The effect of coloured light on *Ipomoea purpurea* growth

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**Abstract.** *Ipomoea purpurea* is a climbing ornamental plant native to Mexico. The paper is describing the experimental setup and results for indoor growing plants exposed to white LED light (inside a reference chamber) and four different wavelength LED lights (inside a measure chamber). Four growing experiments of 12-15 days, took place in identical environmental conditions (identical temperature and relative humidity inside the reference and measure chambers, similar lighting conditions and soil moisture). At the end of the experiments, the plant chlorophyll and xanthophylls content have been measured and the plant aspect (vegetal mass, leaves colour and robustness) has been observed. The smallest content in chlorophyll (a and b) was developed by the plants growth in blue light (480 nm), however those plants where 10% taller than plants growth in white light, but less robust. The higher content in carotenoids and xanthophylls was observed in plants which growth in white and red light.

1. **Introduction**
A few US patents [1, 2] including NASA research, claim the combination between red and blue LED light effect for plant growing acceleration. The experiment presented in our work, is searching for the optimal wavelength combination for *Ipomoea purpurea* growth.

2. **Experimental setup**
The experimental setup (figure 1) consists of two identical anechoic chambers (1, 2), both with door access, four LED light sources (6), temperature and relative humidity sensors (4) and fans (7). The reference chamber (1) has four white LED-group sources while the measure chamber has four different LED sources: red 650 nm, yellow 590 nm, green 550 nm and blue 480 nm. The chambers are anechoic, against any external radiofrequency waves which can accelerate the growing plants process [3]. The
humidity / temperature sensors of both chambers are connected to a microcontroller datalogger and automation device (5) which is storing to own memory the temperature and humidity samples taken with a programmed sampling time. For this set of experiments, the sampling time was set to 5 minutes over the entire experiment period of 12-15 days. The microcontroller is also driving the fans (7) which keep the same humidity and temperature in both chambers within ± 3% RH and ± 0.5°C. Each of the LED lamps (6) are supplied from a controlled current power supply (10) to achieve a constant illuminating intensity of 300 lux measured at the soil level in both chambers. For light intensity measurement an Iso-tech 1332A Digital Illuminance Meter with a known amplitude to wavelength sensitivity has been used. To avoid any power supply malfunction, the datalogger (5) has its own lithium accumulator and the whole experiment is supplied from a 2KVA UPS unit (11) with an autonomy of 24 hrs in absence of the main power supply.

Seeds with almost similar shape, size and colour have been selected at the beginning of each experiment. Five seeds laid in every four transparent plastic vessels (3) placed below the LED light spots (6). Seeds have been moistured initially with 2.5 ml of tap water and kept exposed to light for 24 hrs (figure 2).

![Figure 2. Seeds in moisture under white light.](image)

On the second day of each experiment, seeds have been buried below a 5cm³ of uncompressed Terra Dena soil manufactured by Matecsa Ker. Es Kert. KFT Hungary and moistured with 5 ml of tap water. Twice per day over the entire experiment period, the soil was moistured with the same amount of 2.5 ml of water using an 8 stage modified peristaltic pump (8) model Cole Palmer Masterflex 7568-10, driven from the same datalogger/automation device (5). During the experiment, the growing ratio of the plants from various plastic vessels has been observed, but not all five seeds have always germinated.

![Figure 3. Plants after 12 days in white light.](image)
When the smallest plant from the measuring chamber reached a size of 5cm tall and leaves expanded (figure 3), the taller plant from each vessel has been removed and the vegetal content was analyzed (figure 4) and leaf pigments have been measured.

**Figure 4.** Plants length grow in white light (reference chamber, A1…A4= white). Plants length grow in coloured light (measure chamber, G=green, R=red, Y=yellow, B=blue).

The remaining plants have been moved in flower pots using the same soil; they were placed in the room and the growing speed and robustness (alternating moisture to dryness periods) were observed. Four experiments took place between February 2009 to April 2009 (the experiment is still in progress).

3. Measurements

3.1. Humidity and temperature measurements inside the reference and measuring chambers

**Figure 5.** Temperature variation in chambers over 9 days (less than 0.5°C difference between chambers).

**Figure 6.** Humidity variation in chambers over 9 days (less than 3% RH difference between chambers).

At the end of each experiment, datalogger memory is transferred to a PC using the RS232 interface. The temperature and humidity variation between chambers over 9 days of experiment is represented in figures 5 and figure 6. The same environmental conditions have been kept inside of both chambers over the entire experiment.

3.2. Pigments determination
The leaf pigments were colorimetric determined in 80% acetone extract, at wavelengths of 663 nm, 646 nm and 470 nm. 0.1 g plant material was ground in the presence of quartz sand and washed
several times with 100% acetone, filtered in vacuum and passed quantitatively into a 10 ml quoted flask containing 2 ml distilled water. The acetone extract of plant was spectrophotometrically dosed and compared to a blank of 80% acetone. Results were calculated based on formulas developed by McKinney [4] and values were expressed in mg/100g plant material (equation1 to equation3 and table1)

\[
Chlorophyll\ a = (12.21*A_{663} - 2.81*A_{646}) * 5 \\
Chlorophyll\ b = (20.13*A_{646} - 5.03*A_{663}) * 5 \\
carotenoids\ &\ xanthophylls = \frac{1000*A_{470} - 3.27*Chlorophyll\ a - 1.04*Chlorophyll\ b}{229} * 5
\]

4. Results and discussion

Table 1. Pigment quantities in plants growing under different LED light.

| Pigment                        | White light (480 nm) | Blue light (550 nm) | Green light (550 nm) | Red light (650 nm) | Yellow light (590 nm) |
|--------------------------------|----------------------|---------------------|----------------------|-------------------|-----------------------|
| Chlorophyll\ a                 | 96.6375              | 81.0385             | 90.2607              | 85.6420           | 78.0534               |
| Chlorophyll\ b                 | 89.0604              | 69.1358             | 84.9778              | 94.2400           | 73.2494               |
| Carotenoids and xanthophylls   | 34.5147              | 28.1003             | 33.1352              | 34.1374           | 32.8025               |

The following plant behaviour have been observed:

- in each experiment, plants growing in red light (650 nm) have used less water for photosynthesis than other plants;
- on each experiment, plants growing in red, yellow and green light are growing facing to the blue light, while plants growing in blue light are growing straight upwards (figure 3);
- plants growing in white light developed the largest chlorophyll (chlorophyll a + chlorophyll b) content (table 1) followed by the plants growing in green and red light;
- on most experiments, plants growing in blue light where 10% taller than other plants but they have the smallest robustness to dryness once they are moved in natural light;
- there is no major difference in total chlorophyll content between plants growing in red or green light (table 1).

References

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