experiments test by comparing the effect of full spectrum light bulb and light-emitting diode (LED) lamps on different samples (i.e. plants). Utilized full spectrum light is comparable with our universe sun spectrum, and only its intensity is lower. Utilized LED lamps cannot be so useful because plants need different kinds of spectra and cannot grow with limited number of spectra. Each limited range spectrum effects on the growth of special part of plant. Chlorophyll is not the same in all plants. Different chlorophyll, absorb different spectra.

Keywords : *: Artificial Lightening, Growing plant, Spectra, Cholorophyll*

1. Introduction

Our life completely depends on plants because they keep us alive by making food. They need light to produce food by action of light on their cells containing chlorophyll ($C_{55}H_{72}O_5N_4Mg$). This process is called photosynthesis (an example of energy transformation). Plants usually use sunlight for photosynthesis but it is not always possible all around the clock. Hence, we can use artificial lights when the sunlight is not available.

The effect of artificial lights on growth of plants has been experimented. Blue and red light have been used to help the growth of leaves and flower, respectively [1]. Artificial lights can be used to grow plants in areas that are not suitable for plants such as dark places. Another advantage of the artificial lights is that they can be used in the desired season, for example in winter that the intensity of sunlight is low [2]. But using LED light bulbs, with limited spectrum range, is not always a good idea to grow plants because most plants need full spectrum lights and other energies [3].

We used both LED and full spectrum light bulbs to stimulate the sunlight and also use the advantages of artificial lights. The utilized LED frequencies were in the range of the 430–770 THz (about 1.6 – 3.2 eV, i.e. visible spectrum). Results shown that the light wavelength ($\lambda = \frac{c}{f}$, where f and c are frequency and light velocity, respectively) has directly influence on the growth of a particular plant. Chlorophyll is an important pigment in the process of photosynthesis. It is a photoreceptor that is found in the chloroplast of green plants. Chlorophyll A and chlorophyll B are the two major types of chlorophyll. Chlorophyll C and chlorophyll D are less common and are found in different algae.

Chlorophyll A is the most prevalent type of chlorophyll. This type of chlorophyll absorbs red, blue and violet wavelength. Chlorophyll B is found primarily in plants as well, but this type absorbs blue light only and is yellow in pigment [4]. Different types of spectra have different effects on the growth of plants [5].

Visible light waves are the only electromagnetic waves human eyes can see. These waves are seen as the colors of the rainbow. Each color has a different wavelength. Red has the longest wavelength and violet has the shortest wavelength. When all the waves are seen together, they make white light. When white light shines through a prism, the white light is broken apart into the colors of the visible light spectrum [6].

2. Experiment

Potting soil was put into the plant pots, and a bean seed was buried under half an inch in each pot. LED lamps (blue, red, green, colors) and full spectrum light bulbs (incandescent and fluorescent lamps) were placed over the boxes (Figs. 1 and 2) .

Fig. 1: plant under fluorescent lamp

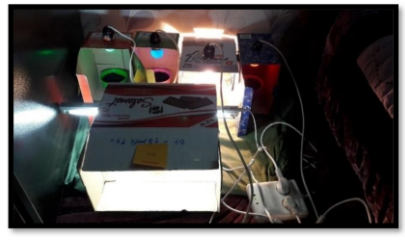

Fig. 2: Lamps are above the boxes

The boxes were sealed to prevent the light to escape. Lights were turned on/off every morning/evening at certain times. Another important point which must be considered is the different intensities of the LED lamps. In here, to have a good and acceptable estimation the growth parameter was normalized to the utilized intensities. The bean seeds under fluorescent lamp, grew in a really good way and became very strong, healthy, and green plant. So fluorescent is a good light source for plants (Fig. 3). Blue

LED was very useful for plant`s height but the plant didn`t become strong and green. But the plant`s leaves didn`t grow as good as its height (Fig. 4).

Fig.3: Plant under fluorescent lamp, day 1 to 13

Fig. 4: Plant under blue LED, day 1 to 13

The plant that was under red LED, didn`t become high. But it`s leaves grew in a suitable way (Fig.5). although Incandescent lamp has most of the necessary spectra of plant, because of making the area so hot, it cannot be a good light source (Fig. 6). Green LED is not a good light source, because the plant cannot grow in a good way and it became yellow and weak. Because green spectrum is the reflection of green color of plant`s leaves which don't have a lot of effect on plant`s growth (Fig. 7).

Fig. 5: Plant under red LED , day 1 to 13

Fig. 6: Plant under incandescent lamp , day 1 to 13

Fig. 7: Plant under green LED , day 1 to 13

3. Results

Plants prefer full spectrum artificial light (fluorescent lamp), because full spectrum light gives the full range of required energy to survive a plant. However, sometimes a bulb can be better than sunlight because most part of the light that plant receives from sunlight is not necessary. It means that some wavelengths are not absorbed by plants and they only reflect from the surface. Some other wavelengths have only an influence on the growth of special parts. At the blue, plants receive the materials for being high, while the red have influence on plants leaves [1], and at white (fluorescent lamp), plant would have the best growth.

Incandescent light bulbs give off too much heat for most plants, and although they meet the red light needs, they do not supply enough blue rays. Fluorescent tubes are better light sources and last about 10 times as long as an incandescent bulb . Because bean could grow better with blue and red lights, therefore, we can say that bean has chlorophyll A and chlorophyll B. (Fig. 8) there are some differences about the leaves of plants. The leaves of a plant that grew with fluorescent light is thicker and veins are less obvious. The leaves of a plant that grew with red LED were thinner than others (Fig. 9). There are also some differences about plant`s leaves size. Leaves of a plant that grew by fluorescent lamp were bigger than others.

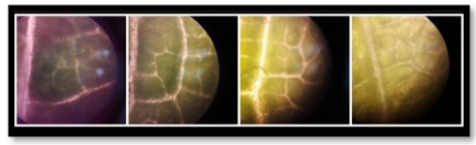

Fig .8: From left, plant under fluorescent light, blue LED, green LED, red LED

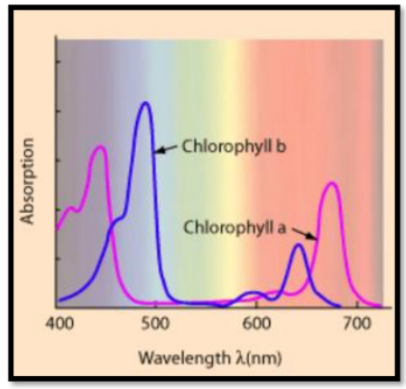

Fig. 9: Chlorophyll A and B absorb red and blue wavelength

4. Conclusion

Fluorescent bulb is the best choice for artificial lightening (beans) because it acts like sunlight and the plant can use all needed spectra. Gradually, artificial lightening can replace sunlight because it is more available and more manageable and also Artificial lightning is sometimes better than sunlight because all part of the light that plant receives from sunlight is not necessary. Using LED light bulbs cannot be so useful because plants use each spectrum for special usage but sometimes a special plant grows better with special spectrum. The difference between growth of different plants under different spectrums is because of the chlorophyll of plants. Green plants mostly, have chlorophyll A and B, which absorb red and blue spectra.

References

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