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Water Use Efficiency in Rice Cultivar Inpago 7 in The Context of Searching for Drought Tolerant for Indonesia's National Food Security

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Abstract

Rice is a staple food source in Indonesia, but its production is declining due to drought stress that can hinder its growth and development. Therefore, it is necessary to identify rice varieties resistant to drought stress. This research aims to determine the efficiency of water use in the Inpago 7 rice cultivar. This research uses the method of measuring relative water content. The measurement of relative water content is done by weighing the fresh weight, turgid weight, and dry weight. The samples used are the leaves of the Inpago 7 rice cultivar and Inpago 5 rice cultivar as a positive control, with each sample undergoing two repetitions. Each leaf sample is weighed to obtain the fresh weight, and then add distilled water and left at room temperature for 24 hours. The leaves are weighed again to obtain the turgid weight. The leaves were dried at a temperature of 60°C for 24 hours, and then the dry weight was measured. The data obtained is then correlated with the physiological responses of the leaves from each sample. The relative water content in the Inpago 5 rice cultivar is lower than the relative water content in the Inpago 7 rice cultivar and has a negative correlation with the physiological response of the leaves. The efficiency of water use in the Inpago 7 rice cultivar can be a candidate for a plant breeding program that is resistant to drought stress, which can support Indonesia's national food security.

Keywords: *Drought Stress; Inpago 7; Physiological Response; Relative Water Content; Rice*

Introduction

Rice is the staple food for the majority of the population in Indonesia and is a primary food necessity. The Indonesian rice production balance has managed to show a slightly consistent surplus recently, in the period of 2010 to 2021, but the country has continued to import rice to secure its rice reserve [1]. The increase in rice production needs to be continued and enhanced to achieve national food security. Efforts to increase rice production in Indonesia have always been a top priority in development, especially in the agricultural sector. The main strategy in efforts to increase rice production involves intensification and extensification. Intensification is carried out by applying technology in varieties and cultivation techniques to enhance land productivity, both by increasing planting intensity from once to two or three times a year. Meanwhile, extensification is achieved by opening new rice cultivation areas through the construction of irrigation channels and the creation of new rice fields, expanding dry rice cultivation, and opening swamp land [2].

Based on data published by the Central Statistics Agency (2021), rice production in Indonesia has shown a tendency to decline from 2018 to 2021. This results in Indonesia frequently importing rice to meet domestic rice needs. The low

productivity of rice in Indonesia is also caused by several factors, one of which is climate. The decline in rice productivity is due to Indonesia's tropical dry climate. Such climatic conditions lead to soil being deficient in water and nutrients, as well as having a relatively low organic matter content. Therefore, specific location varieties that have drought-resistant characteristics are needed. Dry land can be utilized as a center for rice production. The type of rice suitable for dry land is gogo rice, which can grow in dry land conditions. Gogo rice has great potential as a variety for dry land, but until now, its productivity is still considered low compared to various varieties of rice grown in irrigated fields. [3]. This is due to the fact that the development of gogo rice varieties has not yet been able to adapt well to low water supply conditions and pest and disease attacks. Severe and prolonged water shortages are causing plants to experience drought stress [4]. Improvements in dryland rice can be made by developing and selecting existing varieties of dryland rice or by utilizing varieties that are commonly cultivated in paddy fields, thereby obtaining a wide spectrum of genetic diversity.

The issue of drought stress in plants can be addressed through plant breeding activities. Plant breeding is one of the actions to modify the appearance of plants to make them more ideal [5]. The success of plant breeding in obtaining drought-tolerant plants requires effective methods. One way to do this is by identifying several plant varieties that can thrive under stress conditions [4]. Drought can affect the physiological processes of rice plants [6]. The physiological changes that occur as a response of rice plants to drought stress include a decrease in photosynthesis, transpiration, stomatal conductance, and relative water content [7]. Optimization of physiological processes is one of the requirements to increase crop productivity under drought conditions [8]. To minimize the impact of drought stress that occurs, efforts are needed to enhance the resilience of dryland rice plants to drought in dry land by utilizing cultivars that have the potential to be drought-tolerant. The aim of this research is to determine the efficiency of water use in the Inpago 7 rice cultivar.

Materials and Methods

Materials

The tools used in this research include an analytical balance, an oven, tweezers, and petri dishes. Meanwhile, the materials used in this study are the leaves of the gogo rice cultivar varieties Inpago 5 and Inpago 7, and distilled water. This research was conducted in September 2024 at the Biology Laboratory of the Republic of Indonesia Defense University.

Methods

This research was conducted by measuring the relative water content in the leaves of the gogo rice cultivars Inpago 5 and Inpago 7. The treatment was repeated twice for each variety. The determination of the relative water content is carried out by taking fresh rice leaves, which are then weighed using an analytical balance to determine the fresh weight. (FW). Next, add 1 mL of distilled water to the Petri dish, and place the

rice leaf into the Petri dish, then label it and incubate for 24 hours at room temperature. After that, the rice leaves were weighed again using an analytical balance to determine the turgid weight (TW). Then, the leaves of both rice varieties were dried in an oven at 60°C for 24 hours, and then weighed again using an analytical balance to determine the dry weight (DW). The relative water content has been determined based on the following [9] formula :

$$RWC = \frac{(FW - DW)}{(TW - DW)} \times 100$$

RWC : Relative Water Content (%)

FW : Fresh Weight

TW : Turgid Weight

DW : Dry Weight

Data analysis

Data analysis was conducted using descriptive statistical testing. Data was processed by calculating the average, standard deviation, and standard error using Microsoft Excel. Meanwhile, physiological data was processed using ImageJ software and then visualized using correlation tests (t-test).

Results and Discussion

The results of this study indicate that the gogo rice variety Inpago 5 has a relatively lower water content than the variety Inpago 7. Additionally, there is significant difference between the two varieties (Figure 1). The gogo rice cultivar Inpago 7 has a relative water content of 38.35%, while the Inpago 5 variety has a relative water content of 7.48% (Figure 1.). This indicates that the Inpago 7 variety has a relatively high water content under drought stress conditions.

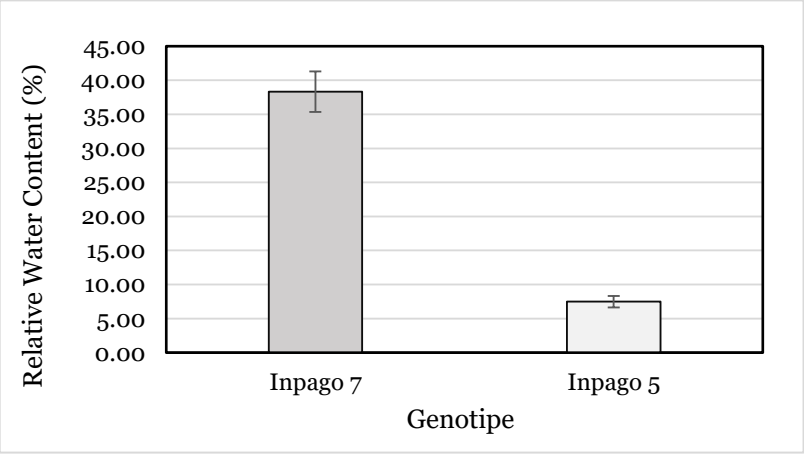

Figure 1. Relative Water Content (RWC) of rice cv. Inpago 5 and Inpago 7 in Drought Treatment

The exploration of drought-tolerant rice lines, such as Inpago 7, is vital for ensuring sustainable rice production in Indonesia, where water scarcity is increasingly becoming a challenge. Reduction in leaf water potential occurs when soil water

becomes deficient, resulting in the plants being less able to absorb water and leading to a decrease in turgidity and leaf water potential [10].

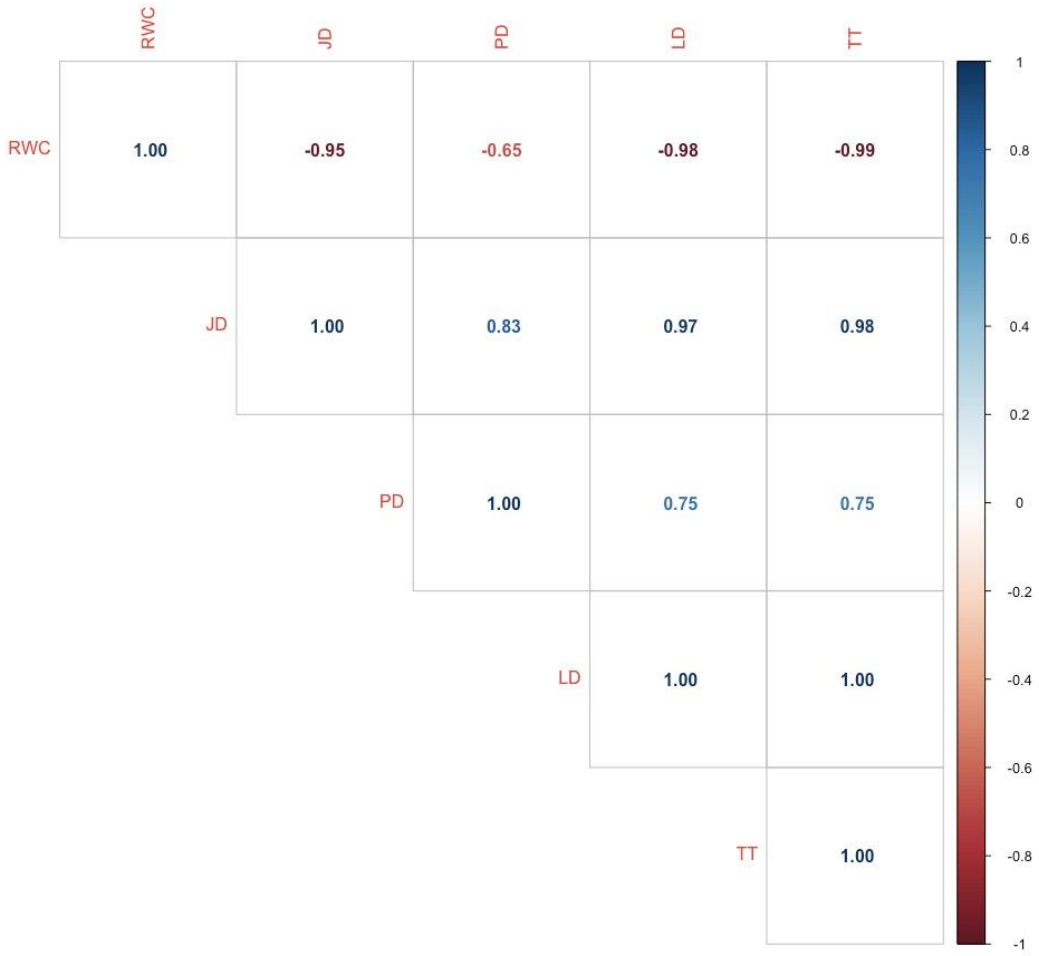

Figure 2. The correlation of relative water content with the physiology of the Inpago 7 variety

The image explains that Relative Water Content has a strong negative correlation with the number of leaves, leaf length, leaf width, and plant height. The physiological responses of Inpago 7 to drought stress have been documented, emphasizing the importance of traits such as relative water content (RWC) and root architecture in determining water use efficiency. Research has shown that varieties with deeper root systems and better RWC management can sustain productivity under drought conditions [11].

Conclusion

In conclusion, the efficiency of water use in the Inpago 7 rice cultivar can be a candidate for a plant breeding program that is resistant to drought stress, which can support Indonesia's national food security. The water use efficiency of the Inpago 7 rice cultivar is a vital aspect of developing drought-tolerant lines that can support Indonesia's national food security. Its ability to maintain productive tillers, adapt to varying soil moisture conditions, and exhibit favorable physiological traits under drought stress positions Inpago 7 as a promising candidate for future breeding

programs aimed at enhancing rice resilience in the face of climate change.

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