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Characteristics of indigenous mycorrhiza of weeds on marginal dry land in south Konawe, Indonesia

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Abstract: South Konawe is one of the areas that have the potential for the development of marginal farming dry land, which is wide enough, with a predominance of Ultisol type. In such area, more than 80% of farming communities who are dependent on the farming activities are still conventional to characterize the shifting cultivation. In many cases, most weeds that grow in their land are always considered to be destructing and disturbing the human interests, both during the land clearing and after the fields abandoned. On the other hand, the presence of weeds can be useful for the growth of plant as it provides benefits against microorganisms. One of the microorganisms which is associated with roots of weed is mycorrhiza. This study aims to determine the characteristics of indigenous mycorrhiza being present on dry weeds from marginal land. This study was conducted from May to November 2013 in South Konawe, Indonesia. The result shows that two types of indigenous mycorrhiza were present on the marginal dry land; *Glomus* sp and *Gigaspora* sp. The highest percentage of indigenous mycorrhiza infection was found in the roots of weeds *Amaranthus gracilis* and *Sida rhombifolia*, each of which by 90%. The presence of the vesicles and internal hyphae on the roots of weeds indicate the indigenous mycorrhiza infection.

Keywords: Marginal Dry Land, Ultisols, Indigenous Mycorrhiza, Weeds

1. Introduction

The presence of weeds in crop acreage greatly affects all aspects of growth and yield. This happens because the weeds have a high ability to compete for water, nutrients, sunlight and CO2. Thus, the weeds that grow in the area of the plant must be controlled before incurring losses. On the other hand, the presence of weeds can provide benefits for the life of the soil microorganisms. One of microorganisms associated with roots of weeds is mycorrhiza fungi, which are generally found associated with weed species about 80% -90% [3]; [15]; [19]), and even 90% - 95%, spread across the Arctic to the tropics and from the desert to the forest area [24]; [8]). Mycorrhiza spread almost all over the earth's surface and can be associated with most of the weeds. Approximately 83% dikotiledon, 79% monokotiledon and all gymnosperms studied was infected by mycorrhiza [25].

The types of weed that are found in association with mycorrhizal include *Imperata cylindrica*, *Cyperus rotundus*, *Eupatorium odorata, Ageratum conyzoides*, *Amaranthus spinosus*, *Cleome rutidosperma*, *Euphorbia hirta*, *Dactyloctenium aegyptium*, *Digitaria ciliaris*, *Heliotropium indicum*, and *Scoparia dulcis* [8]; [11]. The type of weeds that are infected by mycorrhiza has a very rapid growth, making it possible to be used as a propagation medium mycorrhiza [10]. Weed growth is very rapid in nature even though the marginal lands. Some research shows that the growth of weeds were allegedly due to mutualism between

mycorrhiza associated with the roots of weeds. The relationship between mycorrhiza with weed roots lasted from weed seeds form sprouts. This is in accordance with [26], the relationship causes the weeds easily absorb nutrients, while mycorrhiza is able to take advantage of root exudates of weeds as a source of carbon and energy.

The use of weed as a propagation medium mycorrhiza, because weeds have high adaptability to marginal lands [10]. With the mycorrhiza, weeds can absorb water and nutrients (especially P) optimally. Moreover, mycorrhizae can improve the formation and spread of the roots of weeds through external hyphae which resulted in an increased uptake of other nutrients by plants and weeds [14]. [12] reported that the *Eupatorium* odorata L. and *Imperata cylindrica* (L.) Beauv found the types of mycorrhiza like *Acaulospora* sp, sp *Gigaspora* sp and *Glomus* sp with spore number density of each 883 spores, 667 spores and 994 spores in the 250g of soil sample. However, if the weeds were inoculated on maize plant roots, the weeds around the maize plant were infected by mycorrhiza [11]. The types of weeds infected by mycorrhiza are *Ageratum conyzoides* (L.), *Amaranthus gracilis* Desf, Borreria alata (Aubl.) DC, *Centrosema plumieri* (Pers) Beath, *Mimosa invisa* Mart.ex. Colla, and *Digitaria adscendes* (HBK) Henr [11]. This shows that the weed has the potential to be used as a medium for the growth of mycorrhizae, especially for long-term goals that will support sustainable agriculture by utilizing local resources. This local resource, if used optimally, is able to restore the health of the soil and increase the strength of soil biological power, all of which could potentially improve the welfare of farmers. In this study, the characteristics of indigenous mycorrhiza being present on weeds from marginal dry land were examined.

2. Methodology

2.1. Exploration Mycorrhiza

Exploration of indigenous mycorrhiza of dry weed was carried out on marginal land, which is dominated by weeds classified as a secondary vegetation. The sampling method used is a nested plot technique as a minimum model for taking samples of weed species which have been determined [20]. The identification process of the weeds of indigenous mycorrhiza was conducted in the Laboratory of Forestry, Faculty of Agriculture, Halu Oleo University, Kendari, Indonesia. Propagation of indigenous mycorrhiza propagules was held in a plastic house Sindang Kasih village, district of West Ranomeeto, Southeast Sulawesi Province. The materials used in this study were *raffia* ropes, water, soil, the roots of weed, corn seed, polybag (size 10cm x 20cm), 30% sucrose, Acero Formalin Alcohol (FAA), 10% KOH solution, a solution of hydrogen 10% alkaline peroxide (H_2O_2), a solution of HCl 1%, dyes carbol fuchin 0.05%, laktogliserol, filter paper and paper labels. The tools used were tillage tools, machetes, meter, digital cameras, filters to see mycorrhizal spore size (mesh size of 500lm, 250lm, 90lm, 60lm, and 50lm), analytical balance, autoclave, microscope, glass measuring, petridish, pipettes, scissors, and stationery.

2.2. Identification of Indigenous Mycorrhiza

Identification of indigenous mycorrhiza was performed by using wet sieving method on soil taken from around the roots of weeds to observe the types of indigenous mycorrhiza spores. The process of getting indigenous mycorrhiza spores weeds by wet screening was as follows (1) 250gram of soil taken from the field was mixed with 500ml of water, (2) pour the liquid portion passes through a sieve with a mesh size of 500lm and then collect suspension that passes through the filter, (3) The suspension obtained in step 2 was filtered with a sieve mesh size of 250 lm, 90 lm and 60 lm, (4) suspend the pellets are retained on the filter in 30% sucrose, and then centrifuged for 1 min at 2000 rpm. Spores in sucrose supernatant were poured into a sieve with a mesh size of 50 lm and washed with water to remove sucrose, (5) the spore was observed with a microscope, and (6) other similar spores collected to make a pot culture for propagation of mycorrhiza [5].

2.3. Propagation of Indigenous Mycorrhiza on Weeds

The types of weed that produce seeds were planted with two seeds per polybag. In detail the propagation of mycorrhiza were as follows: (1) taking soil samples from the field on weed rhizosphere region as growing media, (2) sterilizing weed's seeds with a solution of FAA, (3) putting mycorrhiza propagules into a polybag with the planting hole of around 5cm in depth, (4) planting the weeds, (5) watering the plant, (6) allowing the plant to grow until the preferred age, (7) cutting the top of the weeds, (8) storing the rest of the weed roots in plastic bags that have been labeled, (9) staining roots, and (10) observing them by using a microscope [11].

2.4 Staining Roots

The steps in staining roots are as follows: (1) washing the roots with water, (2) saving the FAA for fixation prior to painting, (3) soaking in 10% KOH and heat with an autoclave for 15 -20 minutes at 121^0C, (4) washing with distilled water 3 times, (5) soaking in hydrogen peroxide outsmart 10% (H_2O_2), (6) washing with distilled water 3 times, (7) soaking with HCl 1%, (8) wasting HCl without washed with distilled water, (9) soaking in carbon fuchin with concentration of 0.05% w/v in laktogliserol and heat at 900C for several hours or in an autoclave at 1210C for 15 minutes, (10) removing the paint and soak the roots in laktogliserol, and (11) observing the roots sample using a microscope [5].

2.5. Observed Variables

The variables measured in this study are as follows: the types of mycorrhiza, the percentage of mycorrhizal infection on the weed's roots, and the characteristics of mycorrhiza infection on the weed's roots.

3. Result and Discussion

3.1. Identification of Indigenous Mycorrhiza of Weeds

Based on the identification of indigenous mycorrhiza of weeds among the sites, two types of mycorrhiza were obtained, namely *Glomus* sp and *Gigaspora* sp. The characteristics of the indigenous mycorrhiza found in this study were listed in Table 1.

Based on the observation of the form of mycorrhiza spores originating from weeds, two types of mycorrhiza were obtained mycorrhiza; *Glomus* sp and *Gigaspora* sp. The Mycorrhizae found were distinguished by spore surface shape, decoration spores, spore size and color changes due to the reaction spores dye [6]; [18]; [27]; [23]. Each type of mycorrhiza found has different characteristics; the ability to adapt to the environment and also the different host plants. The results of soil analysis at a sampling marginal land were pH 4.9, organic matter 4.80%, Nitrogen 0.15% Phosphorous 0.29 me/100 g and Potassium 17.88 ppm me/100 g. Based on the results of the soil analysis, the mycorrhiza can thrive. This is in accordance with [28] that the differences in the nature of mycorrhiza adaptation are influenced by the chemical properties of the soil. However, indigenous mycorrhiza in general has higher adaptability if compared with mycorrhiza in the form of fertilized mycorrhiza [11]. The observation of Mycorrhiza spores was made after one week from the time period of the roots and the soil in which the mycorrhiza spores are still alive. If the host plants are not present, mycorrhiza is able to survive for 20-30 days [22]. In unfavorable conditions, the presence of mycorrhiza can be observed in the form of spores, either individually or in the form of sporokarp, before it interacts with the roots of host plant [1]; [4]. *Gigaspora* sp was more tolerant on acid soils and soil-high aluminum [28] while the type of mycorrhiza *Glomus* sp was more common in alkaline soils and less in soils sour [7].

Table 1. *Characteristics of Indigenous Mycorrhiza of Weed*

No.	Types of Indigenous Mycorrhiza	Characteristics
1.	 Spores of Glomus sp	Spores formed singly or in pairs. Spore is located on the terminal gametangium undifferentiated hyphae in a sporokarp. Spore-hyphae are formed on the external hyphae near the roots. Colored spores at a young age at the riping time hyalin and white or tawny
2.	 Spores Gigaspora sp	Spores formed singly on terminal non gametangium hyphae and external ends of undifferentiated hyphae in a sporokarp. At the time of the mature spores separated by a bulkhead adhesive hyphae. The spores globos, round, spore wall more than one layer. Color brown spores in water. There is a complementary tool in the form of bulbous suspensor.

3.2. Percentage of Mycorrhiza Infection on Root Weeds

The percentage of mycorrhiza infection on the roots of weeds is listed in Table 2. The shape of mycorrhiza infection on the roots of weeds is shown in Figures 1 and 2.

Table 2. *Percentage of indigenous mycorrhiza Infection indigenous on weeds rooting*

No.	Types of Weeds	Root sample										Percentage of Mycorrhiza (%) Infection
		1	2	3	4	5	6	7	8	9	10	
1.	*Ageratum conyzoides*	-	-	-	+	-	+	+	+	+	+	60
2.	*Ageratum haustianum*	+	+	-	-	-	+	+	+	+	+	70
3.	*Amaranthus gracilis*	-	+	+	+	+	+	+	+	+	+	90
4.	*Alternanthera sessilis*	-	-	+	+	+	-	-	+	+	+	60
5	*Alternanthera philoxeroides*	-	-	-	-	+	+	+	+	+	+	60
6.	*Croton hirtus*	+	+	+	+	+	-	-	+	+	+	80
7.	*Cleome rutidosperma*	-	-	+	+	+	+	+	+	+	+	80
8.	*Cyperus killingya*	-	-	+	+	+	+	+	+	+	+	80
9.	*Eleusina indica*	-	-	-	+	+	+	+	+	+	+	70
10.	*Fimbristylis aestivalis*	-	-	+	+	+	+	+	+	+	+	80
11.	*Ludwigia hyssopifolia*	-	-	+	+	+	+	+	+	+	+	80
12.	*Mimosa pudica*	-	-	+	+	+	+	+	+	+	+	80
13.	*Mimosa pigra*	-	-	-	+	+	+	+	+	+	+	70
14.	*Nefia spirata*	-	-	-	+	+	+	+	+	+	+	70
15.	*Sida rhombifolia*	-	+	+	+	+	+	+	+	+	+	90

Note: - = not infected, + = infected

The percentage of mycorrhiza infection on the roots of weeds varies between 60% - 90%. This occurs because of differences in weed species, morphology and structure of the root [17]; [21]), the content of nutrients in the root [29] as well as the conformity between mycorrhizae with host plants [16]. The highest percentage of mycorrhiza infection occurred in the weeds of *Amaranthus gracilis* and *Sida rhombifolia* by 90%, respectively. This happens because the content of the root exudates of these weeds is very suitable for the growth of mycorrhiza [13]. In [21], it suggests that the ability of mycorrhiza to infect the roots was greatly influenced by the characteristics of the host plant. The Characteristics of mycorrhiza infection on the roots of weeds are shown in Figures 1 and 2.

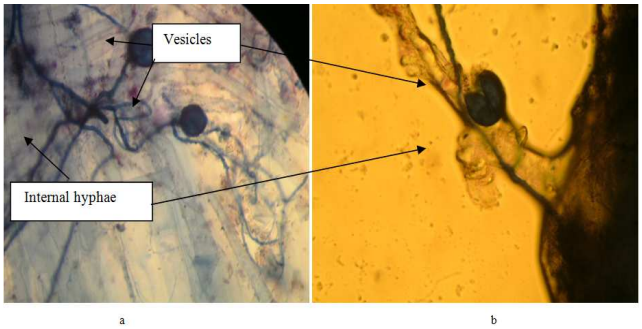

Figure 1. *Characteristics of mycorrhiza infection on the roots of weeds Ageratum conyzoides (a) and Amaranthus gracilis (b)*

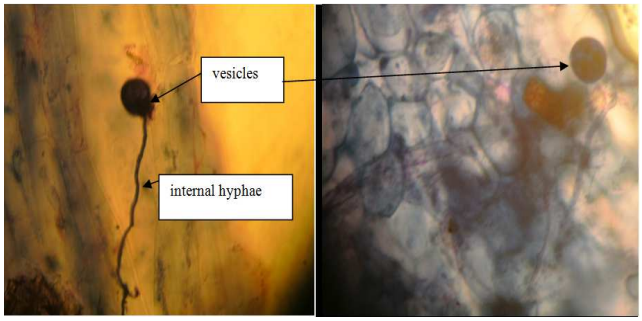

Figure 2. *Characteristics of mycorrhiza infection on the roots of weeds Sida rhombifolia*

Indicators used as a sign of mycorrhiza infection on the roots of weeds are spores, vesicles and arbuscular [9]. From these indicators, spores and vesicles were found in all types of weeds while arbuscular was not found in all types of observed weeds. The presence of mycorrhizal in the root zone of weeds allegedly is so rapid. When the mycorrhizae population on rhizosphere of weeds is very abundant, the competition of mycorrhizae in obtaining root exudates as a source of energy occurs. As a result the failed competitive mycorrhizal forms resting spores [11]. While vesicles are formed as an indication, mycorrhizae can help weed in absorbing nutrients which are then kept as a reserve food in the network weeds. According to [6], the vesicles function are the storage organs of food reserves. Fungi are not found on the network trunk weeds due to long observed age so that arbuscular was not formed again. According to [2], arbuscular in general began to form about two to three days after the infected roots. Based on the percentage of mycorrhizal infection on the roots of weeds, there is an indication that the dependence of weeds on mycorrhizal was very high. The weed's dependence on mycorrhiza was identical to the percentage of dry weight increase of weeds that were inoculated with mycorrhiza [30]. This means that the higher the value of the mycorrhiza dependence weeds, the higher the percentage of dry weight of weeds to decrease. Thus, there is a positive correlation between the dry weight of weeds decrease with the dependence value of the mycorrhiza weeds.

4. Conclusion

The results of this study are summarized as follows: (1) two types of indigenous mycorrhiza found at the site are Glomus sp and Gigaspora sp, (2) the highest percentage of indigenous mycorrhiza infection was found in the roots of weeds *Amaranthus gracilis* and *Sida rhombifolia r*espectively by 90%, (3) Indicators of indigenous mycorrhiza infection on the roots of weeds was the vesicles and internal hyphae.

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