Effects of Pulsed Lighting on Growth Rate of Spirodela Polyrhiza

Contents

Appendix

1. INTRODUCTION

1.1. Background

Spirodela Polyrhiza, commonly known as giant duckweed, has gained many uses due to its fast-growing ability and adaptability to a wide range of environments. These features have been especially important in making it the perfect candidate for cleaning urban waste water. Additionally its chemical properties have made it potentially useful for creating biofuel. Being a floating plant has allowed Spirodela Polyrhiza to be easily handled by automated systems, making it ideal for mechanized processes such as those that might be used for food production.

The plant, measuring under a centimeter in diameter, consists of a frond and root enabling it to efficiently perform photosynthesis on the surface of the water while using the nutrients found below. In certain conditions the plant is able to double biomass in just a few days by using asexual reproduction.

Photosynthesis is a process in which plants are to create food from chemical processes involving carbon dioxide, light energy, and water, a crucial part of their growing process. Previous studies have analyzed the effect of pulsed lighting on lettuce and found that higher frequencies did result in a statistically significant result.

PWM modulation is a common technique in controlling lighting brightness, but is often limited to frequencies of up to a few kilohertz. The potential efficiency gained from higher frequencies could allow for power consumption of artifical lighting to be minimized.

1.2. Research Question

This exploration will dive into how how rapid digital control of lighting impacts the efficiency of photosynthesis and plant growth. **How does the Frequency of pulsed light effect the growth rate of Spirodela Polyrhiza?**

2. METHODOLOGY

2.1. Materials

- Camera
- 12-50mm Lens
- Tripod
- Photo background
- Seachem Flourish Plant Supplement
- Spirodela Polyrhiza (Giant Duckweed)
- LED
- STM32 devboard
- Black foam core board
- Temperature sensor
- Humidity sensor
- Plastic cup
- Pipette
- Tap water

2.1.1. Camera

An Olympus OM-D E-M5 Mark II mirrorless camera was used with the following settings:

- ISO 1600

- WB Sunlight
- 1/20
- 16 MP Resolution
- 50mm
- F8

2.1.2. LED

The LED chosen had a warmth of 4000k and Color Rendering Inde (CRI) of 90. The spectrum of light emitted is shown in Figure 1.

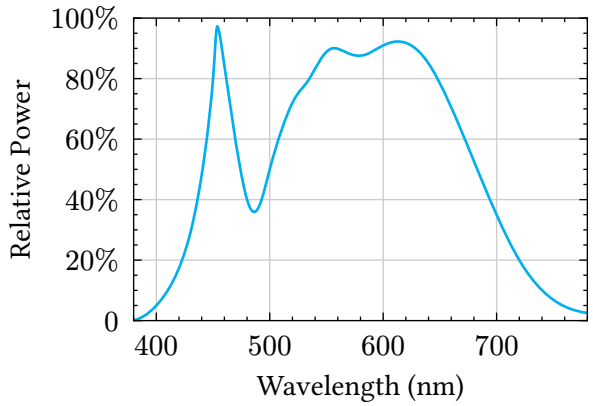

Figure 1: LED Spectrum

The LED was controlled with an N-channel MOSFET and a gate driver as shown in Figure 2. The value of R1 was chosen to be 20Ω.

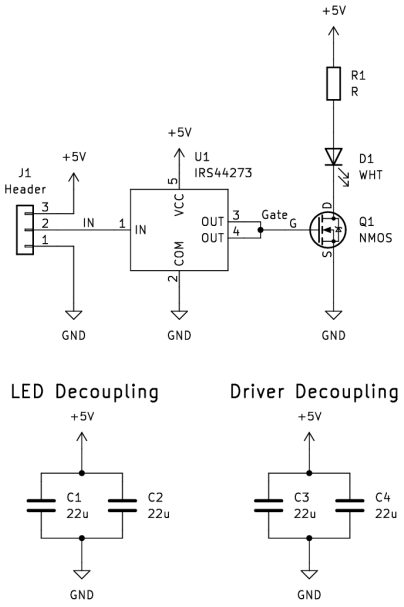

Figure 2: Schematic of LED Driver

2.1.3. Plant supplement

Seachem Flourish Plant Supplement was used and contains the nutrients required for plant growth as shown in Table 1.

Type	Percent
Total Nitrogen (N)	0.07%
Available Phosphate (P_2O_2)	0.01%
Soluble Potash (K_2O)	0.37%
Calcium (Ca)	0.14%
Magnesium (Mg)	0.10%
Sulfur (S)	0.27%
Boron (B)	0.008%
Cobalt (Co)	0.0004%
Copper (Cu)	0.0001%
Iron (Fe)	0.32%
Manganese (Mn)	0.0118%
Molybdenum (Mo)	0.0009%
Zinc (Zn)	0.0007%

Table 1: Contents of Seachem Flourish

2.1.4. Spirodela Polyrhiza

The plants was acquired at a local aquarium store as part of a larger collection of floating plants that included, duckweed, dwarf water lettuce, and red root floaters . Spirodela Polyrhiza was separated and stored at 68° in a shallow pool of tap water prior to experiment.

2.1.5. Tap water

Tap water was left out in plastic container for a week prior to experiment in order to remove chlorination.

2.2. Procedure

1. Measure 1500ml of prepared tap water into large container and using a pipette add 3 drops of plant supplement into water. Stir the mixture using a metal spoon .
2. Using another pipette add 20ml of the mixture prepared in step 1 to a small plastic cup.
3. Repeat step 2 until 18 cups contain water.
4. At random select 18 Spirodela Polyrhiza plants and add them to containers, adding lids with holes .
5. Place containers in a 3 by 6 grid with a spacing of 15 cm between the centers of adjacent containers.
6. Place LED lighting grid above the containers so that lights are centered above plastic cups
7. Set five PWM outputs with a 50% duty cycle and a frequency as determined by Table 2.
8. Measure temperature and humidity
9. After approximately 24 hours remove LED grid and indivually place plastic cups on piece of paper.
10. Take photo from directly above paper with the end of lens 70cm above paper. Note time at which photo was taken.
11. Repeat above steps 9 and 10 until five days have passed

0.01 Hz	1 Hz	100 Hz	10 KHz	1 MHz
0.01 Hz	1 Hz	100 Hz	10 KHz	1 MHz
0.01 Hz	1 Hz	100 Hz	10 KHz	1 MHz

Table 2: Arrangment of plants

2.3. Controlled Variables

A Tables and Data

B Additional Listings