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The Diversity of Arbuscular Mycorrhiza Fungi at Rhizosphere of Cassava of Thailand Clone Cultivated in Lampung Timur and Tulang Bawang Barat

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SUMMARY

Arbuscular mycorrhiza fungi (AMF) naturally are found in the soil, however its effectiveness, population and diversity is vary ant tend to low due to continuous use of high rate chemical fertilizer and pesticides, mono culture practices, intensive tillage using heavy machinery, etc. Therefore the aim of this study was to explore the population and diversity of AMF from 2 different location of central cassava production in Lampung i.e. Lampung Timur and Tulang Bawang Barat. Population of AMF was counted directly from rhizosphere soil of cassava Thailand clones and the diversity of AMF was assested by pot culture. The results showed that the population and the diversity of AMF in rhizosphere soil of Thailand clones in Tulang Bawang Barat was not significantly different from Lampung Timur. Total AMF type isolated from Lampung Timur was 11 species while 13 species were isolated from Tulang Bawang Barat.

Introduction

Indonesia is one of the world largest producer of cassava (*Manihot utilisima*) after Brazil and Thailand. Based on Ditjen Perkebunan Indonesia (2009), in year 2009 land cultivated with cassava in Indonesia was 1,199,504 hectares with a production of about 22.4 million tons (the productivity was about 18.45 ton/hectare). The cassava was cultivated in Sumatera, Java, Kalimantan and Sulawesi. In Sumatera, the largest area of cassava is in Lampung Province. The total area of cassava in Lampung was 316,806 hectares where 117,556 hectares was in Tulang Bawang Regency, 95,614 hectares was in Lampung Tengah Regency, and the rest are scatter in 8 other regencies (BKPM, 2012).

Cultivation of cassava in Lampung under subsistent or semi-commercial scale is often in poor Podsolik Merah Kuning (Ultisol) soil. The Ultisol soil characteristics were low pH, low fertility, high available Al, low cation exchange capacity, low avaiable P, and low organic matter content (Prasetyo and Suriadikarta, 2006). This situation together with the fact that this crop extracts large amounts of nutrients from the soil (Pellet and El-Sharkawy, 1993) making addition of nutrient (fertilizer) to the soil after each harvest mandatory if the subsequent yield is to be worthwhile. However, the use of high rate chemical fertilizer for the long period has negative impact on soil fertility, soil compaction, and soil microorganism.

Arbuscular mycorrhizal fungi (AMF) are ubiquitous symbionts formed in roots of a large majority of higher plants except those belonging to families Brassicaceae, Chenopodiaceae, Caryophyllaceae and Cyperaceae. The symbiosis is characterized by bidirectional movement of nutrients, where carbon flows to the fungus and inorganic nutrients move to the plant, thereby providing a critical linkage between the plant root and soil. Under diverse stress conditions the hyphae of the fungi exploit water and mineral (especially P) from soils better than the roots and effectively transfer them to the plants. The hyphae are fine and highly branched able to intensively explore a soil volume, less efficiently explored by plant roots. The fungi also can improve soil aggregation through binding and aggregating soil particles by intensively growing mycelium, primarily due to physical entanglement (Quilambo, 2003; Smith and Read, 2008).

AMF naturally are found in the soil including in rhizosphere of cassava. However, population and diversity is very low due to continuous use of high rate chemical fertilizer and pesticides, mono culture practices, intensive tillage using heavy machinery, etc. (Sieverding, 1991; Rosendahl, 2008). The population of AMF may be affected by biotic factors such as plant species and abiotic factors such as temperature, soil pH, soil moisture, organic matter content, phosphorus and nitrogen, and heavy metal concentrations (Brundrett and Ashwath, 2013; Bedini et al., 2013; Omorusi dan Ayanru, 2011; Lekberg et al., 2008). Nowadays, about 160 species of fungi had been identified belong to arbuscular mycorrhiza fungi from 7 generas i.e. Glomus, Entrophospora, Acaulospora, Archeospora, Paraglomus, Gigaspora, and Scutellospora (Morton and Benny, 1990). Therefore, this research aimed to determine population and diversity of AMF in the rhizosphere of Thailand clone of cassava which are cultured in the Regencies of Lampung Timur and Tulang Bawang Barat.

Material and Method

Soil Sampling

In order to meet the objectives of the project, the rhizosphere soil of cassava were collected from Lampung Timur and Tulang Bawang Regency. The soil was taken from cassava farms belongs to small holders (1—2 ha). In each regency, 7 replicates soil sample were collected using randomized sampling design. For every replicate, rhizosphere soil was collected from 12 cassava plants (soil were collected from two points per plant at 15—20 cm depth). The samples then bulked and mixed thoroughly to constitute one replicate (± 5 kg weight), kept in plastic bags and labeled precisely. Therefore, the total of 7 soil samples were collected from each regency.

Soil Analysis

The chemical (pH, N, P, K, Ca, Mg, C-org, CEC) and physical (soil texture) properties of the soil were determined by sending the soil sample to Soil Laboratory Analysis at Department of Soil Science, Faculty of Agriculture, University of Lampung. For chemical and physical analysis purposes, the soil were allowed to dried by open it at room temperature for 7 days and then sieved with 2 mm mesh sieve. The total population of AMF spore presence inside the soil were checked using wet sieving method (Sieverding, 1991) to isolate the spores and count it under stereo microscope manually.

Pot Culture

AMF is obligate fungi, they need plant as the host to grow and develop and cannot be propagated in agar media or in vitro. The success of AMF production is affected by the host and media used in propagation (Setiadi, 2004). Therefore, in this study different host and media will be used in trap culture to propagate propagule of FMA (spore, hyphae, infected root, etc.) present in the soil. The spore from trap culture were then used to identify the type of AMF to Genera level.

The AMF propagule inside the soil samples were trapped by planting some different host (sorghum, maize, and *Pueraria javanica*) in 1000 ml pot size. The soil samples from one regency containing of 7 soil samples were compiled into 1 homogenous sample. A total of ± 300 g of soil samples were introduced into polybags which contained a mixture of sand and zeolite media of ± 600 g. The germinated seed of host plant was planted on soil samples and cover back with a mixture of sand and zeolite media. Seven replicates were prepared for each host plant. The planted polybags were kept in green house for 3 months (sorghum and maize) or 4 months (*P. javanica*). Two weeks before the end of experiment, the plants were allowed to dry by stop watering to trigger AMF hyphae produce spore. The spores were collected from a mixture of zeolite and sand media from each polybag using wet sieving method by Sieverding (1991). Identification of isolated spores to level of genera were done through observation spore's characteristics such as the present of bulbose suspensor, germination shield, auxiliary cell, sporopherous saccule type, subtending hyphae, spore walls, and spore reaction to melzer solution.

Result and Discussions

Population of AMF spore from cassava rhizosphere of Thailand clone showed that number of AMF spore at Lampung Timur Regency was significantly not different with the number of spore in Tulang Bawang Barat (Table 1).

Figure 1. Number of AMF spore at cassava rhizosphere of Thailand Clone in Lampung Timur and Tulang Bawang Barat Regencies

Location	Number of Spore per 50 g soil
Tulang Bawang Barat	583.0 a
Lampung Timur	536.7 a

Number of AMF spore from the two regencies was not affected by abiotic factors such as soil chemical and physical properties. Number of AMF spore in the soil were considered very high, about 500 spores per 50 gram soil in both regencies. This may be due to that cassava is highly mycorrhizal dependent (Opik et al., 2006). One type of AMF is attributed to cassava i.e. *Glomus manihotis* because this species is frequently found in association with cassava root (Sieverding, 1991).

The result of soil analysis can be seen at Table 2. In general, the characteristics of the soil from these to regencies not much different especially for pH and available P (low) which mostly affect the existing of AMF in the soil (Rosendahl, 2008). This situation may be a reason why the number of AMF spore or population from these two regencies were not significantly different.

Table 2. Soil characteristic from rizhosphere soil of cassava of Thailand Clone at Lampung Timur and Tulang Bawang Barat Regencies

Chemical/physical Charateristic	Value: Tulang Bawang Barat	Value: Lampung Timur
pH	4,29	4,54
P-available(ppm)	14,43	8,82
K-dd (me/100g)	0,14	0,07
N-total(%)	0,10	0,06
Fe(ppm)	46,69	57,05
C-org (%)	1,38	0,68
Al-dd (me/100 g)	0,70	0,43
Sand	40,30	56,31
Silt	08,61	12,53
Clay	46,16	31,16

Based on pot culture data, it signified that the type of AMF in Tulang Bawang Barat is varied more (12-13 types) compared to East Lampung (8-11 types). Types of AMF derived from the host plant maize were higher than the other host plant for soil samples from Tulang Bawang Barat and Lampung Timur (Table 3). This indicates that the AMF derived from the rhizosphere of Thailand clone from the two regencies is more compartible with the maize host plant. In addition, the maize host plant was one of the most popular host plants in AMF propagation because this plant can associate with a wide range of AMF species (Sieverding, 1991). Furthermore, AMF diversity in soil samples from Tulang Bawang Barat was higher than in Lampung Timur. The higher diversity can be attributed to the fact that the host plants in Tulang Bawang Barat are not only cassava, but also chili. The farmer planted cassava and chili alternately in rotation program. Meanwhile, there is no rotation of cassava with other crops in Lampung Timur. Types of plants that exist in an ecosystem will affect the type and population of AMF (Rosendahl, 2008). The same result were reported by Higo *et al.* (2013) and Jansa *et al.* (2003) who mention that the crop rotation has the potential contribution to a higher AMF diversity.

Table 3. Number and type of AMF spore from pot culture of soil sample taken from cassava rhizosphere of Thailand clone at Lampung Timur and Tulang Bawang Barat.

Location	Host Plant	Number of AMF Type
Lampung	Maize	11
Timur	Sorghum	8
	Pueraria javanica	11
Tulang	Maize	13
Bawang	Sorghum	12
Barat	*Pueraria javanica*	12

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