CHAPTER I. INTRODUCTION

1.1 The Background of the Study

The rice plant (*Oryza sativa* L.) is a crop that has become the main staple food of more than half of the world's inhabitants. Rice is the main commodity in Indonesia that plays a role in supporting the community's food. Based on data from the Central Bureau Statistics Agency, rice production in Indonesia has fluctuated from 2017-2019, namely 5.35 tons/ha, 5.2 tons/ha and 5.11 tons/ha[1]. This productivity is relatively low compared to the optimum productivity which can reach 8-10 tons/ha[2].

The decline in rice production and the increasing demand for rice have resulted in uncontrolled intensification and caused humans to use excessive chemical fertilizers and pesticides. In fact, excessive use of chemicals can damage the environment and even cause disasters. As explained in the words of Allah SWT in Q.S. Ar-Ruum verse 41, the destruction of nature or the occurrence of a natural disaster has to do with what is done by humans[3]. The verse reads as follows:

ظَهَرَ ٱلْفَسَادُ فِى ٱلْبَرِّ وَٱلْبَحْرِ بِمَا كَسَبَتْ أَيْدِى ٱلنَّاسِ لِيُذِيقَهُم بَعْضَ ٱلَّذِى عَمِلُوا۟ لَعَلَّهُمْ يَرْجِعُونَ

[1] BPS, "Luas Panen, Produksi Dan Produktivitas Padi," 2019, https://jakbarkota.bps.go.id/indicator/53/268/1/luas-panen-produksi-dan-produktivitas-padi.html.

[2] K Agus Wirawan, I K Budi Susrusa, and IGAA Ambarawati, "Analisis Produktivitas Tanaman Padi Di Kabupaten Badung Provinsi Bali," *Jurnal Manajemen Agribisnis* 2, no. 1 (2014): 76–90, https://media.neliti.com/media/publications/26279-ID-analisis-produktivitas-tanaman-padi-di-kabupaten-badung-provinsi-bali.pdf.

[3] Eko Prayetno, "Kajian Al-Qur'an Dan Sains Tentang Kerusakan Lingkungan," *Al-Dzikra: Jurnal Studi Ilmu Al-Qur'an dan Al-Hadits* 12, no. 1 (2018): 1–20, http://ejournal.radenintan.ac.id/index.php/al-dzikra.

Which means: "it has been seen that damage on land and at sea is caused by the actions of human hands; Allah wants them to feel a part of their deeds, so that they may return (to the right path).

One of the alternatives chosen by farmers is to use biofertilizer as a substitute for chemical fertilizers[4]. Biofertilizer is a material that contains microorganisms that act on the rhizosphere of plants and is useful for increasing supply and nutrients and stimulating plant growth[5]. Microorganisms that are widely used as biofertilizers are from the bacterial group, but some mushrooms also have the potential as biofertilizers, one of which is *Trichoderma* sp.

The use of organic fertilizers containing microbes in rice paddy soil improves plant growth and soil fertility by affecting microbial activity and population. According to the research of Erlinda, et al., (2020) the application of indigenous microbes in rice cultivation accelerates growth and increases production yields, especially in the SRI system[6]. *Trichoderma* sp. fungi containing various secondary metabolites support the application of biofertilizers so that they can be a substitute for chemical fertilizer applications in the agricultural industry. Biofertilizers can also reduce environmental pollution due to excess chemical fertilizers in the agricultural industry[7].

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[4] Diah Sudiarti, "The Effectiveness of Biofertilizer on Plant Growth Soybean 'Edamame' (Glycin Max)," *Jurnal SainHealth* 1, no. 2 (2017): 97.

[5] Bhattacharjee Ritika and Dey Utpal, "Biofertilizer, a Way towards Organic Agriculture: A Review," *African Journal of Microbiology Research* 8, no. 24 (2014): 2332–2343, http://www.academicjournals.org/AJMR.

[6] Rita Erlinda, Nelson Elita, and Agustamar, "The Effect of Indigenous Azotobacter Isolate on Rice Results of Sri and Land Quality Methods," *International Journal of Advanced Research* 8, no. 1 (2020): 185–193.

[7] Nelson Elita et al., "Identifikasi Molekuler Trichoderma Spp. Indigenous Dari Rizosfer Beberapa Varietas Padi Asal Kabupaten Lima Puluh Kota Dan Kota Payakumbuh," *Agroteknika* 5, no. 1 (2022): 1–13.

The application of *Trichoderma* sp. in addition to being a control of soil-borne pathogens can also increase soil pH and soil nutrient content such as available P, total N and K[8]. The fungus *Trichoderma* sp. which is symbiotic with plants at the root provides a considerable influence on the fulfillment of plant nutrients. *Trichoderma* sp. can promote plant growth by releasing hormone-like compounds that promote root development and plant growth. Rapid plant growth increases microbial populations through the secretion of large amounts of root exudate, and in turn increases the availability of nutrients for microbial consumption[9]. *Trichoderma* sp. has been shown to increase the rate of decomposition leading to high nutrient availability in the soil for utilization by other organisms.

Trichoderma sp. is usually found in the rhizosphere (root area) of plants. These fungi gather around the rhizosphere and produce organic compounds that are a source of energy and food for organisms around the roots. The symbiotic relationship between *Trichoderma* sp. and the rhizosphere is shown by root surface colonization which can improve root productivity and health. *Trichoderma* sp. also helps plants to overcome abiotic stress and increase nutrient uptake[10].

Several studies explain that the utilization of microorganisms plays an important role in improving rice yields. Swain, et al., (2018) said that *Trichoderma* sp. promotes

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[8] Nelson Elita, Eka Susila, and Yefriwati, "The Potential Types of Indigenous Arbuscular Mycorrhizal Fungi as Sources of Inoculum and Their Effect on Rice Production Using the System of Rice Intensification Method," *Pakistan Journal of Nutrition* 17, no. 12 (2018): 696–701, https://scialert.net/abstract/?doi=pjn.2018.696.701.

[9] Lilia C. Carvalhais et al., "Linking Jasmonic Acid Signaling, Root Exudates, and Rhizosphere Microbiomes," *Molecular Plant-Microbe Interactions* 28, no. 9 (2015): 1049–1058.

[10] Sanjeev Kumar, "Trichoderma: A Biological Weapon for Managing Plant Diseases and Promoting Sustainability," *International Journal of Agricultural Sciences and Vetinary Medicine* 1, no. 3 (2013): 18–25, http://www.ijasvm.com/currentissue.php.

root growth, increases seedling strength, increases nutrient absorption, aids seed germination in poor soil conditions, improves yield parameters and suppresses the growth of harmful root microflora[11]. *Trichoderma* sp. helps growth by colonizing roots and living in the soil, therefore the object of study in this study is rice roots. Irrigation also affects rice productivity, in addition to the environment and fertilization.

Soil with nutrient and water content will play an important role in plant productivity. Water is the basic need for plants to be able to grow, develop and produce properly. Continuous irrigation or conventional systems are common methods that many farmers do. This irrigation allows plants to be flooded from the time of planting to a few days before harvest. However, continuous irrigation becomes less than optimal when the dry season arrives and when the cultivation area lacks water[12].

Proper irrigation technology is needed to control water needs in rice cultivation. According to Utami et al (2016), the application of irrigation technology in aquaculture has the goal of adapting to the growing environment, so that optimal growth and productivity are obtained[13]. One of the water-saving technologies is intermittent irrigation. Intermittent irrigation is waterlogging that is carried out at certain intervals. In addition to saving water, intermittent irrigation can reduce methane gas emissions

[11] Harekrushna Swain et al., "Novel Trichoderma Strains. Isolated from Tree Barks as Potential Biocontrol Agents and Biofertilizers for Direct Seeded Rice," *Microbiological Research* 214, no. January (2018): 83–90.

[12] Raflen Aril Gerungan and Mecky Christofel Telis Pandelaki, "Pengaruh Rekayasa Pengairan Terhadap Produktivitas Budidaya Padi (Oryza Sativa) Sawah," *Jurnal Matematika Sains dan Teknologi* 21, no. 1 (2020): 11–21.

[13] Sri Nuryani Hidayah Utami, Achmadi Priyatmojo, and Subejo, "Penerapan Teknologi Tepat Guna Pada Padi Sawah Spesifik Lokasi Di Dusun Ponggok, Trimulyo, Jetis, Bantul," *Indonesian Journal of Community Engagement* 1, no. 2 (2016): 239–253.

from rice fields because flooded soils such as paddy fields are one of the sources of atmospheric CH4 gas and contribute around 20-100 Tg CH4/year[14].

In addition to *Trichoderma* and irrigation techniques, the choice of rice variety significantly influences plant growth and yields. As Hatta (2012), noted, different varieties exhibit variations in tiller number and panicle length, which directly impact overall yield[15].

1.2 The Research Questions

1. What is the effect of varieties on the planting medium in combination with *Trichoderma* on plant growth and rice root morphology?
2. What is the effect of irrigation techniques on the planting medium in combination with *Trichoderma* on plant growth and rice root morphology?
3. What is the effect of the combination of varieties and irrigation techniques on the planting medium in combination with *Trichoderma* on plant growth and rice root morphology?

1.3 The Research Objectives

1. To investigate the effect of varieties with planting medium in combination with *Trichoderma* on plant growth and rice root morphology.
2. To investigate the effect of irrigation techniques with planting medium in combination with *Trichoderma* on plant growth and rice root morphology.

[14] Netera Subadiyasa, Nyoman Arya, and Makoto Kimura, "Methane Emissions from Paddy Fields in Bali Island, Indonesia," *Soil Science and Plant Nutrition* 43, no. 2 (1997): 387–394.

[15] Muhammad Hatta, "Uji Jarak Tanam Sistem Legowo Terhadap Pertumbuhan Dan Hasil Beberapa Varietas Padi Pada Metode SRI," *Jurnal Agrista* 16, no. 2 (2012): 87–93.

3. To investigate the effect of the combination of varieties and irrigation techniques with planting medium in combination with *Trichoderma* on plant growth and rice root morphology.

1.4 The Aims of the Research

The benefits of this research can be categorized into two, such as

a. Practical implications. The findings of this research can provide valuable insights to farmers, enabling them to optimize rice production through the selection of suitable varieties, efficient irrigation techniques, and the application of Trichoderma as a biofertilizer. By reducing reliance on chemical fertilizers and adopting sustainable practices, farmers can enhance agricultural productivity and environmental sustainability.
b. Theoretical implications. This study is expected to be an additional information on rice varieties with the addition of *Trichoderma* at the time of soaking combined with proper irrigation techniques so that it can improve the morphology of the roots, where the root architecture will be highly correlated with the ability to absorb nutrients and the resistance of abiotic stress in rice.