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Effectiveness of Using the Types of Mycorrhizal Fertilizers to Increase Production and Oil Content of Several Patchouli Varieties in Andisols

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ABSTRACT

Using of mycorrhizal biofertilizers and right varieties can spur the production of patchouli on Andisol soil. Besides that, it can also increase root colonization by mycorrhizal and P2O5 uptake which is needed by patchouli plants so as to produce a high oil content. This study used a Randomized Block Design (RBD) Factorial with three replications. The first factor observed was mycorrhizal biofertilizer of various types of strains, namely mycorrhizal biological fertilizer of genus Glomus mosseae, mycorrhizal biofertilizer of genus Gigaspora sp. and mixture of Glomus mosseae and Gigaspora sp. While the second factor was the use of varieties with the Tapak Tuan and Lhokseumawe varieties levels. The results showed that the best mycorrhizal biofertilizers on production, root colonization, P2O5 uptake and oil content were found in the mixture of mycorrhizal genus (Glomus mosseae + Gigaspora sp.). The best variety for production, root colonization, P2O5 uptake and oil content was found in Tapak Tuan variety.

Keyword: Tapak Tuan variety, mycorrhizal biofertilizer, root colonization, patchouli production

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INTRODUCTION

Patchouli is one of the plantation commodities that produces essential oils and is widely used for the biopharmaceutical, perfume and cosmetic industries. Particularly in Aceh, patchouli production is carried out in Andisol, Entisol and Ultisol soils. Research by Syafruddin et al (2000) has proven that patchouli has a good production rate and good oil quality on Ultisol soil. Furthermore, Syafruddin et al (2020a) concluded that the Entisol patchouli soil had good yields and quality with the use of the biological fertilizer strain *Glomus mosseae*. There is no precise information on how the production of patchouli on Andisol soil and the effectiveness of using the appropriate strain of mycorrhizal biofertilizer, even though the wide potential and use of Andisol soil in Aceh for patchouli is very promising.

According to Syafruddin et al (2020b) and Nurmasyitah et al (2013), the main obstacle in using Andisol soil is the binding of P elements by the mineral alopane so that it cannot be used by plants. Giving mycorrhizal biological fertilizers is hoped that the bound of P elements can be absorbed by plants, including patchouli (Syafruddin et al, 2020a; Safrianto et al, 2015; Hardjowigeno, 2018).

In the use of mycorrhizal biofertilizers, the existing mycorrhizal genus is crucial for increasing the productivity of the soil used and the production of patchouli varieties. According to Fikrinda et al (2019) and Syafruddin (2017), generally the mycorrhizal genus *Glomus mosseae* can be used on soils with neutral pH, while the genus *Gigaspora* sp is generally used for soils with acidic pH (<6). Mycorrhizal biofertilizers used in several plants prove that plant production increases due to the increase in nutrient absorption, especially P and external hyphae in mycorrhizae, which also helps the maximum absorption of water (Syafruddin et al, 2016; Syafruddin, 2017; Doudd et al, 2010).

In addition to mycorrhizal biological fertilizers, the use of varieties also greatly determines the increase in patchouli production. Several varieties of patchouli that are very well known in Aceh or Indonesia are the Tapak Tuan variety, the Lhokseumawe variety and the Sidikalang variety. Especially the Tapak Tuan variety is most widely used by the people of South Aceh on Ultisol soil, as well as the Lhokseumawe variety, which is mostly cultivated on Ultisol soil in Lhokseumawe. There is no complete information about how the two varieties and their yield levels are cultivated on Andisols. In general, the Lhokseumawe variety has a high oil yield compared to the Tapak Tuan variety when cultivated on Ultisol soil (Syafruddin et al, 2000). Meanwhile, the information on the production and quality of patchouli oil for the two varieties is unknown if cultivated on Andisol soil.

Based on the description above, it is necessary to study the effectiveness of using mycorrhizal biological fertilizers from various genus and the use of several varieties of patchouli cultivated on Andisol soil.

RESEARCH METHODS

Soil Preparation for Research

The land used in this study is the Andisol order from Burni Telong, Bener Meriah. The soil pH content is 6.5 and the texture of clay dusty. Soil is taken in the top soil and dried. After drying, the soil was sieved with 16 mesh sieves. Then the soil is put into a pot with the contents of 12 kg.

Planting Seeds and Giving Mycorrhizae

Planting seeds and giving 10 g of mycorrhizal bio-fertilizers from strains *Glomus mosseae*, *Gigaspora* sp. and the mixture between of *Glomus mosseae*, *Gigaspora* sp. was given to each seed that was 1 month old after transplanting. The patchouli seeds used must be uniform with the same criteria for seedling height and number of leaves.

Giving of Basic Fertilizer

The basic fertilizer given is NPK fertilizer which is dissolved at the beginning of planting at a dose of 25 percent of the recommended dose (150 kg / ha). NPK fertilizer was given at planting time, on the 30^{th} and 45th day after planting.

Plant Cultivation

The plants are watered daily with a water volume of 270 ml per pot. If the plant is attacked by pest and disease, it is controlled with organic pesticides with a concentration of 14 cc per liter of water. Types of organic pesticides used by Glio Nasa.

Observed parameters

The parameters observed were plant height, stem diameter, number of leaves and number of branches at the age of 90 days after planting (DAP). Whereas for root colonization by mycorrhizae and uptake of P_2O_5 were observed at 45 days after planting (DAP). The patchouli oil content is taken from oil refineries which are harvested at the age of 90 days after planting (DAP). Examination of root colonization by mycorrhizae is carried out by methods from Kormanik and Graw (2002) and Langer et al (2010).

DATA ANALYSIS

Data analysis was carried out with ANOVA and if there were significant differences in the results of the treatment, then tested by using the HSD 0.05 further test.

RESULTS AND DISCUSSION

Effect of the type of mycorrhizal biofertilizer on production, root colonization, P uptake and oil content

The average value of production parameters, colonization and soil P uptake by patchouli due to mycorrhizal type treatment after being tested with HSD 0.05 available in Table 1.

Table 1. "Average of growth, yield, root colonization, P_2O_5 absorption and oil content of patchouli due to types of mycorrhizal bio-fertilizer treatmen".

Parameters	Mycorrhizal Types			HSD $_{0.05}$
	Glomus mosseae	*Gigaspora* sp.	*Glomus mosseae + Gigaspora sp.*	
Plant Height 90 DAP	61.82 a	66.90 ab	74.60 b	9.87
Stem Diameter 90 DAP	8.99 ab	8.64 a	9.29 b	0.46
Number of Branches	59.50	59.17	60.17	-
Number of Leaves	265.67 b	260.75 a	282.92 c	2.08
Uptake of P_2O_5	44.17 a	46.17 b	47.00 b	1.52
Root Colonization (%)	73.33	80.00	86.67	-
Oil Content (%)	2.89 b	2.60 a	3.55 c	0.13

Note: Numbers followed by the same letter in the same column are not significantly different at the 0.05 level (HSD Test)

Table 1 shows that the highest patchouli plant height was found in the treatment of mixed mycorrhizal types which were significantly different from *Glomus mosseae,* but not significantly different from treatment of *Gigaspora* sp. Then for larger stem diameter found in mixed mycorrhizal types compared to other treatments. Furthermore, the highest number of leaves was also found in the treatment of mixed mycorrhizal types which were significantly different from other treatments. In the parameters of the number of branches, the highest P2O5 uptake and root colonization (%) were also found in mixed mycorrhizal types. The highest oil content parameters were found in mixed mycorrhizal types which were significantly different from other mycorrhizal treatments.

Several parameters show that mixed mycorrhizal strains give the highest yield on several growth and yield parameters, this is in line with the research of Syafruddin et al (2020b) and Nurmasyitah et al (2013) where mixed mycorrhizal strains give the best results because they have advantages in helping the process absorption of P and N as well as absorption of water by plants in Andisol soil.

The results of nutrient uptake studies were also reported by Kabirun (2002), Hasanudin (2003), and Musfal (2010), namely that AMF can increase nitrogen (N) and potassium (K) uptake. Giving AMF to legumes can increase the uptake of Cu and Zn micro elements. Adequate water and nutrient absorption by plants lead to better plant growth, which is indicated by optimal plant height growth (Sastrahidayat, 2011)

AMF also plays a role in stimulating the formation of plant growth hormones, such as cytokinins and auxins. These cytokinin and auxin hormones play a role in cell division and elongation, causing an increase in plant height (Talanca, 2010). Good root growth due to AMF inoculation can increase crown growth through coffee plant height, stem diameter, and number of leaves. Yildiz (2010) stated that the crown growth of cucumber and tomato plants given AMF was better than those not given AMF. Plants given AMF have better roots, because the hyphae outside the roots help the absorption of nutrients, especially P elements and water needed by plants for growth.

In addition, mixed strains of mycorrhizae can live in various pH range conditions ranging from neutral to alkaline (Fikrinda et al, 2020). The ability of mycorrhizae to survive in slightly acidic soil causes its role as a bio-fertilizer and helps the absorption of nutrients to be carried out properly. Research by Syafruddin et al (2020b) proved that the mycorrhizae used in more than strains gave satisfactory results for both patchouli and chili growth. The same thing was also found by Arpana et al (2014) and Arpana et al (2008) that the administration of mycorrhizae from mixed strains combined with rhizobacteria can stimulate the growth, yield and quality of patchouli oil.

Effect of varieties on patchouli production, root colonization, and P uptake and oil content

The average value of production parameters, colonization and soil P uptake by patchouli due to mycorrhizal type treatment after being tested with HSD 0.05 available in Table 2.

Table 2. "Average of growth, yield, root colonization, P2O5 absorption and oil content of patchouli due to varieties of patchouli treatment"

Parameters	Varieties of Patchouli		HSD $_{0.05}$
	Tapak Tuan	Lhokseumawe	
Plant Height 90 DAP	69.03	66.51	-
Stem Diameter 90 DAP	9.25 b	8.76 a	0.45
Number of Branches	60.22 b	59.00 a	1.19
Number of Leaves	270.28	269.28	-
Uptake of P_2O_5	45.67	45.56	-
Root Colonization (%)	77.78	75.56	-
Oil Content (%)	3.11 b	2.92 a	0.13

Note: Numbers followed by the same letter in the same column are not significantly different at the 0.05 level (HSD Test)

Table 2 shows that the plant height was higher in the Tapak Tuan variety compared to the Lhokseumawe variety. This can also be seen from other parameters such as stem diameter, number of leaves, P_2O_5 uptake and mycorrhizal colonization. Furthermore, the highest number of branches was also found in the Tapak Tuan variety compared to the Lhokseumawe variety. Then the highest patchouli oil content was also found in the Tapak Tuan variety, which was significantly different from the Lhokseumawe variety.

The study by Syafruddin et al. (2000) proved that the varieties used were critical to the growth, yield and content of patchouli oil. In their findings, Syafruddin et al. (2000) proved that the content of patchouli oil and patchouli alcohol was higher in the Aceh patchouli variety, namely Tapak Tuan, which was cultivated on the soil of various soil orders. This is reinforced by research by Keusumaninggrum et al (2016) which proves that the Tapak Tuan variety of Aceh patchouli has a higher oil and patchouli alcohol content compared to Javanese variety of patchouli.

In 2005 the Indonesian Spice and Medicinal Crops Research Institute released three superior varieties of patchouli, namely Tapak Tuan, Sidikalang and Lhokseumawe, which have their respective advantages in productivity and oil yield (Haryudin, 2014). The oil yield of patchouli is generally produced from the leaves and stems, which then produce biomass for the refining process. Dry biomass production from 3 superior varieties of patchouli that have been released respectively, namely Sidikalang 10.90 tonnes ha^{-1}, Tapak Tuan 13.29 tonnes ha^{-1} and Lhoksumawe 11.09 tonnes ha^{-1} (Haryudin, 2011). This is linear with the results of this study, the plant height, stem diameter, number of branches, and number of leaves of the Tapak Tuan patchouli were higher than the Lhokseumawe varieties.

The research of Nuryani (2004) proved that the Tapak Tuan variety patchouli was superior in the production and content of patchouli alcohol compared to the other 2 varieties; with the respective levels of patchouli alcohol, namely: Tapak Tuan (28.69-35.90%), Lhokseumawe (29.11-34.46%) and Sidikalang (30.21-35.20%). The use of soil types that are fertile, loose, rich in humus and organic materials such as Andisol soil can support the growth of patchouli, especially in producing oil content and patchouli alcohol. Patchouli oil and alcohol content produced by patchouli is also inseparable from genetic control factors of patchouli plants. It has been studied in Wang et al. (2019) which proves that the oil and patchouli alcohol content of patchouli plants are influenced by the biosynthesis of *Methyl Jasmonate* (MeJA) signal receptors in producing secondary metabolite products from patchouli plants.

CONCLUSION

The best production and P uptake of oil content in patchouli was obtained from the use of mixed mycorrhizal types of *Glomus mosseae* and *Gigaspora* sp. on Andisol soil. However, the use of mixed mycorrhizal did not affect the number of patchouli branches and the percentage of root colonization produced. Furthermore, from the use of varieties it can be concluded that the use of the Tapak Tuan variety is far better than the Lhokseumawe variety when viewed from the parameters of stem diameter and number of branches at 90 DAP and the resulting patchouli oil content.

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