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The Potential of Endophytic Fungi From Local Rice Genotypes of Kuantan Singingi in Improving Rice Plant Growth

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ABSTRACT

This study aims to investigate the potential of endophytic fungi derived from local genotypes of Pulut Karate and white Sisgam rice plants to enhance the growth of rice plants. The research was conducted in a laboratory setting using an experimental approach. Initially, the endophytic fungi were isolated from the rice plants of Pulut Karate and white lionfish genotypes, which were previously collected in another research project. These fungi were then cultured on PDA media and incubated for seven days. Subsequently, the germination and growth of rice seedlings inoculated with each endophytic fungus isolate were examined. The growth parameters of the rice seedlings, including seed height, root length, and number of leaves, were carefully observed. The findings of this research were presented in the form of data and images. The results indicate that the seed germination rate ranged from 90% to 100%. Among all the isolates, isolate PB03 demonstrated the most significant impact on rice plant growth, as evidenced by its taller plant height (8.03 cm) and longer root length (6.27 cm) compared to the other isolates and the control group.

Keywords: *endophytes, local genotypes, rice, triggers, growth*

1. INTRODUCTION

As an agricultural nation, Indonesia has the potential to enhance and advance its rice cultivation. Rice holds a significant role in the lives of Indonesian people, and it is undeniable that this commodity has a profound impact on the political structure and national stability. Insufficient rice production and low land productivity can be attributed to various factors. Conversely, the demand for rice continues to rise in tandem with population growth. Increasing and developing rice production is imperative to meet the expanding population's food requirements and revive local rice varieties (Nurmala, 2003). Farmers in Kuantan Singingi still cultivate local rice plants and employ local rice seeds (genotypes). This preference for local genotypes is due to the specific conditions of rice fields in Kuantan Singingi, where the crops are typically planted only once a year. This is carried out due to the insufficient water system in farmers' rice fields, most of which rely on rainfall. According to a study conducted by Ezward et al. (2020), there are 24 different local rice genotypes that the residents of Kuantan Singing cultivate extensively. These local genotypes possess a higher resistance to abiotic stresses such as drought, floods, and poisoning, as well as biotic stresses like pest and disease attacks. The resistance of these genotypes to various stress conditions, both biotic and abiotic, is attributed to the symbiotic relationship between the plants and endophytic microbes, including endophytic fungi (Dewi et al. 2011).

Endophytic fungi typically reside within plant tissue without causing any harm to the host plant (Faeth, 2002). In a recent study exploring endophytic fungi in four local Kuantan singing rice genotypes during the generative phase, researchers discovered 22 isolates of endophytic fungi in the leaves, stems, and roots (Andriani et al. 2022). These endophytic fungi can produce metabolite compounds that act as growth regulators, including hormones like ethylene, auxin, and cytokinin. Additionally, they can produce hydrolytic enzymes such as amylase, cellulase, xylanase, ligninase, and chitinase. Apart from their role in enhancing plant growth (plant growth promotion), the presence of endophytic fungi in plant tissue is also attributed to their ability to produce growth-promoting substances, fix nitrogen, mobilize phosphate, and contribute to overall plant health (plant health promotion). A study conducted by Triwidodo et al. (2021) demonstrated that the growth of rice seedlings in vitro was enhanced when they were inoculated with endophytic fungi. Similarly, Ramdan et al. (2013) found that endophytic treatment resulted in increased plant height and root length of chili plants after being treated with endophytic fungi. This research aims to evaluate the potential of endophytic fungi derived from local Kuantan singingi genotype rice plants in promoting the growth of rice plants.

2. MATERIAL AND METHODS

The research was conducted at the FAPERTA UNIKS Basic Agricultural Laboratory, Riau Province, Jalan Gatot Subroto KM 7, Kebun Nenas, Kuantan Regency. This research was carried out for eight months, from April 2023 to November 2023.

Research Implementation

This research was conducted experimentally in the laboratory. The results obtained are displayed in the form of data and images. Then, the data is explained descriptively. The flow of research activities is shown in the flow chart below.

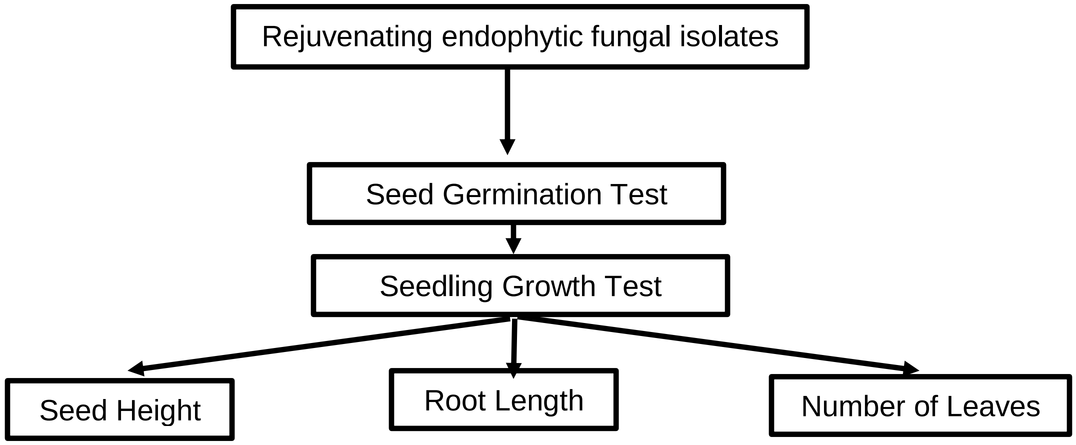

Figure 2. Research Flow Diagram

Research Implementation

Rejuvenating endophytic fungal isolates

Endophytic fungi from previous research isolated from 4 local genotypes of the Kuantan Singingi district were rejuvenated on Potato Dexrose Agar media. Each isolate was grown on PDA media and incubated for seven days. Purification results will be used for further testing.

Rice Seed Germination Test

Seed germination tests on endophytic fungi tested on rice seeds were carried out by surface sterilizing rice seeds gradually by soaking the seeds for 60 seconds in 70% ethanol, 3% NaCl for 60 seconds, and 70% ethanol for 30 seconds. Then, they were rinsed four times with sterile distilled water. As many as ten rice seeds germinated in a pure culture of endophytic fungus isolates and then incubated at room temperature for seven days.

Rice Seedling Growth Test

The seed growth test on endophytic fungi was tested on rice seeds by gradually surface sterilizing the rice seeds by soaking the seeds for 60 seconds in 70% ethanol, 3% NaCl for 60 seconds, and 70% ethanol for 30 seconds. Then, they were rinsed four times with sterile distilled water. Then, ten rice seeds were germinated in a pure culture of endophytic fungus isolate and incubated at room temperature for 14 days.

Observation Parameter

Seed Germination Percentage

The percentage of seed sprouts in endophytic fungi was observed after the seeds were grown in each isolate, which had been incubated at room temperature for seven days. Then, the germination percentage is calculated. The data obtained is displayed in the form of tables and images.

Seedling Height (cm)

Seedling height was calculated after 14 days of incubation with each endophytic fungus. Seedling height was measured from the base of the stem to the longest leaf. The data obtained is displayed in graphical form.

Root length (cm)

Root length was calculated after 14 days of incubation with each endophytic fungus. The length was measured from the base of the root to the longest root. The data obtained is displayed in graphical form.

Number of leaves

After 14 days of incubation with each endophytic fungus, the number of leaves was counted. The data obtained is displayed in graphical form.

3. RESULT AND DISCUSSION

3.1 Seedability Percentage

The percentage level of seeds in each isolate of endophytic fungi of local rice genotypes from Kuantan singingi has a high presentation level of 90-100% (Table 1). Testing the germination of seeds on each isolate of endophytic fungi shows that almost 100% of fungi can germinate after being inoculated with each endophytic fungus, only in isolates SP13 and PP16, whose germination power is 90%.

Table 1. Percentage of Seed Germination in Endophytic Fungus Isolates of Local Rice Genotypes from Kuantan Singingi

NO	Isolate Code	Seedability Percentage
1	PB03	100%
2	SP13	90%
3	SB07	100%
4	SB08	100%
5	PB14	100%
6	PD17	100%
7	PP16	90%
8	PB04	100%
9	SP05	100%
10	DP02	100%

Seed germination testing also indicates that the inoculated fungal isolate is not a pathogenic fungus or a potential pathogenic fungus. Pathogenic endophytic fungi will cause seeds to be unable to germinate, while potentially pathogenic fungi cause germinated seeds to grow abnormally. According to Kartika (2013), what is meant by sprouts with normal growth is sprouts with good/perfect development of the root system, hypocotyl, plumula, and cotyledons without any damage or abnormalities in the tissues.

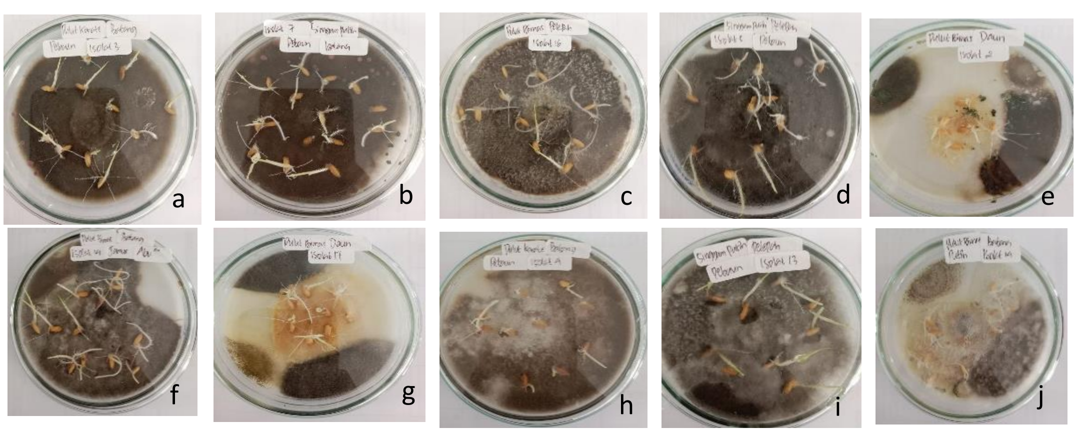

Figure 2. Seed germination test (a. isolate PB03, b. isolate SP13, c. isolate SB07, d. isolate SB08, e. isolate PB14, f. isolate PD14, g. isolate PP16, h. PB04, i. isolate PD17 , j. isolate DP02

The high seed germination rate indicates that the endophytic fungus isolate used is a non-pathogenic isolate (beneficial fungus). According to Sucipto et al. 2015, endophytic fungi from non-pathogenic rice plants function as growth-promoting fungi (PGPF) that can increase plant growth.

3.2 Seed Height

The use of endophytic fungi can increase plant growth, including seedling height. Each endophytic fungus can increase the height of rice seedlings (Figure 1). The results of growth tests based on plant height showed that all endophytic fungus isolates had a higher average than the control, which was 5.83 cm (Figure 1). The highest average plant height was in the PB03 isolate, which was 8.03 cm. The lowest average height value was isolate PB14, which was 4.04 cm. According to Syukur et al. (2014), endophytic fungi can increase plant fertility by helping application of nutrients and dissolving fixated nutrients such as phosphorus (P).

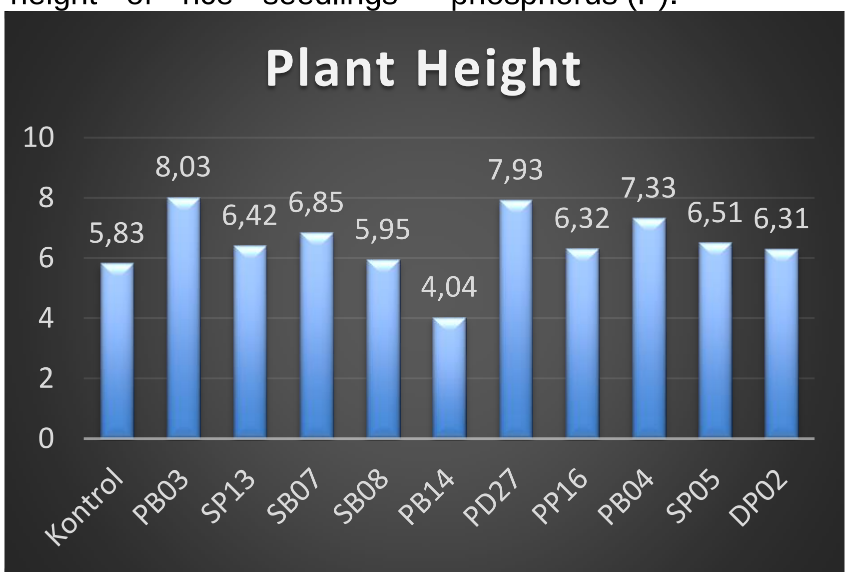

Figure 3. Seed Height Chart

Endophytic fungi are typically fungi that carry out mutualism symbiosis with their host plants. Mei and Flinn 8 (2010) reported that endophytic fungi can improve plant nutrition. The ability of endophytic fungi to increase plant growth depends on their ability to produce high amounts of growth-promoting metabolites (Ramdan et al., 2013). Endophytic fungi play a very important role in the fertility of their host plants because they can function as biological fertilizers, biological control of pests and diseases, help absorb nutrients, decompose organic matter, and dissolve fixed nutrients such as phosphorus (P) (Rubini et al. 2005). In the research of Triwidodo et al. (2021), the use of endophytic fungi from rice plant stems increased the height of rice plant seedlings to 9 cm on day 11. This study measured seedling height on day ten after inoculation, with the highest seedling height of 8.03 cm in the PB03 isolate treatment.

3.3 Root Length

Endophytic fungi can increase plant growth, one of which is root length. Each endophytic fungus can increase the roots of rice plants (Figure 2). Apart from plant height, measuring root length affects plant growth. Observation results: The root length of rice seedlings after inoculation with endophytic fungus isolates had varying root lengths. Isolate PB03 had the highest average root length compared to the other isolates and controls, namely 6.27 cm, while the lowest average root length was found in isolate PB14, namely 2.5 cm (Figure 2).

Endophytic fungi also have the potential to stimulate root growth. According to Ramdan et al. (2002), plant endophytic fungi can elongate the main roots and increase the number of root hairs and lateral roots. Lateral roots can expand the area for nutrient absorption, resulting in nutritional needs being met more quickly, thereby increasing plant growth.

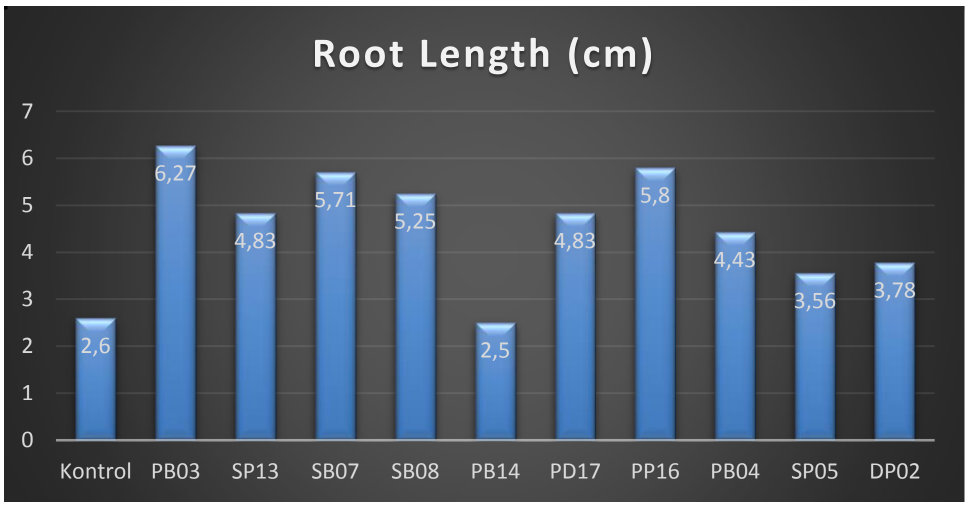

Figure 4. Root Length Chart

Several endophytic fungi in plant tissue can also provide phosphate elements due to the activity of endophytic fungi, which can dissolve fixed phosphate elements. Phosphorus plays an essential role in plant growth and development. The primary function of P in plants is to store and transfer energy in the form of Adenosine Diphosphate (ADP) and Adenosine Triphosphate (ATP) (Liferdi, 2010). Apart from that, phosphorus is also found in all plant cells, whose function is to form nucleic acids, stimulate cell division, and assist in assimilation and respiration. The large important role that the P element plays means that this element must always be available in sufficient quantities so that plants grow well (Ardhana, 2012). Phosphates affect plant metabolic processes. Lack of phosphate results in stunted plant growth. Roots do not develop properly, and old leaves fall off quickly because phosphate in plants is mobile and moves from old to young leaves. Endophytic fungi can trigger root development and additional lateral roots in plants due to the influence of the fungus' activity in dissolving phosphate. Research by Ramdan et al. (2013) found that 33% of endophytic fungus isolates from chili plants could increase root elongation of chili plant seeds.

3.4 Number of Leaves

Endophytic fungi can increase plant growth, one of which is the increase in the number of leaves. Each endophytic fungus can increase the number of leaves on rice plants (Figure 2). The observation of the number of leaves of rice seedlings after being inoculated with endophytic fungus isolates has a varying number of leaves.

Isolate PP16 has the highest average number of leaves compared to other isolates and the control, which amounted to 3.6 (fruit). In contrast, the lowest average number of leaves was found in isolate SP05 and control, which amounted to 2.3 (fruit) (Figure 2).

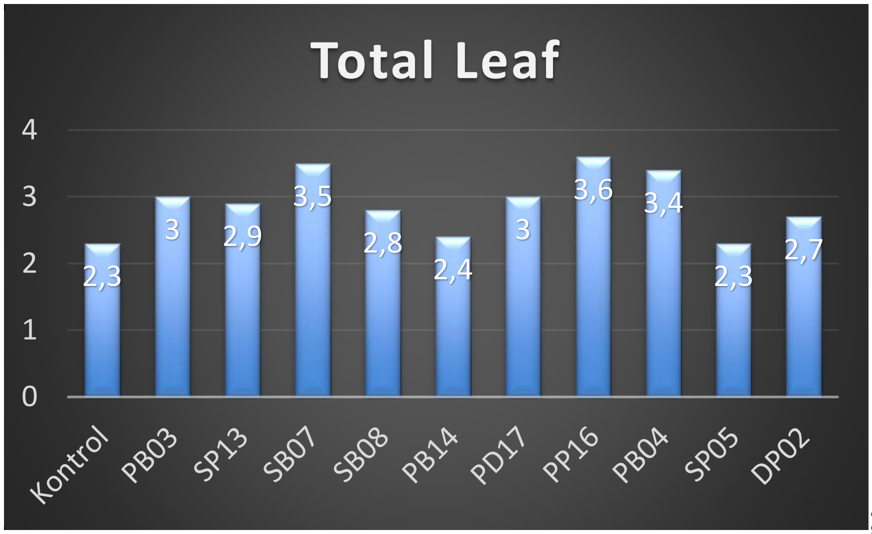

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Figure 5. Leaf count graph

In addition to height and increase in root length, the number of leaves contributes to enhancing plant growth after the inoculation with endophytic fungi. According to Feronica et al. (2017), the introduction of endophytic fungi to plants tends to result in an increase in the number of leaves. The absorption of sunlight during photosynthesis is influenced by the number of leaves, which subsequently impacts the overall photosynthetic yield utilized by the plant. Marschner (2012) highlights that the plant's ability to produce assimilate is not solely dependent on photosynthetic activity but also on the size of the photosynthetic area, encompassing leaves, stems, and other green organs of the plant. The leaf area of an individual plant is influenced by the leaf's position and the prevailing environmental conditions during its development, including environmental stressors such as low temperatures, drought, salinity, and nutritional deficiencies. Furthermore, Susanto et al. (2014) argue that a higher number of leaves corresponds to an increased ability to photosynthesize compared to plants with fewer leaves.

4. CONCLUSION

None of the endophytic fungi isolates obtained from local Kuantan Singingi rice genotypes exhibited any pathogenic or potentially pathogenic characteristics, as they did not hinder seed germination. The germination rate of inoculated seeds with these endophytic fungi ranged from 100-90%. Furthermore, all isolates demonstrated the ability to enhance the growth of rice seedlings, as evidenced by increased plant height, root length, and number of leaves. Among these isolates, the PB03 isolate proved to be the most effective in promoting the growth of rice plants, with a plant height of 8.03 cm and a root length of 6.27 cm.

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