Effect of different light intensities on growth rate in *Mentha arvensis*

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Abstract. *Mentha arvensis* was used as plant models as it can respond typically to different environmental conditions by marked alterations in growth rate. Among the environmental factors affecting growth rate, light eternally at an improper level. In nature, the intensities are overhead of the saturation point and might high enough to inhibit the growth during substantial of the day. Such information is rudimentary to the evaluation of physiological studies and this parameter is less studied on *M. arvensis*. Thus, this study describes the growth response of *M. arvensis* to different light intensities. In order to determine the effect of different light intensity on their growth rate, (50%, 70% and 100 %) of full ambient light (FAL) were introduced to the plant after they were grown using stem. The treatment were introduced after a month of germination. Furthermore, to observe their growth rate, few parameters were taken as the fresh and dry weight, plant height, number of leaves and branches were measured for each treatment.

As a consequence, the 100% of FAL treated plants showed the highest mass for fresh (3.3275 g) and dry weight (0.932 g). However, 50% of FAL treated plant showed the highest result for the plant height, number of leaves and branches, compared to 70% and 100% of FAL treatment. Therefore, *Mentha arvensis* is best grown under low light intensities.

1. Introduction

Light is one of the main components that can influence the growth of plants [1]. Plants carry out photosynthesis by the help of sunlight that triggered the reaction between carbon dioxide and water to produce glucose and oxygen. Glucose acts as food in plants and helps plants to grow. In the natural environment, plants experience a range of light intensities due to changes in sun angle and cloud cover through the year in addition to shading from overlapping leaves and neighbouring plants.

Besides, plants in the forest also need to outcompete between themselves to get enough sunlight. For example, many herbaceous species that living under closed canopies such as forest understory, cannot compete tall tree thus they need to develop their strategies of shade tolerance to cope with dim light and to optimize light capture. Besides, gaps in canopies also provide potential access to unfiltered sunlight that give good response and opportunity for understory canopy get higher amounts of light for photosynthesis. Further-more, excessive light or less light can cause plants to have stressful environment. Extraordinary unpredictable and unfavourable changes in their environment can cause...
threat in their life since plants is immobile [2]. Exposure to insufficient light limits photosynthetic activity whereas exposure to excess light energy can damage the photosynthetic apparatus.

*Mentha arvensis* is an herbaceous perennial plant belongs to family Lamiaceae in genus Mentha. This species can grow up to 60cm high. The flowers are small purplish and arranged in loose cylindrical pattern with slender spikes whereas the seeds are small and mucilaginous. Its leaves grow in opposite bearing at each node. Besides, the internode region has smooth and striated surface. The stem is dark green in colour. This plants gives a sharp peppermint odour and has a pleasant acrid taste [3]. These plants have long been credited as useful medicinal plants in combating stomach ailments [4]. Besides that, *M. arvensis* can grow better under favourable weather condition which are at higher air temperature and lower relative humidity [5]. In this condition, *M. arvensis* can produce valued essential oil because the plants were grown better in terms of plant height and leaf area index that result in higher fresh yield.

2. Methodologies

2.1. Plant propagation
The stem of *M. arvensis* were cut for 10cm and placed it in the sandy loam soil about ¼ of the soil. Once the leaves emerged from the stem, it was transferred into another big pot for a better growth.

2.2. Plant treatment
Plants were grown under natural light with canvas to provide 50%, 70% and 100% of full ambient light (FAL). The treatments were started after a month of growth and allowed to put under treatments from 0th -20th days.

2.3. Growth rate parameters
The plant height was measured from the main stem base to the top of the young plants using ruler. The number of branches and leaves were counted for each plants. The measurements were taken at 4th day intervals. The growth experiments were repeated 3 times with 5 plants in each treatment. After the treatment was finished, the fresh and dry weight were taken using electronic balance.

2.4. Statistical analysis
All experiments were carried out in at least three replicates in 3 independent experiments. The result was presented as mean ± standard deviation. The data was statistically analysed by Microsoft Excel.

3. Results and discussions
Plants of *M. arvensis* were treated with light treatments at 50%, 70% and 100% FAL. It has been shown that different light intensities affected the growth rate parameters. Fluctuation in light intensity can lead to stress in plants. Light as an energy source for plant life is known to affects the photosynthetic rate and assimilate accumulation, thereby it also controls growth and development of the plants. *Mentha arvensis* had the highest fresh weight followed by 70% and 50% (Table 1). 100% treated plant show 37.9% change in weight, whereas for the 70% treated plant, the change was 32.09% and for 50% treated plant the change in weight was 30.06%. The changes in percentage do not show the gap between the weights after being dried in the oven.
Table 1: Effect of different light intensities on weight of *Mentha arvensis*.

| Light intensity | Fresh weight (g) | Dry weight (g) |
|-----------------|------------------|---------------|
| 50%             | 2.455            | 0.555         |
| 70%             | 2.5175           | 0.4925        |
| 100%            | 3.3275           | 0.932         |

Over the course of treatment, the height of the plants were increased (Figure 1). 50% treated plants were measured higher than 70% and 100%. The plant height for 50% treated plant was increased 41% from day 0 to 20. For 70% treated plant, the height was increased 29% while 100% treated plant was increased about 30%.

![Figure 1](image.png)

*Figure 1.* Effect of different light intensities on plant height of *Mentha arvensis*. *M. arvensis* was treated for 50%, 70% and 100% FAL. Measurement was taken at 4th day interval. All data are mean ± SD for at least 3 replicates.

In this experiment, the results show an increase in plant height for 50% FAL treated plants. The plant height grow slowly as the light intensity increased. These results are in agreement with the results of [6], who observed a decrease in plant height of *Ocimum gratissimum* at high light intensity. It is depicted that; the stem growth is higher in increasing shading compared to full sunlight. Thus, the increasing stem’s lengths are closely related to the increasing height of plants. Hence, it shows that, the *Mentha arvensis* have the prominent capabilities as shade-loving plant. [11]

The numbers of leaves for all treatments were increase gradually (Figure 2). At 50% treated plants, number of leaves were counted higher than 70% and 100%. The number of leaves per plant for 50% treated plant was increase 41% from day 0 to 20. For plant under 70% FAL the percentage increase was 31% from day 0 to 20 whereas the lowest percentage was 100% treated plant which was 28% only. Most of the commercial herbs grower will plant and crop the mints under partial shades and cool environment. This shows that, most of Mentha sp. has the ability to tolerate and grow well under partial shades. Meanwhile, most of the Mentha sp. grown best under partial shades, indicates that the mentha have the ability to survive and live under partial shades [12].
Figure 2. Effect of different light intensities on number of leaves of Mentha arvensis. M. arvensis was treated for 50%, 70% and 100% FAL. Measurement was taken at 4th day interval. All data are mean ± SD for at least 3 replicates.

Besides that, 50% treated plants also show an increase the number of leaves. These adaptations maximize the capture of the available light, meeting the demand of photosynthesis [7]. For 100% treated plants it has the lowest number of leaves per plant. This is because the plant need to adapt with high radiance of light [8]. The least number of leaves also helps the plants to prevent from cellular damage caused by excessive light energy ensuring the proceeding of photosynthesis [8]. Their adaptation under partial light also have been prove and the study claims, the number and area of Mentha spicata’s leaves, a Mentha sp., are increasing in partial light compared to full sunlight. Thus, it depicted that, the Mentha arvensis might have the same possibilities and capable of growing under partial light as mentha spicata [13].

The numbers of branches per plant for all treatments were increased (Figure 3). For the plant under 50% FAL shows the highest number of branches. The plant increase 39% from day 0 to 20. For 70% treated plant the percentage show an increase about 31.2% while 100% show an increase about 29% from day 0 to 20. A study have shown that, the greatest morphological responses of increasing stem length are increases with the increases of shading [11], as well as might lead to the increasing the number of branches. Thus, the partial light might contribute to higher number of branches compared to full sunlight.
Figure 3. Effect of different light intensities on number of branches of *Mentha arvensis*. *M. arvensis* was treated for 50%, 70% and 100% FAL. Measurement was taken at 4th day interval. All data are mean ± SD for at least 3 replicates.

In this experiment it found that all three parameters show an increases in plant growth under low light intensity (50%). It shows that, when the plants exposed to low light intensity, the growth rate become increase. Previous studies, based on other plants model under different light intensity, have shown that the growth rate increase strongly under low light compared to high light [9-10].

4. References

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