JPPIPA 9(12) (2023)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Effect of Light Intensity on Phenology and Morphological Characteristics of Aglaonema Bigroy (*Aglaonema* sp.) Leaves

Triana Putri Silalahi[1], Pinta Murni[1*]

[1] Program Studi Pendidikan Biologi, Fakultas Keguruan dan Ilmu Pendidikan, Universitas Jambi, Jambi, Indonesia.

Received: October 9, 2023
Revised: November 9, 2023
Accepted: December 20, 2023
Published: December 31, 2023

Corresponding Author:
Pinta Murni
pinta.murni@unja.ac.id

DOI: 10.29303/jppipa.v9i12.5593

Abstract: Leaf phenology is the period of leaf development that is influenced by environmental factors. One environmental factor that is very influential is light intensity. Limited information on the phenology and morphological characters of aglaonema results in a lack of knowledge about the appropriate environmental requirements for the growth and development of its leaves. The research aims to analyze the phenology and morphological characteristics of *Aglaonema* sp. leaves at different light intensities. The research used a single factor Completely Randomized Design experiment consisting of three treatment levels, namely P0 without shade, P1 with 50% shade, and P2 with 75% shade. The treatment was repeated nine times so that a total of 27 experimental unit samples were obtained. The sample was taken using purposive sampling technique. Observations were made at the stages of leaf buds, mature leaves, wilted leaves, leaf color, leaf size, stalk length, and environmental factors. Qualitative data was analyzed descriptively and quantitative data was analyzed using the ANOVA test and 95% DNMRT follow-up test. The results of the research showed that there was a difference in the average length of the leaf development phase in the shade treatment which was higher than without shade, the average length of this phase in the three treatments was 58, 81, and 85 days respectively. Meanwhile, there are also differences in the morphological characteristics of the leaves, namely that the shade treatment has an average leaf size and petiole length that is greater than without shade. These sizes were successively in the three treatments, namely mean leaf width 6.856, 8.411, and 8.589 cm, and leaf length 15.167, 17.867, and 18.067 cm, and leaf petiole length 5.989, 7.733, and 7.989 cm. The environmental factor that influences is the intensity of light with the most optimal paranet shade, namely paranet density of 75%.

Keywords: Aglaonema bigroy; Light intensity; Morphological characters; Phenology

Introduction

Seasonal dynamics is a description of the visual changes in plants. The way to study these changes is by conducting an in-depth study of phenology. According to Haggerty et al. (2008), phenology is the science of measuring the time of events or periods of plant life and detecting environmental conditions that influence them. Plant phenology events include the emergence of leaf buds, first flowers, flower fall, ripe fruit, and leaf fall.

Phenological observations are an integrative measure of physical, chemical, and biological environmental conditions as a simple and cost-effective way to measure long-term climate and environmental changes that can provide information about the timing and duration of resource availability in ecological communities, so that phenologists generally describe phenology by recording the time phenophases occur, the duration of each phase, and the speed of transitions between phenophases that occur at various biological and geographical scales in the environment (Haggerty & Mazer, 2008). One of the plant phenology events is leaf phenology, namely the period of leaf development, which is related to the photosynthesis process. Information about leaf development periods is still very limited, so it is necessary to carry out more in-depth

How to Cite:
Silalahi, T. P., & Murni, P. (2023). Effect of Light Intensity on Phenology and Morphological Characteristics of Aglaonema Bigroy (Aglaonema sp.) Leaves. *Jurnal Penelitian Pendidikan IPA*, *9*(12), 10892–10901. https://doi.org/10.29303/jppipa.v9i12.5593

studies or observations to obtain comprehensive data and information about the periods of each phase of leaf development and to find out whether each phase can work optimally as a place for photosynthesis to occur.

Sunlight is an environmental factor that needs to be considered because it plays a very important role in metabolism, especially in the continuity of photosynthesis as a producer of energy in the form of ATP and plant nutrients, so it is always related to the growth and development of the plant. Based on the need for light intensity, plants are divided into sun plants and shade plants (semi-shade plants). Providing shade is one of the efforts aimed at providing a physical defense mechanism for plants against unfavorable weather conditions. One of the plant groups included in this shade plant is various types of ornamental plants.

Ornamental plants are cultivated plants that have high aesthetic value, for example the aglaonema leaf ornamental plant. Aglaonema is a very popular ornamental plant and is in great demand among the public and even ornamental plant collectors even though it has a fairly high selling value. According to Salimah et al. (2010) and Simamora et al. (2017), aglaonema (*Chinese evergreen*) is an indoor ornamental plant which is very suitable for living in semi-shade, has beautiful Due to its beautiful variety of colors and leaf patterns, it is in great demand and has high economic value, so fans definitely want their aglaonema to have thick leaves and last a long time.

Based on surveys conducted in several ornamental plant sellers and communities around Jambi City, it was found that the type of aglaonema that is often found is aglaonema bigroy. However, based on the results of a survey conducted by several ornamental plant sellers, they have placed aglaonema in shaded locations, but have not paid attention to the type and density of paranet they use and in the observed community environment, many aglaonema are still found used as outdoor plants that are exposed to direct sunlight. Lack of knowledge and information about proper care and environmental requirements for aglaonema results in hampered leaf development and damage to the leaves so that they cannot last as long as their developmental lifespan should. Therefore, this research was carried out with the aim of analyzing how much influence different light intensities have on the developmental phases (phenology) of leaves and characterizing the morphology of Aglaonema bigroy leaves.

Method

Place and Time of Research

The research was carried out from February to April 2023 on Jl. Ahmad Yani RT.15/RW.02 Arza Griya Mandiri II Housing, Mendalo Indah village, Jambi Luar Kota District, Muaro Jambi Regency, Jambi.

Research Design

This research is an experimental study that uses a single factor Completely Randomized Design (CRD), namely light intensity consisting of three treatments with nine replications each so that the samples used are 27 experimental unit samples.

P0 = Without Paranet Shading (Control)
P1 = Paranet Shade 50%
P2 = Paranet Shade 75%

Population and Sample

The population in this study was all Aglaonema bigroy plants found in Mrs. Richa's flower shop, which is located in Mayang Mangurai, Alam Barajo, Jambi City. The samples used were 27 pots of Aglaonema bigroy plants. The sampling technique used is a purposive sampling technique, namely the sample is selected based on certain considerations and criteria that are adjusted to the research objectives. So the category of aglaonema in this research sample is aglaonema that is planted in a pot in fertile and healthy condition, consists of only one aglaonema plant per pot, has almost the same or uniform size, has the same number of leaves (four), and has leaf shoots, will only be observed until the leaf wilting phase.

Tools and Materials

The tools used consisted of a hoe, scissors, knife, hammer, nails, stationery, wood/poles, plant table, pot, pot, ruler, cellphone camera, galaxy sensors application and weather application (AccuWater) on a smartphone, and a Munsell Color book Charts for Plant Tissues. The materials used consisted of 27 pots of Aglaonema bigroy plants as research samples, homogenized soil as a planting medium, 50% and 75% density paranet, rope, water and label paper.

Research Procedure

Land Preparation and Plot Creation

Land preparation begins with clearing the land of wild plants that grow around the land. The land will be divided into three plots with a size of 2x2 meters each. After that, poles and a shade frame with a height of about three meters are installed.

Shade Making

Making paranet shade is done by installing paranets on the existing frame, each paranet is installed at the top and sides until the paranet covers the plot as a whole, the paranets installed are 50% paranet for P1 and 75% for P2 while for P0 there is no shade of paranet.

Label Installation

Each sample pot is given a label with the aim of making it easier for researchers to make observations and anticipating confusion in the observation data. The samples are labeled U_1, U_2, U_3, …, U_9. Then samples will be taken at random and placed on a shelf in the three plots (P_0, P_1, P_2,) that are available, each plot contains nine samples. The P symbol indicates the light intensity treatment, while the U symbol indicates the leaf sample being observed, so that each sample will be labeled P and U, for example P_0U_2.

Maintenance

Maintenance of aglaonema in each treatment plot is carried out by watering and weeding. Watering was carried out using the same amount of clean water for each sample. Watering is adjusted to needs and weather conditions. Weeding is done if there are weeds in the planting medium, it is done regularly so that the weeds do not affect the development of aglaonema.

Direct Observation

Observations were carried out directly starting from the emergence of leaf buds on the midrib of the stem measuring approximately 0.5 cm until the leaves withered. Observations were carried out every day at the same time, namely between 11.00-13.00 WIB.

Observation Variables

The parameters observed in this research include the Phenology (Leaf Beginning to Appear Phase (F_1), observed when the buds of the leaves begin to appear with a size of 0.5 cm, until the next phase occurs, namely when the buds or leaf buds begin to open at the ends; Perfect Leaf Development Phase (F_2), The time is calculated from when the leaf opens until a perfect leaf is formed, which is indicated by the size of the leaf no longer increasing and it will enter the withered leaf phase; Wilted Leaf Phase (F_3), calculated from when the color of the leaf begins to change (the leaf starts to turn yellow) and the leaf stalk droops); Morphological Characteristics of Leaves (Color Pattern of Leaves. The color pattern is observed every time a change in color pattern occurs during the time the observation is carried out. The leaves observed are leaves that are designated as observation samples. The color pattern is observed by comparing changes in leaf color patterns from each treatment and control; Leaf Size (Width and Length of the Leaf), the leaf is measured from the base of the leaf to the tip of the leaf 1x with the unit of measurement being cm, namely when the leaf is mature or fully developed, it is marked by the leaf size reaching its maximum size (no increase in leaf size); Length of the Leaf Stem, measured 1x with the unit of calculation in cm when the leaves are mature or fully developed; and Environmental factors (light intensity according to the percentage of light, air temperature, air humidity and rainfall).

Data Analysis Technique

Data from quantitative observations covering each phase of leaf phenology, measurements of leaf morphological characters (size and length of leaf stalk) were analyzed statistically through the analysis of variance (ANOVA) normality test, and if the results of the ANOVA test showed that the treatment had an effect on the parameters observations, the Duncan New Multiple Range (DNMRT) further test was carried out at a confidence level of 95%. The qualitative research data includes the characterization of leaf morphology including changes in leaf color patterns and observations of environmental factors analyzed descriptively.

Result and Discussion

Aglaonema Leaf Phenology

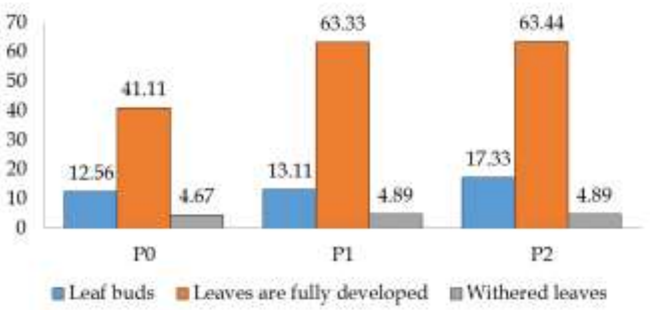

Figure 1. Graph of the Average Length of Aglaonema Bigroy Leaf Development Phase. The profile of the development phases of aglaonema leaves, starting from the formation of leaf buds until the leaves wilt in each light intensity treatment, is different based on the type of paranet shade density used

Leaf phenology will go through several phases of development until the leaves wither and fall. The first phase is the leaf initiation phase, which is the time when leaf buds form from the leaf primordial and the formation of radially symmetric protrusions formed on the apex meristem, this primordial will grow into a new leaf. Based on Table 1, it is known that different light intensities due to shade have a significant effect on the initiation phase or emergence of leaf shoots, as can be seen from the average age of leaf shoots in 75% shade which is significantly different from other treatments. This is because aglaonema as a semi-shade plant requires shade to protect it from direct sunlight. Light intensity also plays an important role in the leaf initiation phase in supporting leaf growth, namely increasing the number of cells and cell elongation which is related to the hormone auxin. This is in accordance with the opinion of (Haryanti, 2012; Lukitasari, 2012), that the leaf buds are formed in the lateral area of the apex and initial growth occurs due to the apical and marginal meristems which have a pattern of cell division so that a protrusion is formed, called leaf support. According to Silva et al. (2018) and Singh et al. (2005), leaf production occurs mainly when water is available, because water is a resource that supports the physiological processes of leaves and stem rehydration is a prerequisite for vegetative buds burst, this condition is generally found in environments that have higher humidity, such as shaded environments.

Table 1. Analysis of the Average Time Range (Length) of Aglaonema Bigroy Leaf Development Phase

Treatment	Leaf Development Phases
	Average Age of Shoots to Start Developing (days)
P0 (control)	12.56 a
P1 (50%)	13.11 a
P2 (75%)	17.33 b
	Average Age of Leaves from Opening to Full Development (days)
P0 (control)	41.11 a
P1 (50%)	63.33 b
P2 (75%)	63.44 b
	Average Age of Withered Leaves (days)
P0 (control)	4.67 a
P1 (50%)	4.89 a
P2 (75%)	4.89 a

Note: Numbers followed by the same lower case letter are not significantly different based on the DNMRT test at the 5% level.

According to Ariany et al. (2013), leaf shoots tend to utilize low light intensity to support cell growth, assisted by the presence of the auxin hormone which plays a role in the cell elongation process by stimulating the cell wall proton pump which increases the acidity of the cell wall and activates enzymes, expansin (an enzyme that breaks chemical bonds in cell walls), so that cell walls weaken and are able to grow larger. According to Ekawati et al. (2020) and Anni et al. (2013), that in conditions of low light intensity it will cause etiolation (cell elongation) in plants. Etiolation occurs due to the buildup of the auxin hormone found at the tip or shoot (apical) of the plant. However, the auxin hormone will experience damage or degradation at high light intensity, whereas at low light intensity auxin can be produced optimally and work normally, this is what causes leaf shoots to be longer when given shade.

The next phase is leaf expansion, differentiation and leaf maturation, which is a phase characterized by an irreversible increase in cell size, cell division stops, and cell enlargement occurs in the leaves which can be seen macroscopically through the increasing size of the leaves. In this phase, observations begin when the leaf buds begin to open, young leaves, fully developed leaves or mature leaves, and are limited when the leaves experience morphological changes in leaf color, starting to turn yellow or entering the wilted leaf phase. Based on Table 1, it is known that different light intensities due to providing shade also have a significant effect on the complete development phase of aglaonema leaves. This can be seen from the average length of the phase in the shade treatment which is significantly different from the control treatment without shade. This is because aglaonema is a shade-tolerant plant that likes places with high humidity and limited lighting, so that an environment that does not suit its needs can inhibit the growth and development of aglaonema, this is what happened to aglaonema that was given control treatment.

This is in accordance with the opinion of Chairudin et al. (2015), that plants that are in an environment with limited light will experience a decrease in the rate of photosynthesis so that plant development will last longer. Apart from that, the use of shade can also reduce the dryness of plants because shaded plants will experiencing limitations in the amount of energy that can be absorbed for the photosynthesis process which results in a decrease in plant dry weight (the net accumulation of carbon dioxide during plant growth and development). According to Hui et al. (2023), who researched *Aglaonema commutatum*, Aglaonema plants tend to reduce soluble proteins in tissues but accumulate reducing sugars in response to high light intensity and temperature, as well as drought, so there is potential for photoinhibition in Aglaonema increases which results in excitation of excessive amounts of light which can damage the chloroplast pigment in the leaves. Furthermore, the leaves will be more easily damaged and this will affect the lifespan of the leaves.

The final phase is the wilting leaf phase, namely the leaf aging phase which is characterized by the leaves starting to wilt (a change in leaf color occurs, namely the leaves start to turn yellow and the stems droop) before finally entering the next phase, namely leaf abscission, which is the process of the loss or fall of the leaves. Wilting leaves is a rapid communication response between resource availability where sugar signals and hormonal influences play a major role. Based on the results of the analysis of variance, it is known that different light intensities do not have a significant or real effect on the wilting phase of the leaves. This can be seen from the average length of the wilting phase in the three treatments which is not significantly different so no further tests were carried out, this is because environmental factors do not have significant correlation with the wilting leaf phase, but influenced by internal factors, namely plant genetics and reduced nutrition in the leaves. This is in accordance with the results of research by Endewip et al. (2020), that the phases of leaf wilting and leaf dropping in plants are usually influenced by genetic factors and do not experience changes in patterns due to climate change. However, in general, tree species will experience leaf fall during the dry season, with the aim of reducing evaporation.

According to Ebeid et al. (2013), states that wilting and falling leaves are caused by a combination of increasing leaf age and dryness as well as decreasing the photoperiod of the leaves. Furthermore, Singh et al. (2005) stated that drought causes water stress on the leaves so that the leaves wilt and fall. According to Devi et al. (2019) and Silva et al. (2018), that withering leaves and falling leaves is a leaf strategy to show adaptation in controlling the plant's ability to utilize resources in connection with its ability to conserve resources by translocating nutrients to new or younger leaves. This nutrient cycle is what supports continuous leaf change in plants.

Leaf Morphology Characterization Leaf Color Pattern

Figure 2. Leaf color pattern (a). Control treatment, (b). Shade 50%, (c). Shade 75%

Leaf Size and Petiole Length

Table 2. Analysis of Mean Results of Measuring Leaf Morphological Characters including Leaf Size and Petiole Length

	Measuring Leaf Parts
Treatment	Leaf width (cm)
P0 (control)	6.856 a
P1 (50%)	8.411 b
P2 (75%)	8.589 b
	Leaf Length (cm)
P0 (control)	15.167 a
P1 (50%)	17.867 b
P2 (75%)	18.067 b
	Petiole Length (cm)
P0 (control)	5.989 a
P1 (50%)	7.733 b
P2 (75%)	7.989 b

Note: Numbers followed by the same lower case letter are not significantly different based on the DNMRT test at the 5% level.

Leaf Color Pattern

Aglaonema Bigroy is a hybrid aglaonema resulting from crossing aglaonema originating from Thailand, with characteristic leaf morphology, namely complete leaves with irregular ruby-type or marbled leaf motifs, oval in shape, striptease-like leaf color, a combination of green-yellow gradations. , green, pink to red, leaf size is larger than other types of aglaonema, namely around 6-15 cm wide and 15-25 cm long (Trubus, 2009; UPT UPT Pengembangan Konservasi, 2021). Based on the research results, it is known that shade has an effect on the color pattern of aglaonema leaves, seen from the leaf colors produced by each treatment. In accordance with the Munsell Color Charts for Plant Tissues book which is used from the emergent leaf phase until the full development of leaves or mature leaves is in the color code 5R (Red) and 5 GY (Green Yellow) but differs in the value and chroma codes. The P0 treatment tends to produce a paler red color and only a slight green color on the leaves so that there are only a few ruby motifs on the leaves.

The 50% shade treatment produces leaves that are dominantly yellowish green and have more marbled motifs with a mixture of pink in the middle of the leaf and between the leaf motifs. Meanwhile, the 75% shade treatment produces dominant pink to red brighter leaf colors with a mix of green and yellow. This is in accordance with Zulkarnain (2009) that absorbing too much light will have a negative effect on leaf chlorophyll, resulting in the leaf color becoming pale yellowish green. This leaf color occurs due to exposure to light intensity that is above the optimum range for a long time so that chlorophyll levels continue to decrease due to solarization, as a result the rate of light absorption and photosynthesis becomes low.

According to Haryanti (2012), leaves that are exposed to direct sunlight will be purplish green or the green color on the leaves tends to be very slight (covered). This is thought to be the presence of anthocyanin pigments which function to protect chlorophyll and protochlorophyll from damage due to photooxidation, however It also functions to capture light in the process of photosynthesis. Furthermore, according to Zulkarnain (2009), if plants are given sufficient light or according to their needs, they will be green which indicates the presence of chlorophyll and photosynthetic activity.

Furthermore, the color of the leaves in the withering leaf phase is 5Y (Yellow). The color change in wilted leaves is because old leaves lose chlorophyll so that the color of the leaves changes to yellow or red as part of aging. This is in accordance with the opinion of Latifa

(2015) that the green color of the leaves comes from the chlorophyll content in the leaves. Chlorophyll is a pigment compound that plays a role in selecting the wavelength of light whose energy is taken in photosynthesis. Apart from chlorophyll, leaves also have other pigments, for example anthocyanins (red, blue or purple depending on the degree of acidity). Old leaves lose chlorophyll so their color turns yellow or red.

Leaf Size (Leaf Width and Length)

Based on the results of analysis of variance, it is known that different light intensities due to providing shade have a significant effect on leaf size, this can be seen from the average leaf size in the shade treatment which is significantly different from the leaf size in the control plant. This is because generally plants that grow with limited light can inhibit the photosynthesis process because the light absorbed by the leaves is also limited. One of the efforts of plants is to expand their leaves with the aim of expanding the light absorption area to efficiently capture light energy for normal photosynthesis under light intensity conditions low. Based on these results, 75% shade is thought to be the most optimal treatment.

This is in accordance with research results from Chairudin et al. (2015) and Tanari et al. (2017) that shade results in an increase in trifoliate leaf area and leaf area. Increasing the area of trifoliate leaves and specific leaf area in shaded environments is an attempt by plants to increase the maximum light absorption surface area and light capture efficiency by increasing the area per unit of light absorption, maintaining a balance in the use of photosynthate, and reducing the number of leaves to compensate for the limited amount of light. So that the rate of photosynthesis is optimal, because leaves are the main organ for absorbing light and carrying out photosynthesis.

According to Haryanti (2012), shaded leaves have wider leaves than leaves without shade, but have thinner leaf thickness, larger stomata size, thinner epidermal cells, and more space between cells. Initial leaf growth occurs due to the apical and marginal meristems, both of which have a division pattern. Expansion in the leaf surface is also associated with an increase in the number and size of chloroplasts and the amount of chlorophyll found in the palisade and spongy parenchyma. The arrangement of palisade tissue cells is attached to each other but some parts are separated so that the air in the space between the cells still reaches the long side with the chloroplasts attached to the edge of the wall.

Meanwhile, the control treatment aglaonema (P0) had smaller leaf sizes than the other treatments given paranet shade. This aims to prevent excessive rates of transpiration and light absorption and maintain water levels in plants. This is in accordance with the opinion of Lukitasari (2012), that in plants without shade or with low shade, the light intensity received is higher so that the leaves grow less, are smaller in shape with a small number of stomata, have a thicker cuticle layer and thick cell walls, small intercellular spaces with a harder leaf structure to keep the rate of photosynthesis in plants balanced.

Petiole Length

Based on the results of analysis of variance, it shows that shade has a significant effect on the length of aglaonema leaf stalks. These results show that the 50% and 75% shade treatments produced an average leaf petiole length of 7.733 cm and 7.989 cm, respectively, and is significantly different from P0 which has an average petiole length of 5.989 cm. This is in accordance with the results of research by Nugroho et al. (2020), namely that shade treatment on the growth of soybean plants produces soybean plants with higher growth than in full light conditions, this is because the plant stems experience etiolation or elongation between segments. Stems that receive shade stress. The lengthening of the stem segments is a result of the lengthening of the protein molecules in the cell walls.

Apart from causing longer leaf stalks, shading treatment also results in differences in the sitting position of the leaf stalks. The control treatment showed that the leaf stalks were shorter and straighter so that the leaves were also straighter and less beautiful. This is in accordance with Suci et al. (2018), that the light intensity treatment has a real effect on the angle of the leaves and the diameter of the stem. As the level of light intensity received by the plant increases, the leaf sitting angle decreases (smaller), and the diameter of the plant stem becomes wider, so that plants in this condition tend to be shorter and stockier. Meanwhile, if the plant is shaded or has low light intensity, the plant will slowly expand its leaves and the angle of the leaf stalk or branching angle of the plant will be wider so that the canopy of the plant becomes wider.

Environmental Factor

Based on research, it is known that the use of paranet shade which aims to limit the intensity of light entering plants can also influence other environmental factors. According to Hamdani et al. (2016), who conducted research on potato plants and showed that paranet shading with different shade percentages can result in differences in the microclimate environment including light intensity, air temperature, soil temperature and air humidity. This situation causes the growth of different plants with different percentages of shade. The higher the level of shade, the lower the air temperature, soil temperature and light intensity, but the air humidity increases.

Based on research, it is known that shade has a negative linear relationship to light intensity, that is, the higher the level of density of shade provided, the lower the light intensity entering the treatment area. This results in treatments P1 and P2 that are given shade getting lower light intensity than the control treatment. This is according to Ardika et al. (2019) that the difference in the profile of the distribution of sunlight intensity is because each shade treatment has a different level of absorption of sunlight intensity. The treatment without shade had a higher average light intensity compared to the shade treatment. This is because the higher the intensity of the shade, the lower the level of acceptance of the light intensity entering the shade.

Table 3. Environmental Factor Conditions during Observation

Treatment	Light intensity (Lux)		
	F1	F2	F3
	Phenological Phases of Aglaonema Bigroy Leaves		
P0 (No Shade)	8173 – 27013	7077 - 35256	8907 – 35256
P1 (Shade 50%)	2423 – 9629	2276 - 10578	2763 – 12252
P2 (Shade 75%)	905 – 4678	813 - 9328	1762 – 9382
	Air Temperature (°C)		
P0 (No Shade)	29 - 35.8	28 - 34.8	29.5 - 34.8
P1 (Shade 50%)	25.1 – 32	27 - 31.8	31.2 - 35.5
P2 (Shade 75%)	24.4 – 30	26.4 – 30	30 – 33
	Air Humidity (%)		
P0 (No Shade)	33.4 – 72	33.4 – 73	39.8 – 57
P1 (Shade 50%)	57-80	56 – 82	63 – 78
P2 (Shade 75%)	60 – 80	56 – 83	63 – 79
	Rainfall (mm)		
P0 (No Shade)	0.0 - 32.1	0.0 - 29.2	2.0 - 9.8
P1 (Shade 50%)	0.0 - 32.1	0.0 - 29.2	2.0 - 9.8
P2 (Shade 75%)	0.0 - 32.1	0.0 - 29.2	2.0 - 9.8

The light intensity was very high and tended to change quite drastically every day in the control treatment resulting in stunted leaf development. This is in accordance with Ariany et al. (2013) that the leaf initiation phase requires sufficient intensity and tends to utilize low light intensity to support cell growth assisted by the presence of the auxin hormone which helps the cell elongation process, while high light intensity causes growth. Cells are inhibited so that leaf shoots become small. Furthermore, according to Lakitan (2012), plants with limited sunlight and shade can reduce dry stover in plants and plants will experience a decrease in the rate of photosynthesis so that plant development will last longer.

Next is air temperature, which has an important role in the growth, development and reproductive processes of plants, generally the air temperature required for the plant growth process is 15-40°C. Air temperatures below 15-40°C can cause enzymes to be inactive and metabolism to stop, while temperatures above the optimum point can also reduce enzyme activity (enzymes are degraded) so that metabolism does not run well, thus affecting plant growth and development which decreases drastically (Wiraatmaja, 2017). Based on the research results, it is known that the air temperature in treatments P2 and P1 is always lower than P0. This is in accordance with Ardika et al. (2019) and Handriawan et al. (2016), that air temperature is significantly influenced by shade intensity, the relationship between light intensity and air temperature has a positive linear tendency, if the higher the light intensity received, the air temperature at the research location will increase.

Based on the research results, it shows that low temperature is a temperature that suits the needs of aglaonema, this is in accordance with the opinion of Wiryanta (2006), and the suitable temperature range for aglaonema growth is 28-30 ° C during the day and 20-23 ° C at night. Furthermore, according to Chuine (2010), low to sufficient air temperatures are needed to break shoot dormancy which is necessary for cell growth in the leaves. Temperatures that are too high affect the bud dormancy period so that it can reduce the level of development of the leaf bud opening date, plants can even experience abnormal buds due to temperatures that are too high. According to Hanum (2019), the phases of developing leaves and withering leaves are correlated with temperature. Temperature has a negative correlation with leaf development, leaf development is influenced by high air temperatures.

Another factor that influences the leaf development process is air humidity, which plays a role in maintaining the water content in plants so that they do not dry out quickly due to evaporation. Based on the research results, it is known that air humidity in the shade treatment is always higher than in the control treatment, and air humidity has a significant influence on leaf development. This effect is that the age of the aglaonema leaves in the control treatment is smaller than in the shade treatment, this is because in environmental conditions with high light intensity the air humidity will decrease so that the transpiration process takes place more quickly and the water content in the leaves tends to be less so the plants wilt more quickly. This is in accordance with Ardika et al. (2019), the treatment without shade has the lowest humidity level compared to other treatments because the treatment without shade is influenced by wind which causes faster heat transfer, so the air humidity level decreases. The higher the shade intensity, the smaller the light intensity and the lower the temperature in the air. High and low temperatures are inversely proportional to air humidity, the lower the temperature in a location, the higher the air humidity in that location.

According to Lukitasari (2012), the lower the level of shade, the lower the air humidity. Low air humidity will inhibit plant growth and flowering. Air humidity can affect plant growth because it can affect the photosynthesis process. The rate of photosynthesis increases with increasing air humidity around the plant. This humidity shows that there is an influence on leaf development, if the more water vapor (high humidity) in the air, the smaller the difference in water vapor pressure in the leaf cavity and in the air, the slower the transpiration rate will be.

The next environmental factor is rainfall. Based on the observations, it is known that the rainfall in each treatment is the same every day, this is because shade has no effect on rainfall but providing shade helps the speed of water entering the plants not directly in large quantities. Based on these results, rainfall did not show a significant effect on the development of aglaonema leaves. This is in accordance with the opinion of Lee et al. (2009), stating that the phase of leaf emergence is not correlated with rainfall. In general, leaves appear in the colder season, then leaf expansion and leaf senescence as well as the maturation and release of spores in ferns mostly occur in the warmer season. However, high rainfall can cause plant damage. Furthermore, Anni et al. (2013) also believes that there is no significant correlation between rainfall and leaf development. Most leaf expansions were significantly positively correlated with temperature, but negatively correlated with rainfall. Or it may not correlate significantly with temperature and precipitation.

Conclusion

Different light intensities due to shading affect leaf phenology phases. The average number of days required from the emergence of leaf shoots until the leaves wilt at P0 is 58 days, while for P1 it is 81 days, and for P2 it is 85 days. Different light intensities also affect the morphological characteristics of the leaves, such as lighter leaf color, greater size and length of leaf stalks in the shade treatment than in aglaonema without shade. So P2 with 75% shade is the most optimal treatment for the development of aglaonema leaves. Apart from different light intensities, shade also results in changes in the conditions of micro environmental factors at the research location, namely air temperature, air humidity and rainfall. Although rainfall does not correlate or have a significant effect on leaf phenology phases.

Acknowledgments
The researcher would like to express his gratitude to the research land owner who has provided permission and support in carrying out this research.

Author Contributions
Triana Putri Silalahi conceptualized the research idea, designed of methodology, management and coordination responsibility, analyzed data, conducted a research and investigation process; Pinta Murni conducted literature review and provided critical feedback on the manuscript.

Funding
This research received no external funding.

Conflicts of Interest
The author declared no conflict of interest.

References

Anni, I. A., Saptiningsih, E., & Haryanti, S. (2013). Pengaruh Naungan terhadap Pertumbuhan dan Produksi Tanaman Bawang Daun (*Allium fistulosum* L.) di Bandungan, Jawa Tengah. *Jurnal Akademika Biologi*, *2*(3), 31-40. Retrieved from https://ejournal3.undip.ac.id/index.php/biologi/article/view/19151

Ardika, I. P. T., Setiyo, Y., & Sumiyati, S. (2019). Dampak Penggunaan Naungan Plastik terhadap Profil Iklim Mikro pada Budidaya Kentang Bibit (*Solanum tuberosum* L) Varietas Granola KelompokG0. *Jurnal Beta (Biosistem dan Teknik Pertanian),* *7*(1), 135-143. Retrieved from https://ojs.unud.ac.id/index.php/beta

Ariany, S. P., Sahiri, N., & Syakur, A. (2013). Pengaruh Kuantitas Cahaya terhadap Pertumbuhan dan Kadar Antosianin Daun Dewa *(Gynura pseudochina* (L.) Dc) Secara In Vitro. *e-J. Agrotekbis*, *1*(5), 413-420. Retrieved from https://www.neliti.com/publications/243746/

Chairudin, C., Efendi, E., & Sabaruddin, S. (2015). Dampak Naungan terhadap Perubahan Karakter Agronomi dan Morfo-Fisiologi Daun pada Tanaman Kedelai (*Glycine max* (L.) Merrill. *J. Floratek*, *10*(1), 26-35. Retrieved from https://jurnal.usk.ac.id/floratek/article/view/2355

Chuine, I. (2010). Why Does Phenology Drive Species Distribution? In *Philosophical Transactions of the Royal Society B: Biological Sciences*, *365*, 3149–3160. Royal Society. https://doi.org/10.1098/rstb.2010.0142

Devi, N. L., Singha, D., & Das, A. K. (2019). Phenology of Deciduous Tree Species in Traditional Meitei

Homegardens of Barak Valley, Assam, Northeast India. *Tropical Plant Research*, *6*(3), 365–375. https://doi.org/10.22271/tpr.2019.v6.i3.046

Ebeid, A. F. A., & Ali, E. F. (2013). Phenological Study of Some Tree Species at Different Ages in Aswan, Egypt. *In International Journal of Science and Research*, *4*(7), 506-513. Retrieved from www.ijsr.net

Ekawati, R., & Saputri, L. H. (2020). The Effect of Different Shading Level on Growth and Plant Biomass Character of Dayak Union (*Eleutherine palmifolia* (L.) Merr). *Jurnal Hortikultura Indonesia*, *11*(3), 221–230. https://doi.org/10.29244/jhi.11.3.221-230

Endewip, L. N., Astuti, I. P., Witono, J. R., & Sumanto. (2020). Identifikasi dan Fenologi Koleksi Canarium Hirsutum Willd. di Kebun Raya Bogor. *Buletin Kebun Raya*, *23*(3), 162-172. https://doi.org/10.14203/bkr.v23i3.630

Haggerty, B. P., & Mazer, S. J. (2008). *The Phenology Handbook A Guide To Phenological Monitoring for Students, Teachers, Families, and Nature Enthusiasts*. California (US): University of California Press.

Hamdani, J. S., Sumadi, S., Suriadinata, Y. R., & Martins, L. (2016). Pengaruh Naungan dan Zat Pengatur Tumbuh terhadap Pertumbuhan dan Hasil Tanaman Kentang Kultivar Atlantik di Dataran Medium. *In J. Agron. Indonesia*, *44*(1), 33-39. https://doi.org/10.24831/jai.v44i1.12489

Handriawan, A., Respatie, D. W., Tohari. (2016). Pengaruh Intensitas Naungan terhadap Pertumbuhan dan Hasil Tiga Kultivar Kedelai (*Glycine max* (L.) Merrill) di Lahan Pasir Pantai Bugel, Kulon Progo. *Vegetalika*, *5*(3), 1-14. https://doi.org/10.22146/veg.25346

Hanum, S. F. (2019). Fenologi Daun *Dicksonia blumei* (Kunze) Moore di Kebun Raya "Eka Karya"Bali, Indonesia. *Jurnal Penelitian Hutan Tanaman*, *16*(1), 1–57. Retrieved from https://media.neliti.com/media/publications/480857-fenologi-daun-dicksonia-blumei-kunze-moo-e15211a2.pdf

Haryanti, S. (2012). Respon Pertumbuhan Jumlah dan Luas Daun Nilam (*Pogostemon cablin* Benth)pada Tingkat Naungan yang Berbeda. *Buletin Anatomi dan Fisiologi*, *16*(2), 20-26. https://doi.org/10.14710/baf.v16i2.2590

Hui, J., Wu, C., Li, X., Huang, L., Jiang, Y., & Zhang, B. (2023). The Effect of Light Availability on Photosynthetic Responses of Four *Aglaonema commutatum* Cultivars with Contrasting Leaf Pigment. *Applied Sciences (Switzerland)*, *13*(5), 1-12. https://doi.org/10.3390/app13053021

Lakitan, B. (2012). *Dasar-dasar Fisiologi Tumbuhan*. Jakarta: Rajawali Pers.

Latifa, R. (2015). Karakter morfologi daun beberapa jenis pohon penghijauan hutan kota di kota malang. *Research Report*. Retrieved from https://biology.umm.ac.id/files/file/667-676%20Roimil%20Latifa.pdf

Lee, P. H., Chiou, W. L., & Huang, Y. M. (2009). Phenology of Three Cyathea *(Cyatheaceae)* Ferns in Northern Taiwan. *JForSci*, *24*(4), 233-242. Retrieved from https://www.researchgate.net/publication/290185885

Lukitasari, M. (2012). *Pengaruh Intensitas Cahaya Matahari terhadap Pertumbuhan Tanaman Kedelai* (*Glycine Max)*. Retrieved from https://www.academia.edu/10107539/

Nugroho, H., & Jumakir, J. (2020). Respon Pertumbuhan dan Hasil Tanaman Kedelai terhadap IklimMikro. *Seminar Nasional Virtual*, 265-274.

Salimah, A., Rochayat, Y., & Fadila, F. (2010). Respons Pertumbuhan dan Kualitas Tiga Kultivar Aglaonema terhadap Kompetisi Media Tumbuh Arang Sekam, Cocopeat dan Zeolit serta ZPT Sitokinin. *Jurnal Agrivogor*, *9*(3), 330–340. Retrieved from http://pustaka.unpad.ac.id/wp-content/uploads/2016/03/Jurnal-Respons-Pertumbuhan-Dan-Kualitas-Tiga-Kultivar

Silva, M. M., Farias, R. D. P., Da Costa, L. E. N., & Barros, I. C. L. (2018). Leaf Phenological Traitsof the Tree Fern *Cyathea praecincta* (Cyatheaceae) in a Brazilian Lowland Tropical Forest. *Australian Journal of Botany*, *66*(8), 618–627. https://doi.org/10.1071/BT18084

Simamora, E. Y. E. W., Hanafiah, D. S., & Damanik, R. I. M. (2017). Pengaruh Kolkisin terhadap Keragaman Fenotipe Tanaman Sri Rejeki (*Aglaonema* Sp.) Var. Yellow Lipstick Secara Setek Batang. *Agroekoteknologi*, *5*(3), 623–628. https://doi.org/10.32734/joa.v5i3.2226

Singh, K. P., & Kushwaha, C. P. (2005). Emerging Paradigms of Tree Phenology in Dry Tropics Rhizosphere Effects of Melocanna Baccifera on Soil Microbial Properties under Different FallowPhases Following Shifting Cultivation View project Nutrient Contents in Fodder Plants. View Project. *Current Science, 89*(6), 964-975. Retrieved from https://www.researchgate.net/publication/25561704

Suci, C. W., & Heddy, S. (2018). Pengaruh Intensitas Cahaya terhadap Keragaan Tanaman Puring (*Codiaeum variegetum*). *Jurnal Produksi Tanaman*, *6*(1), 161–169. Retrieved from http://protan.studentjournal.ub.ac.id/index.php

/protan/article/view/627
Tanari, Y., & Vita, V. (2017). Pengaruh Naungan dan Berbagai Media Tanam terhadap Pertumbuhan dan Produksi Tanaman Selada (*Lactuca sativa* L.). *Jurnal AgroPet*, *14*(2), 1-12. Retrieved from https://ojs.unsimar.ac.id/index.php/AgroPet/article/view/118
Trubus, T. (2009). *Aglaonema Teknik Baru, Peluang Baru*. Medan: PT Niaga Swadaya.
UPT Pengembangan Konservasi. (2021). *Database Tanaman Hias "UNNES ECOFARM"*. Semarang: Universitas Negeri Semarang.
Wiraatmaja, I. W. (2017). *Bahan Ajar Suhu, Energi Matahari, dan Air dalam Hubungan denganTanaman*. Denpasar: Fakultas Pertanian UNUD.
Wiryanta, B. T. W. (2006). *Media Tanam untuk Tanaman Hias*. Jakarta Selatan: AgroMedia.
Zulkarnain, Z. (2009). *Dasar-dasar Hortikultura Edisi 1*. Jakarta: Bumi Aksara.