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The effect of shading on the growth of seedlings of the tabulampot system oranges, mangoes, lai, and avocados

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ABSTRACT

Each type of plant at each stage of its growth is thought to have a different light tolerance to support optimal growth. Research has been carried out to determine the physiology and growth of orange, mango, lai and avocado seedlings grown at different light intensities in the tabulampot system, Kampung 6 Tarakan nursery. Seedlings were planted in polybags in a planting medium in the form of a mixture of soil: sand: manure 2:1:1. The design used was a randomized block design which was arranged factorially. The first factor is the type of plant, namely citrus (T1), mango (T2), Lai (T3) and avocado (T4), while the second factor is shade: without shade (N0), 50% (N1), 60% (N3) and 75% (N4). The results showed that the oranges, mangoes, lai, and avocado seedlings were tolerant to low light. If the Q leaf value is relatively low, photosynthesis can still take place, but if the Q leaf value is too high, the rate of photosynthesis will decrease. The highest rate of photosynthesis (A) was in mango (10.079) followed by avocado, lai and orange. The highest transpiration value (E) was in avocado, followed by lai, orange and mango. The light control treatment had no significant effect on the rate of photosynthesis, but had a significant effect on E and Gs. Shade had a significant effect on both plant height (124 cm high from the N2 treatment) and stem diameter (0.76 cm from the N1 treatment). Orange, mango, lai and avocado seeds give almost the same physiological response to light.

Keywords:

Plants, tabulampot, light, shade, and growth

INTRODUCTION

Mango (*Mangifera indica* Linn.), Lai (*Durio kuthenensis*), orange (*Citrus sinensis*), and avocado (*Persea Americana* Mill.) are Indonesian tropical fruit species that have the potential to be traded, both in the domestic and international markets. Nursery is one of the keys to the success of the development of plants, including fruit trees.

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One of the efforts that must be made to obtain quality seeds is to pay attention to the suitability of the microclimatic conditions in the nursery and the availability of nutrients. Increasing the production of quality fruit needs to be done even starting from the provision of quality seeds and their maintenance since the nursery [1].

Each type of plant at each growth stage is thought to have different tolerances to light and nutrient requirements to support optimal growth. Young cocoa plants in their growth require low light intensity, plants that are 3-4 months old require around 35-40% of sunlight intensity and gradually increase in line with increasing plant age [2]. Light is a source of driving force in the photosystem which will produce ATP, which is the energy source in photosynthesis. The low light intensity will lead to reduced ATP formed. Light affects plant growth and development in many ways. Light affects the vegetative growth of plants because of its effect on photosynthesis, leaf temperature, water balance in plants and photomorphogenesis, namely plant growth and development which is directly controlled by light and does not depend on photosynthesis [3].

The impact of sunlight deficit due to shade on witchgrass (*Rottboellia exaltata* L.f.) can be seen from the decrease in dry matter and stomatal resistance [1]. According to [4] and research conducted by [5] showed that the use of transparent plastic shading made a difference in the weight yield of shallot bulbs and had an effect on the growth process. Based on [6]. the growth and yield of Bengal strawberry plants did not require shade, an increase in the percentage of shade caused a decrease so that the best growth was obtained at 0% shade or without shade. In a study by [7] concerning the effect of shade and variety on the growth and yield of strawberry plants (*Fragaria* sp.) in the lowlands, it was shown that the best growth and yields were found in non-shaded strawberry plants. In the treatment given there was a significant interaction between shade and variety on the number of leaves at 75 days after planting and plant height at 15 days after planting. Michiko variety that is not shaded results in an increase in plant height.

This study aims to determine the effect of shade on the growth of mango, durian, orange, and avocado seedlings grown at different light intensities which can be used as a basis for plant maintenance in nurseries.

METHOD

The research was conducted at the Experimental Garden of Kampung Six Tarakan. Plant materials in the form of durian, mango, orange and avocado seeds (±60 cm high and ±0.56 cm stem diameter) were planted in polybags (30 cm x 40 cm) in the planting medium in the form of a mixture of soil : sand : manure = 2: 1:1. The design used was a randomized block design which was arranged factorially. The first factor is the type of plant, namely citrus (T1), mango (T2), Lai (T3) and avocado (T4), while the second factor is shade: without shade (N0), 50% (N1), 60% (N3) and 75% (N4). Setting the intensity of light that reaches the plant using a black paranet. The variables observed in this study were growth (plant height and stem diameter) and plant physiology (photosynthesis rate (A), transpiration

(E), quantum leaf (Q leaf), stomatal conductivity (Gs), leaf carbohydrate content, and chlorophyll content. leaf). Data analysis was performed using the SAS statistical program.

RESULT AND DISCUSSION

Plant Height and Stem Diameter The results of observations on the height and diameter of each type of plant at the age of 4 months after planting (MAP) are shown in Table 1.

Table 1. Plant height and stem diameter at 4 MAP

Plant Type	Plant Height (cm)	Stem Diameter (cm)
Orange	22,78c	0,26c
Mangoes	34,38a	0,39a
Lai	32,21a	0,38a
Avocados	26,78b	0,33b

Plant Type Plant Height (cm) Stem Diameter (cm)

The results showed that the vegetative growth of plants was in accordance with their genetics, where the growth of each type of plant was significantly different. The tallest plants are manga and Lai, followed by avocados and oranges. Mango and Lai also showed the greatest growth in stem diameter, followed by avocado and orange. Growth in height and diameter of each plant in the shade treatment. Shade has a significant effect on both plant height and stem diameter. Plant height at no shade (N0) was not significantly different from plant height at 75% shade, but significantly different from plant height at 50% shade. The highest plant was obtained from the 55% shade treatment, which reached 133.16 cm. The stem diameters in N0 and N1 were not significantly different, but significantly different from the stem diameters in the N2 treatment. The largest stem diameter was obtained from the N1 treatment, which was 1.502 cm (Table 2). Table 2. Effect of shade on plant height and stem diameter at 4 MAP

Table 2. Effect of shade on plant height and stem diameter at 4 MAP

Treatment (shade)	Plant Height (cm)	Stem Diameter (cm)
0%	26,65b	0,36a
55%	33,29a	0,38a
75%	27,17b	0,28b

This is consistent with the results of a literature search showing that naturally shaded rubber plants, stem diameter and height of rubber plants aged 51 MAP were highest in the treatment without shade, and decreased with increasing shade, whereas at ages 7 and 14 MAP, the dry weight the highest total was achieved in the no-shade treatment and the lowest in the 77% shade [8]. Meanwhile in Vigna radiata, shade reduced total plant dry weight [9]. The dry weight of shaded (*Larix kaempferi* Sarg) at 12 WAP was smaller than that of the control [10]. CO_2 uptake, transpiration, and stomata opening Abiotic factors such as sunlight, temperature, CO_2 concentration, vapor pressure deficit, and nutrient status have a major influence on photosynthesis or CO_2 assimilation, and subsequently on plant growth and productivity. Growing environmental conditions that can result in decreased photosynthesis or CO_2 uptake include less light intensity, temperature, and low nutrient

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availability [11]. Optimal light intensity will affect the activity of stomata to absorb CO_2, the higher the intensity of sunlight received by the surface of plant leaves, the higher the amount of CO_2 absorption relatively high under conditions of sufficient rainfall, but at light intensity above 50%, absorption CO_2 starts to be constant [12]. Setting the intensity of solar radiation that can reach plants is done by providing shade, which will affect the microclimate and photosynthetic activity of plants. These conditions can cause disruption of metabolic processes and decrease in the rate of photosynthesis and synthesis of carbohydrates which have implications for decreasing the rate of plant growth and production [13]. Observations on CO_2 uptake, transpiration, and stomata opening for each type of plant are shown in Table 3.

Table 3. Effect of Treatment on Plant Physiology

Treatment (shade)	A ($\mu molm^{-2}s^{-1}$)	E ($molm^{-2}s^{-1}$)	Gs ($molm^{-2}s^{-1}$)
Orange	2,330 a	0,800 b	0,072 b
Mangoes	2,520 a	0,670 c	0,051 c
Lai	2,430 a	0,960 a	0,082 a
Avocado	2,660 a	0,970 a	0,049.c
0%	0,149 a	0,519 c	0,039 c
55%	2,577 a	0,919 b	0,049 b
75%	2,633 a	1,116 a	0,102 a

This is consistent with the findings of [15] that the carbohydrates in the leaves of plants given shade decreased, lower than plants without shade. According to the genetics, the chlorophyll content of each plant is different. Mango leaves showed the highest chlorophyll content and avocado leaves the lowest. Shade has a significant effect on chlorophyll content. The higher the shade level, the higher the chlorophyll content, as seen in the N2 treatment which showed the highest number (Table 4).

Table 4. Effect of Treatment on Plant Physiology.

Treatment (shade)	Carbohydrate (%)	(SPAD)
Orange	3,841 c	12,101 a
Mangoes	4,101 b	12,132 a
Lai	4,280 b	10,241 b
Avocado	4,869 a	9,623 b
0%	5,604 a	9,566 b
55%	3,740 b	10,914 b
75%	3,473 c	12,594 a

The higher the level of shade given, the plant will adapt or avoid shade stress by increasing the efficiency of light capture per photosynthetic area unit. Adaptations made by plants are by increasing the amount of chlorophyll per unit leaf area and the ratio of chlorophyll b/a [17]. [18] stated that the efficiency of light capture depends on the amount of chlorophyll per unit leaf area. The formation of chlorophyll in shaded leaves is influenced by, among other things, light, carbohydrates in the form of sugars, and the main components that form chlorophyll, namely the elements N and Mg. The results of this study indicate that the seeds of oranges, mangoes, Lai, and avocados give almost the same physiological response to light. If the Q leaf value is relatively low, photosynthesis can still take place, but if the Q leaf value is too high, the rate of photosynthesis will decrease. Each type of plant has a similar ability to photosynthesize. The highest rate of photosynthesis (A) was in mango (10.079) followed by avocado, Lai and orange. The highest transpiration value (E) was in avocado, followed by Lai, Orange and Mango. Shading treatment did not significantly affect the rate of photosynthesis but significantly affected E and Gs. Plants that are shaded by leaves increase in area due to higher CO_2 diffusion rates, more chlorophyll per unit leaf area and increased activity of the parts that carry out photosynthesis [15]. Low light activity will cause the plant to make a physiological change. These physiological changes have an impact on defense carbon balance that will affect changes in the rate of respiration. In shaded plants, there are 3 things to do with low light intensity, namely by: reduction of respiration rate to lower the compensation point, compensation point is the use of CO_2 by photosynthesis equal to the loss of CO_2 produced of respiration, an increase in leaf area to obtain a larger surface area to absorb light and there is an increase in the rate of photosynthesis in each units of light energy and leaf area [16].

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