The effect of light stress and water stress on growth rate in *Mentha arvensis* 

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Abstract. The effect of environmental stresses on growth rate was tested for *Mentha arvensis* (Mint). The plant was planted under different light intensity and watered either within 2 days interval, 4 days interval or 6 days interval. The stresses were monitored to see the significant effect on its physiological parameters and to test the adaptability of *Mentha arvensis* toward those stresses. The aim of this study is to measure the growth rate of *Mentha arvensis* affected by the combination of light and water stress. The findings of this study showed that plant that received less amount of nutrient and sources will try to develop self-mechanism, such plant tends to elongate its roots searching for water access. Through self-mechanism development, plant was able to absorb more nutrient effectively as both light and water act as a main source in providing morphological adaptive strategy for environmental stresses.

1. Introduction

The common name for *Mentha arvensis* is mint. It is an herbaceous species under the Lamiaceae family. This species is known as a remedial and aromatic plant which can bring many benefits for human use [1]. This species requires a site that is visible to sunlight but it is still able to grow normally even in a partially shaded condition because it has the ability to grow best under cool conditions. In fact, mint is much easier to be planted via stem cuttings compared to seeds. Taking good care of mint is crucial to maintaining a healthy growth.

Mint is known to be used a lot in Ayurveda. In India, mint tea is widely used as a cure for illnesses such as for treating indigestion and eliminate exhaustion. For ethnomedicinal plants, as documented in East Nepal, *Mentha arvensis* is claimed to be good for treating cough, cold and fever because as a source of essential oil, mint can be used in medicinal preparation such as itch-relieving balms, cough syrups, and tablets [2]. Parts used in this species are mostly stem and leaves which are used by rubbing it externally [2]. A chemical found in this species, such as methol, has a variety of applications such as in perfume, toothpaste, and whiskies [3].

2. Materials and Methods

2.1. Plant material
Mentha arvensis was bought from a nursery in Batu Pahat, Johor. To maintain the fertility of the soil, an organic fertilizer was used. Stem cutting of the mint plant was taken and planted in a small vase before being treated under a combination of light and water stresses in order to see the effects of its growth rate. The mint plant was replicated to 45 plants and five cuttings for each treatment. The plants were watered accordingly on the starter day of treatment. The growth measurements of the mint plant were taken on-site.

2.2. Water and light treatment
The treatment for the light stress of the plants was set up with 100% Full Ambient Light (FAL), 70% FAL and 50% FAL by using a light meter and canvas shade. Meanwhile, the irrigation system of the crops was controlled manually for 2 days, 4 days and 6 days in order to determine and indicate influences of drought and flood towards the plant. The total number of treatments is 12 days. Each plant was poured with 200ml of water equally and accordingly. The changes on the mint plant was observed up to twelve days of treatment.

2.3. Plant measurement

2.3.1. Growth parameter of Mentha arvensis. The data for the plant’s height and number of leaves were recorded according to the day of treatment. Plant height were measured either by using a ruler or measuring tape while number of leaves were counted manually.

2.3.2. Root length of Mentha arvensis. For root length, the data were collected once the treatment of both light and water stresses were terminated. Root length were measured by using a graph paper for more accuracy.

3. Result and Discussion
The result showed the influence of a combination of water stress and light stress in Mentha arvensis on growth rate. With the existence of stresses, they drive plants to be stunted and lacking in nutrients. But for a plant that grows wild, Mentha arvensis is still able to grow effectively as sunlight acts as the main source in providing morphological adaptive approach for environmental pressures.

Figure 1 shows measurement for height of Mentha arvensis under 100% FAL, while Figure 2 shows measurement of height under 70% FAL and Figure 3 shows measurement of height under 50% FAL. The result shows continuous growth even though the plant faces a limited water access. For the 2 days interval result under 70% FAL (Figure 2) the line graph is fluctuated at day 4. The fluctuation is due to the plant facing some difficulties in absorbing nutrients, but after day 4, it continued to grow normally as it was able to resist the pressure afterwards. The graph showed fluctuation because the plant failed to absorb nutrients during water stress, resulting in the decrease in leaf water potential and in stomatal opening. Water-transport systems across membranes caused a slight change in guard cells and disturbed the development of the shoots [4].

![Figure 1. Plant height of Mentha arvensis under 100% FAL](image-url)
Figure 1 above shows the result for all treatment intervals which are 2 days, 4 days and 6 days. Treatment of 2 days interval started at D-2 with 14.48 cm, and ended at D-12 with 18.67 cm. Meanwhile treatment of 4 days interval started at D-4 with 16.38 cm and ended at D-12 with 19.79 cm. Drastic increase is seen for the 6 days interval treatment which is from 15.75 cm at D-6 to 41.63 cm at D-12.

![Figure 1](image1.png)

**Figure 1.** Plant growth for Mentha arvensis under 70% FAL

Figure 2 above shows continuous increase in plant height for Mentha arvensis in 4 days and 6 days treatment. The 4 days treatment showed a continuous increase from 20.37 cm at D-4 to 21.13 cm at D-12. The 6 days treatment shows similar results where the result increased from 13.63 cm at D-6 to 15.38 cm at D-12.

![Figure 2](image2.png)

**Figure 2.** Plant height of Mentha arvensis under 70% FAL

Figure 3 above shows a consistent increase for 2 days, 4 days and 6 days treatment in plant height of Mentha arvensis. Treatment of 2 days started at D-2 with 13.2 cm and ended at D-12 with 20.88 cm. The 4 days treatment started at D-4 with 21.05 cm and ended at D-12 with 21.88 cm. For 6 days treatment, it started at D-6 with 13.63 cm and ended at D-12 at 15.38 cm.

![Figure 3](image3.png)

**Figure 3.** Plant height of Mentha arvensis under 50% FAL

Figure 4 shows the number of leaves under light and water treatment. The total number of leaves increases except for treatment under 50% Full Ambient Light. This is due to the lack of light intensity which then prevented photosynthesis from happening regularly. Photosynthesis is the most important process that can leave big influences on physical appearance of the plants. 50% Full Ambient Light treated plants had low number of leaves due to influence of water and light stress. In [3] the number of leaves increase in 50% Full Ambient Light, but only one treatment is involved. Based on
Figure 4 under 4 days treatment, the leaves continuously decrease at the end of the treatment. This shows that leaf transpiration is dropping as the plant closed the stomata in response to moderate water stress [6].

Figure 4. Number of leaves of *Mentha arvensis* under 100% FAL

Figure 4 above shows continuous increase in number of leaves of *Mentha arvensis* under 100% FAL for 2 days, 4 days and 6 days treatment. Treatment for 2 days started at D-2 with 14.5 and increased to 75.5 at D-12. While for 4 days treatment, it was increased from 32.13 at D-4 to 87 at D-12. At 6 days treatment, the result increased at D-6 with 18.75 to D-12 with 47.5.

Figure 5 above shows the result for the number of leaves of *Mentha arvensis* under 70% FAL for 2 days and 6 days treatment. For the 2 days treatment, the leaves increased from 17 leaves at D-2 to 58.94 leaves at D-12 while for the treatment of 6 days there was an increase from 20 leaves at D-6 to 50 leaves at D-12. For 4 days treatment, the number consistently decreased to only 23 leaves at D-12.

Figure 5. Number of leaves of *Mentha arvensis* under 70% FAL
Figure 6. Number of leaves of Mentha arvensis under 50% FAL

Figure 6 above shows the result for 2 days, 4 days and 6 days treatment in number of leaves of Mentha arvensis under 50% FAL. For the 2 days treatment, the number of leaves remain constant at the end of the interval with 59.85 from D-10 to D-12. Results of the 4 days treatment showed an increase from 35.9 at D-4 to 77.5 at D-12, while for the 6 days treatment showed an increase from 16 at D-6 to 37.5 at D-12.

As for root length, it can be regarded as a key parameter to see the regulation of plant capacity in capturing soil water and nutrient. Through root length, the physiological process of the species undergoing environmental adaptation can be seen. Based on Figure 4.10, the 2 days treatment under 70% FAL of Mentha arvensis concluded that the root was short and the root would not have to extend itself looking for more water access. As for the 2 days treatment under 50% FAL, it has the longest root thus it could develop an extensive root system so that it can tolerate any harsh environment [7].

Figure 7. Root length of Mentha arvensis

Figure 7 above shows root length for Mentha arvensis. Root length for 2 days treatment under 50% FAL is the longest with 21.5 cm while the shortest is root length for 2 days treatment under 70% FAL with 1.67 cm.

4. Conclusion

This project has been developed to see significant growth rate of Mentha arvensis under light and water stress. The changes shown in the physical parameters of the plants were due to the harsh environment that the plants faced. Plants need to be provided with enough nutrients to prevent withering. But some of
the plants have the capability to tolerate stress by developing its own physiological mechanism. In terms of physical appearance, *Mentha arvensis* under 2 days treatment of 70% FAL look healthier than the other interval treatment. It constantly received enough water sources every 2 days and was put under partially shaded condition of sunlight which are more favorable for Mint to grow best. Plants that face limited water access tend to elongate its roots searching for water, while plants facing limited sunlight, will extend its shoot towards light in order to avoid competition.

**Acknowledgement**
The authors would like to thank FRGS-RACER National Grant (Vot K 165), GPPS University Grant (Vot H 631 and H 421) for assistance and sponsorship.

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