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Article

Evaluation Growth of Hydroponic Fodder With Different Lighting Treatment to Increase Forage Productivity

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Abstract: This study was aimed to determine the effect of lighting and plant type on growth of hydroponic fodder to increase forage productivity. This study used a randomized complete factorial design. The first factor was plant type consisted of maize (*Zea mays*), mung bean (*Vigna radiata* L) and rice (*Oryza sativa*). The second factor was lighting treatment consisted of 12 hours and 24 hours. Each treatment was replicated 6 times. The variables measured were plant growth parameters consisted of plant height, leaves number, width of leave and length of leave. Data was analyzed using Analysis of Variety (ANOVA) and the difference between means was analyzed using Duncan's Multiple Range Test (DMRT). The result showed that plant type increase in height, number of leaves, width and length of leave along with the ages plant. Maize showed the highest of plant height and numbers of leaves. Lighting 12 hours showed the best lighting to support plant height, then lighting 24 hours support to width of leaves. The conclusion of the study showed that the best growth results were corn plants with 12-hour lighting treatment.

Keywords: Forage, Hydroponic Fodder, Lighting Treatment

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1. Introduction

The primary challenge in livestock farming is the limited availability of pasture area, which in turn affects the quantity of forage produced. Forage represents a significant proportion of the diet for ruminant livestock, particularly during the dry season. During this period, farmers may experience difficulty in obtaining sufficient forage, which must be addressed to maintain livestock production.

Hydroponic fodder was an alternative solution to provide the sustainability of quality forage for ruminant [1]. Hydroponic fodder was a system cultivated plant in a short time (7-14 days) in liquid media and under controlled conditions [2] [3] [4]. The advantages of green fodder included lower indigestible fiber content (including NDF and ADF) [5], had high digestibility [6], all part of plant can be utilized by animal [7], it overcomes the problem of limited land [8] [9], didn't require a lot of labor and not dependent season [10]. Hydroponic system can increased productivity of plant, such as maize, wheat [11], barley [12], sorghum [13], and the others plant. The seeds that ware abundant in Indonesia ware maize, soybeans and rice, so these three types ware chosen for hydroponic fodder.

In general, the longer that plant gets sunlight will be more intensive the photosynthesis process, so the production can be higher. But some plants required different lighting times to encourage in vegetative phase and generative phase. Sutoyo [14] stated that day length often a limiting factor for plant growth. Knowledge of day length was important for knowing the introduction of suitable plant varieties in certain areas. This study using 12 hours and 24 hours lighting treatment. Duration lighting treatment is the duration of time per day for plants to receive light. This study was aimed to determine the effect of lighting and plant type on growth of hydroponic fodder to increase forage productivity.

2. Materials and Methods

This research was conducted in Department of Animal Science and Department of Agricultural Technology, Politeknik Negeri Jember.

2.1.Materials.

The materials in this research were the seed of maize (*Zea mays*), seed of mung bean (*Vigna radiata* L), seed of rice (*Oryza sativa*), AB mix fertilizer, hypochlorite liquid, hydroponic rack and hydroponic tray.

2.2.Methods.

This research process consisted of some steps: preparation, planting, watering, fertilizing, and harvesting. The enviromental conditions were temperature 28^0C and humidity 72%. Preparation seed by choose good seed and soaked for 24 hours in tap water. Preparation hydroponic rack by sterilization using sterilization liquid. After 24 hours, seed soaked using hypochlorite liquid in 20 min. Seeds were spread on the hydroponic tray and was closed until 3 days for germination. Watering plant was conducted every day by drained at three times until harvest time. The fertilizer used AB mix nutrient in d 3, d 5 and d 7. Harvesting was performed at 10 days.

2.3.Observed parameters.

The variables measured were plant growth parameters consisted of plant height, leaves number, width of leave and length of leave.

2.4.Data analysis.

The collected data was analyzed using Analysis of Variety (ANOVA) based on a completely randomized design in a 2 x 3 factorial arrangement. The first factor was plant type consisted of maize (*Zea mays*), mung bean (*Vigna radiata* L) and rice (*Oryza sativa*). The second factor was lighting consisted of 12 hours and 24 hours. The difference between means was analyzed using Duncan's Multiple Range Test (DMRT).

3. Results and Discussion

Measurement of plant growth of maize (*Zea mays*), mung bean (*Vigna radiata* L), and rice (*Oryza sativa*) was recorded by measuring the plant height, leaves number, width of leave and length of leave.

3.1. Plant height

The plant height of maize (*Zea mays*), mung bean (*Vigna radiata* L), and rice (*Oryza sativa*) with different lighting system shown in Table 1.

Table 1. The plant height of maize (*Zea mays*), mung bean (*Vigna radiata* L), and rice (*Oryza sativa*) with different lighting treatment (cm)

Lighting treatment	Fodder Plant			Average [ns]
	Maize	Rice	Mung bean	
12 hours	23.12±1.63	8.22±0.87	23.39±1.48	18.24±7.40
24 hours	20.45±1.45	7.93±0.36	22.84±0.38	17.07±6.86
Average	21.78±2.42[b]	8.07±0.65[c]	23.12±1.07[a]	

[abc] Different superscripts on the same line and column show significant differences (P<0.05)
[ns] non-significant

Plant height was significantly influenced by type of fodder plant (P<0.05). The highest plant height was observed in the legume family, represented by mung bean, while the Gramineae family, represented by maize. The observed variation in plant height between varieties can be attributed to the presence of genetically-controlled characteristics that differentiate the plants [15]. The factors that influenced plant height was planting management, seed type, seed quality, capacity and frequency of watering [16].

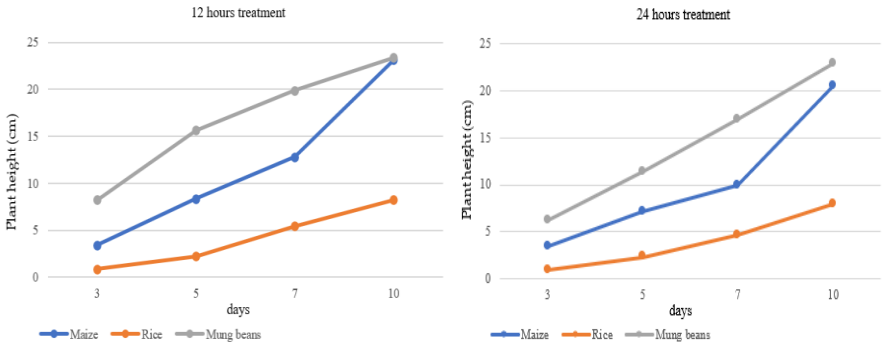

Figure 1. The plant rate of maize (*Zea mays*), mung bean (*Vigna radiata* L), and rice (*Oryza sativa*) with different lighting treatment (cm)

Meanwhile lighting treatment was not significantly influenced. In figure 1. showed that the plant rate of maize (*Zea mays*), mung bean (*Vigna radiata* L), and rice (*Oryza sativa*) with 12 lighting treatment faster than 24 hours lighting treatment. A period of sunlight exposure exceeding 12 hours was found to be ineffective, as this exceeds the optimal exposure limit. In areas where there is insufficient sunlight for the optimal 12-hour period, a 24-hour exposure treatment can be applied. The duration of exposure to LED light has no effect on the plant height fodder Hanjeli. This caused by the treatment of the duration of exposure exceeding the optimal exposure limit for Hanjeli plants, which makes the photosynthesis process not efficiently [17]. Plant height increase is closely related to the rate of photosynthesis and the photosynthate produced.

3.2 Leaves number

The leaves number of maize (*Zea mays*), mung bean (*Vigna radiata* L), and rice (*Oryza sativa*) with different lighting system shown in Table 2.

Table 2. The leaves number of maize (*Zea mays*), mung bean (*Vigna radiata* L), and rice (*Oryza sativa*) with different lighting system (pieces)

Lighting treatment	Fodder Plant			Average ^{ns}
	Maize	Rice	Mung bean	
12 hours	3±0.00	2±0.00	2±0.00	2.33±0.48
24 hours	3±0.00	2±0.00	2±0.00	2.33±0.48
Average ^{ns}	3±0.00	2±0.00	2±0.00	

^{ns} non-significant

Leaves number was not significantly influenced by type of fodder plant and lighting treatment. Leaves number on three fodder plant without different lighting treatment shown same with the others. These results indicate that the growth period was quite short (10 days), so the number of leaves was small. The leave formation occurs on the 3rd or 4th day after planting. The reasearch by Kustyorini et al. [18] showed that the same number of leaves on maize, in the other research showed the increasing number of leaves in the different period growth [4].

Another factor that maybe influenced is liquid media. In this research using AB mix liquid media. The variation of liquid media will affected condition of hydroponic fodder because liquid media was a food source for plants. Variation liquid media used will affected hydroponic fodder, some liquid media that can be used groundwater, commercial mineral solution, and bio slurry [7].

3.3 Width of leave

The width of leave of maize (*Zea mays*), mung bean (*Vigna radiata* L), and rice (*Oryza sativa*) with different lighting system shown in Table 3.

Table 3. The width of leave of maize (*Zea mays*), mung bean (*Vigna radiata* L), and rice (*Oryza sativa*) with different lighting system (cm)

Lighting treatment	Fodder Plant			Average
	Maize	Rice	Mung bean	
12 hours	1.47±0.35	0.25±0.01	1.25±0.10	0.99±0.58[b]
24 hours	2.15±0.06	1.04±0.02	2.02±0.41	1.73±0.51[a]
Average	1.81±0.42[a]	0.64±0.41[c]	1.64±0.41[b]	

[abc] Different superscripts on the same line and column show significant differences (P<0.05)
[ns] non-significant

Width of leave was significantly influenced by type of fodder plant (P<0.05) and lighting treatment (P<0.05). The highest width leave represented as maize with 24 hours lighting treatment. Leave width will affect the rate of photosynthesis. Leave width affected as a parameter to determine the rate of photosynthesis growth per unit of dominant plant is determined through leaf area. Plant growth rate influenced by the net assimilation rate and leaf area. High net assimilation rate and optimum leaf area can increase plant growth [19]. The liquid media in this research also influenced the width of leaves, because plants need nutrients for vegetative phase. Nutrients needed by plants, which function as component of amino acids, forming green leaf substances, forming branches, number of leaves and leave area [20].

3.4 Length of leave

The length of leave of maize (*Zea mays*), mung bean (*Vigna radiata* L), and rice (*Oryza sativa*) with different lighting system shown in Table 4.

Table 4. The length of leave of maize (*Zea mays*), mung bean (*Vigna radiata* L), and rice (*Oryza sativa*) with different lighting system (cm)

Lighting treatment	Fodder Plant			Average [ns]
	Maize	Rice	Mung bean	
12 hours	14.97±0.99	7.42±1.00	3.08±0.17	8.49±5.11
24 hours	16.72±0.55	6.56±0.35	3.32±0.19	8.89±5.88
Average	15.84±1.19[a]	6.99±0.84[b]	3.20±0.21[c]	

[abc] Different superscripts on the same line and column show significant differences (P<0.05)
[ns] non-significant

Length of leave was significantly influenced by type of fodder plant (P<0.05). The longest length of leaves is represented as maize. Characteristic maize leaves were elongated, so it has the longest leaves compared to the others. Length of leaves can influence photosynthesis system in the leaves. Plant metabolic processes include the process of photosynthesis, so the photosynthate produced is high, which can be translocated to all parts of the plant, resulting in an effect on the growth of length of leaves [20].

4. Conclusions

The conclusion of the study showed that the best growth results were maize (*Zea mays*) exhibited the most favorable growth performance under 12-hour lighting treatment.

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Conflicts of Interest: We certify that there is no conflict of interest with any financial, personal, or other relationships with other people or organization related to the material discussed in the manuscript.

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