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DIVERSITY OF MYCORRHIZAL FUNGI IN THE RHIZOSPHERE OF *Avicennia officinalis* (L.) IN THE PENITI MANGROVE FOREST, MEMPAWAH REGENCY

Riza Linda, Rafdinal

Department of Biology, Tanjungpura University, Pontianak

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Corresponding Author:
Riza Linda, Department of Agrotechnology, Faculty of Biology,Tanjungpura University, Pontianak
Email: rizalinda196@yahoo.com

Abstract

Mycorrhizal fungi are a form of mutualistic symbiosis between fungi and plant roots, including mangrove api-api that grows on mangrove area. This study aims to determine the diversity of mycorrhizal fungi on *mangrove api-api* (*Avicennia officinalis L.*) This study used a combination of wet filtering and centrifugation techniques for spore isolation. The results showed that the types of mycorrhizal fungi found in mangrove area were *Scutellospora, Gigaspora, Acaulospora Glomus sp1*, *Glomus sp2, Glomus sp3* and *Glomus sp4*. The diversity of mycorrhizal fungi in Peniti area was 0,07105 and Sungai Purun was 0,47280. the distribution of species is uneven, there are species that dominate and conditions are unstable. Spore density of 103 spores /100 gr soil and level of root infection percentage with low class (class 1) was 0,24% in Peniti dan 0,18 % in Purun River.

.Keywords: Mychorrizae fungi, Avicennia officinalis, diversity, mangrove

1. Introduction

Mangrove forest is a typical ecosystem found along the coast or river estuaries that are influenced by the tides of sea water. Mangroves are often known as brackish forests or tidal forests which are forest vegetation. According to Walsh in Nybakken (1992), it is estimated that 60-75 percent of the coastline of the tropics on earth is covered by mangroves. The mangrove ecosystem consists of biotic and abiotic factors that interact and interrelate with each other. To keep the ecosystem from being disturbed, it is very necessary to conserve and protect the mangrove area. One of the areas that is a mangrove forest protection area is the mangrove forest on the coast of Peniti, West Kalimantan.

From the research results of Rafdinal, et al. (2019) found that there were 16 types of mangroves consisting of 7 true mangrove species, 3 supporting mangrove species and 6 associated mangrove species. Mangrove species Avicennia offinalis was the dominant species (172.39%) followed by other species A. marina (85.57%) and Bruguiera cylindrica (17.19%).

The existence of mangrove vegetation is highly dependent on the presence of microbes in the soil that can interact directly with the host plant and that can live freely. Mycorrhizal fungi are fungi that can associate with the roots of higher plants. Mycorrhizal fungi mutualism relationship with plants can increase plant growth and indirectly mycorrhizal fungi function in conservation, especially in the nutrient cycle, increasing soil fertility in terms of physical, chemical and biological soil properties.

The role of mycorrhizal fungi that can increase soil fertility can be used as a biological fertilizer (biofertilizer) in cultivated plants and plants used as reforestation plants in marginal areas. The suitability of mycorrhizal fungi with host plants really needs to be done research on the types of mycorrhizal fungi and their status and condition in nature.

Several studies have shown different types of fungi and on different plants, such as the results of Gustian's (2015) research finding two genera, namely Glomus, Gigaspora and Acaulospora in the rhizosphere of Avicennia spp. in the village of Terusan, Mempawah Hilir District, West Kalimantan. The results of the study of Saputra et al. (2015) on the rhizosphere of the nipah banana (Musa paradisiaca L. var. nipah) obtained the genera Acaulospora, Archaeospora, Gigaspora, Glomus and Paraglomus from alluvial soil, and the genera Acaulospora, Gigaspora, Glomus and Paraglomus from FMD soil. Adiaty et al.'s research. (2018) on the rhizosphere of lakum (Cayratia trifolia (L.) Domin) found the genera Acaulospora, Archaeospora, Glomus, and Paraglomus on alluvial soil and the genera Acaulospora, Glomus, and Paraglomus Differences in vegetation and environmental conditions affect the type and diversity of mycorrhizal fungi. The purpose of this study was to determine the diversity of mycorrhizal fungi in the rhizosphere of Avicennia officinalis stands in the Peniti Mangrove Forest, Pontianak Regency, West Kalimantan.

General Description of Research Site

The estuary area of the Peniti River is an area in Pontianak Regency which is located in the north of Pontianak City. Geographically, the Peniti River is located between 00o11'05" north longitude and 109o08'14" east longitude and between 00o06'13" north longitude and 109o09'49" east longitude, with a mangrove forest area of ± 390.625 Ha. In general, the Peniti river and mangrove areas are bordered by areas which include: In the north it borders the Sungai Burung Village, in the south it borders the Nipah River Village, in the west it borders the Natuna Sea, and in the east it borders on Peniti Dalam.

Determination of the research location is based on a conceptual approach by looking at the environmental hue of the mangrove forest using the Porposive Random Sampling method. Based on these conditions, 2 observation locations for mangrove vegetation were determined, namely the Peniti Kecil mangrove area and the Kasim Purun River

2. Materials and Methods

This research has been carried out starting from August and September 2019 in the estuary area of the Peniti River, Pontianak Regency. Identification and data analysis were carried out at the Biology Laboratory, FMIPA UNTAN.

The materials used in this study were distilled water, 60% glucose solution, 2% HCl solution, 10% KOH solution, 0.6% NaClO solution, lactoglycerol, Melzer, tryphan blue, root samples and soil samples under Avicennia officinalis stands with depth 0-60 cm.

Soil and root samples of Avicennia officinalis were carried out in two different locations, namely in the Peniti Kecil mangrove area and the Kasim Purun River. The roots of each treatment A. officinalis were washed with distilled water. The roots were soaked with 10% KOH and heated with a hotplate until the roots were clear, then allowed to stand for 24 hours. After 24 hours, the roots were rinsed several times with distilled water. The roots were soaked in 2% HCl solution for 5 minutes. The roots were rinsed with distilled water and dried with filter paper and put in a beaker.

Staining is done by soaking the roots in a solution of Trypan blue until the blue color appears to be absorbed by the roots (± 2 hours). Roots were cut ±1 cm and observed under a microscope.

Percentage of infected roots:

$$\textbf{\%Root Infection} = \frac{\text{Number of infected roots}}{\text{Total number of observed root samples}} \times 100\%$$

The level of root infection was determined based on The Institute Of Mycorrhizal Research and

Development, USDA Forest Service in Novisa (2006), which consists of 5 classes, namely:

1. Class 1, if the infection is 0% - 5% (very low)
2. Class 2, if infection 6% - 25% (low)
3. Class 3, if the infection is 26% - 50% (moderate)
4. Class 4, if infection 51% - 75% (high)
5. Class 5, if the infection is 76% - 100% (very high)

Preparation and staining of roots was carried out using the staining technique according to Brundrett et al. (1996) using trypan Roots were observed under a microscope to see the percentage of root infection by mycorrhizal fungi.

Observational variables in this study included MVA type, number of MVA spores, percentage of infected roots, soil moisture (%), soil temperature (°C), soil pH, C-organic content (%), N (%), P (ppm), K (cmol (+) kg-1), relative frequency of species presence, relative density of spores of each species.

Identification was carried out based on the Manual for the Identification of VA Mycorrhizal (Schenck and Perez, 1990) and internet sources from the International Culture Collection of Vesicular Arbuscular Mycorrhizal Fungi (INVAM, 2021). Data analysis includes Relative Attendance Frequency (FR), Relative Density (KR), Shannon-Wiener Diversity Index (H'), Sorensen Similarity Index, Evenness Index (E), and Dominance Index (C).

3. Results and Discussion

Based on the results of observations of mycorrhizal fungus spores in the rhizosphere of A. officinalis in the Peniti Kecil mangrove area (location I), and the Kasim Purun River (location II) it was found listed in Table 1.

Table 1. Types and number of mycorrhizal fungus spores in the Peniti Kecil Mangrove and Purun River areas, Mempawah Regency

No.	Fungi type MVA	Total spores/100 g soil		Total
		Location I	Location II	
1	*Archaeospora*	1	1	2
2	*Gigaspora*	0	1	1
3	*Scutelospora*	2	1	3
4	*Glomus sp 1*	16	19	35
	Glomus sp 2	14	7	21
	Glomus sp 3	15	12	27
	Glomus sp 4	6	8	14
Spores dencity		54	49	103

Based on Table 1, location I had the highest spore density, which was 54 spores with a total of 7 species, compared to location II, which was 49 spores with 6 types of spores. The results of this study were lower than the results of research by Gustian et al., (2015) there were 9 types of mycorrhizal fungi in Avicennia spp stands. in the Mempawah Hilir canal with a spore density of 443 spores/100g of soil

In contrast to the research results, Fetty et al., (2015) found 7 types of spores from Glomus spp from three managrove stands (Avicennia marina, Bruguiera cylindra, Rhizophora stylosa) in Mempawah Hilir with a spore density of 247 spores/100g soil. This difference is caused by several factors, one of which is environmental factors that differ between locations.

The environment in the Peniti Mangrove Forest, Mempawah Regency. From the results of soil chemical analysis, the pH of the soil in Peniti Mempawah, Pontianak district, ranged from 5.96-6.17, while the pH of the soil at the location. at Mempawah Hilir the soil pH ranges from 6.0 to 6.7, . The higher soil pH in this area causes more mycorrhizal fungal spores than in the Pini area. According to Suhardi's (1990) opinion, the optimum pH for mycorrhizal fungi of Glomus species ranges from 5 -7, Gigaspora 4-6 and Acaulospora 4-5.

From the results of the analysis of the content of C-organic 2.87-6.50%, N-Total 0.34-0.72% and P2O5 (0.81-1.29 ppm). Soil physics is sand 34.94-39.91%, fine sand 34.68-36.67% and clay 25.41-28.39%. Siradz et al. (2007) said that soil conditions in the form of dusty clay fractions and silty soils and tend to be clayey were good soils for the development of Glomus, while sandy soils were mostly found in the genera Acaulospora and Gigaspora.

The data from the soil analysis showed that the soil in the Peniti area contained low N and P nutrients. Low nutrient availability and tidal factors greatly affect the presence of mycorrhizal fungi. In flooded conditions the oxygen content is low. Low oxygen affects the number of spores and their infection in the host plant.

According to Sieverding (1991) the density of spores per unit weight of soil is a propagule for mycorrhizal fungi that is actually present in the field and spore density is often used to calculate AMF populations during plant growth. Daniels and Skipper (1982) said that the soil had a high AMF spore population if the spore density was 20 per gram of soil (2000 per 100 g of soil).

Based on the results of measurements of environmental factors, it appears that N and P are low but the soil pH is in accordance with the life of mycorrhizal fungi. The low level of nutrients is caused by the abrasion process by sea water which causes the erosion of these nutrients. The process of leaching nutrients in mangrove areas in some vegetation will experience difficulties in the growth process and absorb nutrients. The presence of mycorrhizal fungi greatly helps increase the absorption of nutrients.

The relative frequency of presence (FR) and relative density (KR) of MVA fungi in the rhizosphere of the api-api mangrove (Avicennia officinalis L.) can be seen in Table 2.

Table 2. Values of Relative Density (KR), Relative Frequency (FR), and Arbuscular Vesicular Mycorrhizal Fungus (MVA) in Rhizosphere of the Flame Mangrove (Avicennia officinalis L.)

MVA Fungi Genus	Relative density (%)		Relative Frequency (%)	
	Location I	Location II	Location I	Location II
Archaeospora	1,85	2,04	100	100
Gigaspora	0	2,04	0	20
Scutelospora	1,85	2,04	40	20
Glomus sp 1	37,0	35,2	100	100
Glomus sp 2	29,63	13,0	100	100
Glomus sp 3	25,93	22,2	100	100
Glomus sp 4	11,11	14,8	100	100

The highest density and relative frequency of mycorrhizal fungal spores were found in Glomus Glomus spores, respectively Glomus sp 1, Glomus sp 2, Glomus sp 3, and Glomus sp 4. Glomus' ability to adapt to the environment is very high, which means a wide tolerance range. . Its high tolerance and presence can be used as a source of inoculum in the development and utilization of mycorrhizal fungi as biological agents in increasing plant growth and mangrove forest rehabilitation.

A. Value of Species Diversity Index (H'), Evenness Index (E), Dominance Index (C), and Similarity Index (IS) of Arbuscular Vesicular Mycorrhizal Fungus (MVA) in the Rhizosphere of the Flame Mangrove (Avicennia officinalis L.)

The values of the Species Diversity Index (H'), Evenness Index (E), and the Dominance Index (C) of MVA fungi in the rhizosphere of the api-api mangrove (Avicennia officinalis L.) can be seen in Table 4.

Table 3 Values of Species Diversity Index (H'), Evenness Index (E), and Dominance Index (C) of Arbuscular Vesicular Mycorrhizal Fungus (MVA) in the Rhizosphere of the Flame Mangrove (Avicennia officinalis L.)

Locations	H'	E	C
I	0,07105	0,04672	0,97286
II	0,47280	0,25241	0,86362

Based on Table 3, the highest mycorrhizal fungus species diversity index (H') was found in the soil of Location II, which was 0.47280, Location I was 0.07105. The value of the species evenness index (E) was also found to be higher in Location II soil, which was 0.25241, while at Location I soil it was 0.04672. The value of the species evenness index (E) in the two soil types indicates that the two types of soil have low inter-species uniformity, unstable conditions and there is a dominant genus. The value of the dominance index (C) on the soil of Location I is 0.86362, while that of the Land of Location I is 0.97286. The value of the dominance index (C) in the two soil types indicates that there is a very dominant fungal genus, namely Glomus spp, so that the diversity of mycorrhizal fungi is low.

B. Percentage of Arbuscular Vesicular Mycorrhizal Fungal Infection (MVA) in Two Types of Soil Rhizosphere Flame Mangrove (Avicennia officinalis L.)

The percentage of MVA fungal infections in api-api mangrove roots showed an association between MVA fungi and api-api mangroves. The results of the calculation of the percentage of MVA fungal infections on the rhizosphere roots of the api-api mangrove (A. officinalis L.) can be seen in Table 6.

Table 6 Percentage of MVA Fungal Infection on the Roots of the Flame Mangrove (Avicennia officinalis L.)

Location	Average (%)	Infection class
I	0,24	Low
II	0,18	Low

The degree of mycorrhizal fungal infection in mangrove vegetation, especially A. officinalis, was at location I of 0.24% and location II of 0.18%, which means the category is low. The low percentage of mycorrhizal fungal infections is probably caused by environmental conditions in tidal areas with high salinity levels, which are very unstable for mycorrhizal fungi. In high tide conditions, there is a lack of oxygen which affects the respiration and sporulation process of mycorrhizal fungi so that the number of spores contained in the soil and in plants is also low.

4. Conclusions

The types of vesicular arbuscular mycorrhizal fungi (MVA) found in the rhizosphere of the api-api mangrove (Avicennia officinalis L.) in Mempawah District are Archaeospora, Gigaspora, Glomus, and Paraglomus. The diversity of vesicular arbuscular mycorrhizal fungi (MVA) in the rhizosphere of mangrove api-api growing on alluvial soil and FMD soil has a very low value, the distribution of species is uneven, there are species that dominate and the conditions are unstable.

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