Effect of various lighting colours treatment at growth and flowering of *Chrysanthemum Morifolium*

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**Abstract.** Lightning is the important parts in plants as the source of energy that affects growth and development. Differences in the colour of light used will result the differences effect of growth and flowering parameters. The research aims to determine the effect of growth and flowering after the treatment of 3 different light colours on 3 varieties of chrysanthemums. The method used in this research is experimental method of Randomized Block Factorial Design with red, yellow, and white light treatment, and 3 chrysanthemum varieties are Marimar, Suciyono, and Erika Agrihorti. The parameters that observed were plant height, number of leaves, stem diameter, flowering age, stem length and flower diameter. The results showed that there was significant interaction after the treatment of red light with Suciyono varieties with the average diameter of 5 mm. The results showed white light colour treatment effect on flowering age with longest value 59 days after planting. Varieties Erika Agrihorti showed the largest plant height that is 77.33 cm, flowering age at 59 days after planting, and the length of the stem is 81.22 cm. Suciyono variety shows the number of leaves with an average of 52.66 pieces and the diameter of the flowers of 14.78 cm.

1. **Introduction**

Light is one of the most important environmental factors, performing on plants as a single source of energy, affecting its growth and development. Plants are grown with various photoreceptors that control various responses to light parameters, such as spectra, intensity, direction, duration, etc. These photoreceptors are red and far-red, blue and UV-A phytochromes that absorb cytochromes, phototropism, and other photoreceptors that absorb in UV-A and green areas. The spectrum difference will result in different morphogenetic and photosynthetic responses, which vary among different plant species[1][2].

Blue light affects the formation of chlorophyll in the process of photosynthesis, the opening of stomata, and through crypto chrome and phytochrome systems that stimulate a photo morphogenetic response. Red and blue lights are very important on plant growth, since they are the main source of photosynthesis [3].

Chrysanthemum flowers are ornamental flowers that have a high selling value. Lighting is an important factor in chrysanthemum cultivation [4][5]. Light affecting in all periods of plant growth, such as at germination stage, stem growth, root and leaf development, phototropism, chlorophyll formation, branch formation and flowering [6].

The addition of lighting period to chrysanthemum cultivation will increase plant growth significantly. Commonly used light is visible light that has a wavelength between 400-750 nm[7]. The
procedure of supplementary light on chrysanthemum cultivation is equipped at night for 4-8 hours to increase the height of the plant. Chrysanthemum with good quality should have a standard stem height 60 - 80 cm [4].

The difference of light colour at treatment will affect the growth of the chrysanthemum because each colour of light has a particular wavelength that can be absorbed by the plant. The wavelength of light received by plants can affect the process of photosynthesis. Chrysanthemum without additional light has a faster harvesting age, but the length of the harvested crop is not optimal. In the study [7], chrysanthemum flowers with additional blue lighting with wavelength 400-580 nm will affect the acceleration of the formation of flowers. Flower bud formation is most comprehensively influenced by the addition of blue and white light. The resulting flower diameter is larger due to the blue light treatment, greater in the green and white light treatment. The red colour treatment produces the slowest flowering and the smallest flower diameter. The type of lamp and the colour of the lamp significantly influence the rise of chlorophyll index. The colour of light significantly modifies the nutrients of the plant on the content of nitrogen, sodium, iron and manganese, while the type of light source affects the calcium, sodium and iron content in the upper part of the soil [8].

The study [9] on the effect of light on the chrysanthemum micro propagation process shows the treatment of green lights can increase the propagation of chrysanthemum flowers. Green light treatment shows the highest positive effect on stem length and propagation efficiency of the planlet. Planlets grown in blue light treatment have the shortest segments and stems, Micro cuttings are well-rooted in the treatment of green and white light. Planlets which planted under red light has fewest weights and the numbers of leaves are the smallest. Red light treatment also reduces the leaf area compared to white light treatment. The highest chlorophyll content is obtained for white light treatment [9].

2. Method
The experimental design of this research uses Factorial Random Block Design, which consists of two factors: color lighting (red, yellow, and white), and chrysanthemum varieties consisting of Marimar, Suciyyono and Erika Agrihorti varieties. These three varieties are local varieties developed by Indonesian Ornamental Crops Center (BALITHI). There were 9 treatments and 3 replications so that 27 units of experiments were obtained.

The response parameters observed were plant height, leaf number, stem diameter, flowering age, stem length and flower diameter.

In the cultivation of chrysanthemum flowers using greenhouse, the largest cost earned by managers is the cost of labour and electricity costs. To reduce the cost of electricity, the recommended lamp is LED (Light Emitting Diode) type [6][10][11]. Types of lights commonly used by farmers are incandescent and fluorescent lamps. LEDs are rarely used by farmers, because the price is high even though the power spent is more efficient.

Based on the research of Anželika Kurilčik [1] optimal lighting time for stem and root growth is 16 hours. So that supplementary light giving in this research is done 5 hours every day in vegetative phase with period of giving additional light that is from start planting until 5 weeks after planting (WAP). Added light is given daily from 6 pm to 11 pm, using a 23-watt lamp with each lamp given a yellow and white red color filter. Lights are placed at a height of 1.5 meters from the ground.

The test was performed with 9 treatments and 3 replications, followed by a real variance aimed to determine the effect of treatment, with continued analysis using Duncan test at 0.05 or 5% level. Data analysis is done if F arithmetic > F table means to show significant and will do further test using Duncan test, if F arithmetic < F table mean show non-significant hence not done further test.

3. Results and discussion
The experimental results show the highest plant length is achieved on the treatment using white lights. The largest plant height is produced by the varieties Erika Agrihorti.
The number of leaves produced was not affected by the color of the lamps, as there was no significant difference between the different colored lamp treatments. Significant differences occurred in varieties differences, seen from table 1, Erika Agrihorti varieties had the least number of leaves at 10 weeks after planting (WAP).

Marimar varieties have larger stem diameter growth than Suciyono varieties and varieties of Erika Agrihorti. Marimar varieties growth has stem growth of 5.27 mm, while varieties Erika Agrihorti has the lowest growth of 4.66 mm. Suciyono varieties of 5.05 mm are not significantly different from Marimar varieties are also not significantly different with the varieties Erika Agrihorti. Table 1 shows observations at weeks 5 and 10 after planting.

| Table 1. Observation of vegetative development. |
|-----------------------------------------------|
| Treatment | Responses of Parameter (RP) |
|           | 1                | 2                | 3                |
| Color     | 4 weeks after plant | 10 weeks after plant |
| R         | 28.88             | 21.33             | 5.27             |
| Y         | 29.00             | 20.88             | 5.00             |
| W         | 31.22             | 19.77             | 4.72             |
| Variety   |                   |                   |                  |
| Var 1     | 31.00             | 24.44             | 5.27             |
| Var 2     | 30.22             | 24.33             | 5.05             |
| Var 3     | 27.88             | 13.22             | 4.66             |

| Table 2. Observation of generative development. |
|-----------------------------------------------|
| Treatment | Parameter                  |
|           | Flowering age (days after planting) | Flower stem parameter (cm) | Flower diameter (cm) |
| Color     |                            |                            |                    |
| R         | 57.00                      | 72.88                      | 13.50              |
| Y         | 57.89                      | 72.77                      | 13.20              |
| W         | 58.56                      | 76.11                      | 13.00              |
| Variety   |                            |                            |                    |
| Var 1     | 57.56                      | 72.77                      | 13.20              |
| Var 2     | 57.22                      | 67.77                      | 14.78              |
| Var 3     | 58.67                      | 81.22                      | 11.72              |

Information of Table:
R = Red
Y = Yellow
W = White
Var 1 = Marimar
Var 2 = Suciyono
Var 3 = Erika Agrihorti
RP 1 = Plant height
RP 2 = Leaves number
RP 3 = Stem Diameter

Treatment of additional light color did not shown the significant effect on plant height differences ranging from 1 WAP to 10 WAP. To obtain better quality chrysanthemum plants need to spur the vegetative growth with radiation treatment longer than normal day length. At the age of 3 WAP to 8 WAP, there was no significant difference in plant height, which means that the color treatment of light and varieties had no effect on the ages of 3-8 WAP. This is happens because the growth began to
stabilize in the vegetative phase so that the growth of each variety looks no difference. The growth of diameter appears to increase gradually and the largest diameter of the stem is indicated at the treatment of red light, although not much different from the growth of the diameter of the stem in the yellow light treatment. White light treatment produces the shortest stem diameter.

At the age of 9 WAP, the growth of Erika Agrihorti varieties became higher than the other two varieties. Erika Agrihorti's highest growth is 72.00 cm. While Marimar varieties of 65.22 cm and Suciyono varieties of 61.22 cm. At the age of 10 WAP seen a significant difference occurred in the treatment of varieties. Among the three varieties seen a significant difference with Marimar plant varieties of 69.44 cm, Suciyono varieties 65.33 cm and varieties Erika Agrihorti 77.33 cm. Erika Agrihorti variety has the highest growth and the lowest growth is Suciyono varieties.

The difference in light colour has no significant effect on the number of leaves, because the treatment of the difference in light wavelength only affects the chlorophyll index, not the area of the photosynthesis process which can be interpreted as the number of leaves. The colour difference of the lights has no effect because the method is given using cyclic method, so the light needed for photosynthesis process is less than the comparison of additional light using continuous method. The cyclical method is less than optimal in terms of the addition of light required by short-day plants, since the method is used to conserve electrical energy consumption.

The growth of stem diameter appears to increase gradually and the largest stem diameter is indicated by the red light treatment, although not much different from the growth of the diameter of the stem in the yellow light treatment. White light colour treatment has the smallest stem diameter.

Observation of blooming age of chrysanthemum plants with the treatment of light colour difference to the growth of chrysanthemum plants carried out when the chrysanthemum plants began to bloom (generative phase).

Analysis of flowering age showed a significant difference in the treatment of red light colour has a flowering age faster than the other light colour treatment that is 57 days. White light treatment produces the longest flowering age of 58.56 days after planting (59 days after planting). In the treatment of varietal variation, Erika Agrihorti varieties have longer flowering age compared to other varieties that is 58.67 days after planting (59 days), whereas Marimar varieties and Suciyono varieties have similar flowering age.

Light colours affect the age of flowering due to red light is needed in the process of photosynthesis so that the age of flowering with red light treatment more quickly than white and yellow light.

Long stem length observation by giving additional color to three varieties of chrysanthemum plant is done when the chrysanthemum flower blooms perfectly. White light treatment results in higher stalk lengths. This is due to the absorption of red fitokorm in red and yellow light stimulates the rapid development of the generative phase so that plant growth in the vegetative phase is not long and changes to the generative phase. While giving white light has no effect on the formation of red phytocorm, so that vegetative phase growth is not inhibited and vegetative phase change to generative phase is not too fast like treatment using red and yellow light.

Further experiments show that each colour treatment of light has a non-significant influence on flowering diameter, but the difference in diameter of interest in red light is greater than that of other treatments with a difference of 0.3 cm greater than the yellow light treatment and 0.5 cm larger than white light treatment.

Basically chlorophyll absorbs optimal light in red and blue light with wavelength 550 - 700 nm, so the process of photosynthesis will take place more quickly for the treatment of red and blue light.

The observation of diameter of the flower shows the largest diameter achieved by Suciyono varieties of 14.78 cm. This shows that the nature of each different variety will affect the growth value of the diameter of the flower. This value exceeds the value on the description of plants released by BALITHI that is 12-14 cm. This means the growth of diameter of the flowers has been optimal with the treatment given.
4. Conclusion

The best treatment interaction was in stem diameter at 4 weeks after planting, i.e. between red light treatment and Suciyono variety treatment with average stem diameter of 5 mm. White light colour giving effect on generative phase that is on longer flowering age with value 59 Days after planting. Erika Agrihorti varieties produce the best growth at plant height that is equal to 77.33 cm, flowering age with value 59 days after planting, and length of stalk is 81.22 cm. Suciyono varieties showed the best growth in the number of leaves with an average of 52.66 (53 pieces) and the diameter of the flowers of 14.78 cm.

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