Effect of Soilless Media with Alternate Wetting- Drying (AWD) as Basic Irrigation on the Growth of Two Varieties of Rice

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Abstract. The decreasing area of agricultural land and declining water sources are forcing rice farmers to adopt various farming technology. Soil-less farming and alternate wetting-drying (AWD) irrigation can alternatively fix the problems (water substitutes soil as a proper growing media, while in AWD irrigation systems water can be saved), especially in the urban area. This study aimed to observe the growth of two rice varieties grown under soil-less media with AWD irrigation systems. The study was conducted in Sumberjeruk village, Jember city of Indonesia, from June-September 2021. A completely randomized design (CRD) within two factors and three replications was used in the experiment. The first factor was growing media, namely control (soil) + non AWD, water media + rice husk + non AWD, water media + non AWD, and water media + 1 day (once) AWD. The second factor was rice variety specifically Mapan 05 and Ciherang. The result showed that water media + rice husk gave the highest performance at plant height (73,88 cm), the number of the stem (35,25 stems), and the number of leaves (108,92 leaves). Moreover, there was a significant difference in stem diameter number between Mapan 05 and Ciherang (6,95 mm and 5,80 mm respectively).

1. Introduction

Rice is the most popular staple food in Indonesia as well as one of the three main staple foods in the world. Currently, various issues such as low rice productivity, reduced land area, climate change, and drought in rice cultivation threaten the growth and production of rice plants. The area of rice fields is decreasing over time due to land conversion as projected in 2015 there were 8.087 million hectares (a decrease of 0.3% compared to the previous year) [1].

The decreasing area of agricultural land, expensive irrigation costs, and difficulties in obtaining capital for agricultural businesses [2] ultimately force farmers to apply various alternatives and innovations in rice cultivation, and the application of subsistence farming systems is an example. In the subsistence farming system, there are technologies such as soil-less farming and AWD irrigation systems that can be a way to overcome the problems above. In soil-less farming, water can replace the role of soil as a growth medium, while in AWD irrigation systems water use can be saved. The combination of soil-less farming (water media) and AWD can be a promising method for rice cultivation, especially in urban areas.

Soil-less farming is a method to grow a crop without soil as root growth media [3]. It utilizes artificial media that play a role in providing nutrients, water, and growing space [4]. The soil-less farming system and the AWD irrigation system will provide two advantages: optimizing the function of vacant land in urban areas and providing food for households; not only fruits and vegetables but

also staple foods such as rice. Generally, lowland rice requires 2500 liters of water to produce 1 kg of rice seeds [5] This is an unusually high amount for agricultural irrigation. The availability of water will commonly be more limited in urban areas than in rural areas, therefore, cultivating lowland rice in urban areas will be a tremendous challenge. However, the wet-dry irrigation method (AWD) in paddy fields is claimed to save irrigation water up to 44% [6]. With the presence of soil-less farming and AWD irrigation, rice cultivation in urban areas which are limited in land and water sources will hopefully be possible.

The use of soil-less farming and AWD irrigation systems are used to maximize plant growth and yield through the use of alternative growing media and saving irrigation water. Until now, the use of alternative media, especially water, which is combined with the AWD irrigation system has not been widely informed. Therefore, further research to observe AWD irrigation and soil-less farming specifically on rice cultivation is needed.

2. Material and Methods

2.1. Material

The research material consisted of two rice varieties namely Mapan 05 and Ciherang varieties grown on several planting media (soil, topsoil, husks, and water) in a special planting tub with dimensions of 60 cm x 40 cm x 20 cm which had a drainage channel using a tap installed on one side of the planting tub to adjust drying-wetting irrigation. Various sources of nutrients were used (AB Mix, urea fertilizer, and NPK fertilizer) to ensure the nutrient needs of rice plants were fulfilled.

2.2. Methods

This research was conducted in Sumberjeruk Village, Kalisat District, Jember city of East Java province of Indonesia from June to September 2021. This study used a completely randomized design (CRD) with two factors. The first factor was planting media, consisting of four media types namely control (soil) + non AWD, water media + rice husk + non AWD, water media + non AWD, and water media + AWD once a day (water drained from 5 pm to 7 am daily, conducted for 30 days from 15 to 45 days after planting (DAP)). The second factor was rice varieties consisting of Mapan 05 and Ciherang varieties. Based on the treatment design, there were 8 treatments with three repetitions. Consequently, there were 24 experimental units applied. Observation parameters consisted of plant height, number of tillers, stem diameter, and number of leaves. All data obtained were then processed using analysis of variance (ANOVA) and continued with Duncan's Multiple Range Test (DMRT) if the results showed significant differences.

3. Result and Discussion

The results showed that the types of soil-less planting media and rice varieties were significantly different for all observed variables, but there was no significant difference in the interaction between soil-less media and rice varieties on the observed variables.

3.1. Effect of soil-less planting media

The results of this study showed that soilless planting media treatment significantly affected plant height, number of tillers, and number of leaves, as can be seen in Table 1. Table 1 shows that the highest plant growth was found in water + rice husk + non-AWD media. The addition of rice husks to water media seemed to be able to store nutrients thereby increasing the availability of nutrients for a longer period (slow-released). This is similar to Hayati (2006) who reported that a mixture of rice husk and sand media had a high ability to absorb and store nutrients so that the availability of nutrients for plants increased [7]. Moreover, rice husk has properties that are easy to bind water, lightweight, weather-resistant, and provide potassium nutrients for plants.

Table 1. Average Plant Height, Number of Tillers, and Number of Leaves in Several Types of Soil-less Planting Media

Type of Soil-less Media	Plant Height (cm)	Number of Tillers	Number of Leaves
Water + rice husk + non AWD	73,88 a	35,25 a	108,92 a
Control (soil) + non AWD	68,18 ab	25,67 b	87,58 a
Water + non AWD	63,73 b	16,00 c	49,08 b
Water + AWD once a day	63,11 b	18,17 bc	54,33 b

Notes: Different letters in columns indicate a significant difference between treatments at 5% DMRT

The utilization of water + rice husk media has the potential to be developed in urban farming. Compared to water media, the use of water + rice husk media can trigger plant growth even though the EC (electric conductivity) value is quite high. A high EC value indicates an increased TDS (Total Dissolved Solids) which will hinder the absorption of nutrients and water. Until now, research on the use of husk + water as a growing medium has not been widely reported. However, soilless cultivation systems are currently one of the fastest-growing cultures in urban farming [8]. Rusli *et al.* (2018) stated that rice husk application as growing media worked as a pH buffer in soil-less media (the pH media were steadily maintained at 6.5), therefore, increasing *Cucumis sativus* yield due to increasing nutrients uptake [9]. Frasetya (2019) suggested that the use of rice husk silicate extract may increase rice plant height, EC, and pH in a hydroponic system [10].

3.2. Effect of Rice Variety

The results showed that the types of rice varieties had a significant effect on stem diameter. The average stem diameter in various treatments of rice varieties is shown in Table 2.

Table 2. Average Stem Diameter in Two Rice Varieties

Rice Variety	Stem Diameter (mm)
Mapan 05	6,95 a
Ciherang	5,80 b

Notes: Different letters in columns indicate a significant difference between treatments at 5% DMRT

Table 2 shows that the treatment of the Mapan 05 variety was significantly different from the Ciherang variety. The genetic differences between the two varieties resulted in different nutrient absorption abilities that affected plant growth, especially stem diameter. Thus, the stem diameter of each rice variety will vary. This is following Purwansyah *et al.* (2021) informed that both environmental and genetic factors significantly affect the length and diameter of rice stems [11]. Research that has been done by Djaman *et al*. (2018) regarding AWD in rice plants in the Sahel area shows a synergistic relationship between rice genotypes and nitrogen levels [12]. They also stated that AWD affects soil biochemical and physical processes (such as nitrification, denitrification, mineralization, percolation, and leaching) due to water and air equilibrium changes that contribute to rice growth and development. Differences in rice genotypes will affect differences in Nitrogen Use Efficiency (NUE), which is then seen from rice growth and yields. Yang *et al.* (2017) stated that AWD irrigation is an effective irrigation technique to increase rice yields by reducing redundant rice growth, increasing root systems, and improving canopy structure due to increased NUE [13]. The diameter of the stem is closely related to the process of cell division and enlargement. Cell enlargement is

supported by the large turgidity of cells. Lack of water will reduce cell turgor, thereby suppressing plant growth and development and cell wall synthesis [14].

4. Conclusion

a. Water + rice husk media gave the best results on plant height, the number of tillers, and the number of leaves.
b. There was a significant difference in stem diameter between Mapan 05 variety and Ciherang variety.

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