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# PRODUCTION OF OIL PALM (*Elaeis guineensis* Jack) FLOWER BUNCHES IN ULTISOL ON APPLICATION OF BIOFERTILIZERS AND IN ORGANIC FERTILIZERS

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## *ABSTRACT*

*One of the efforts to increase the production of oil palm flower bunches in ultisols is applying biofertilizers and inorganic fertilizers. Biofertilizers can reduce the use and adverse effects of inorganic fertilizers. Arbuscular Mycorrhizal Fungi (AMF) is one of the biofertilizers that can help plants absorb nutrients and increase plant resistance to various environmental stresses. This study aimed to examine the role of AMF (as biofertilizer) and inorganic fertilizers in increasing the production of oil palm flower bunches in Ultisol. This experiment is a factorial experiment using a Randomized Block Design. The first factor is the application of biofertilizers, which consists of two levels without biofertilizers (AMF) and with biofertilizers (AMF). The second factor is the dose of inorganic fertilizer, composed of 5 levels, no inorganic fertilizer, 25, 50, 75, and 100% recommended doses of inorganic fertilizer. The variables observed were the number of sheaths, the percentage of broken sheaths, the number of male flower bunches, the number of female flower bunches, the percentage of male and female flower bunches, sex ratio per plant, and AMF colonization. The results showed that AMF biofertilizer saved 25% of inorganic fertilizers and increased 29.33% of female flowers production. The highest production of oil palm flower bunches was obtained from the application of AMF biofertilizer and 75% of inorganic fertilizers (1.5 kg Urea, 1.1 kg SP-36, 1.2 kg MOP, 0.7 kg Kisserite per plant). Oil palm with AMF had a higher average sex ratio than plants without AMF biofertilizers. The average sex ratio in oil palm plants applying AMF biofertilizer and inorganic fertilizers ranged from 0.42 to 0.73.*

***Keywords: Arbuscular Mycorrhizal Fungi, sex ratio, sheath, AMF colonization***

## INTRODUCTION

Oil Palm is one of the plantation commodities that produce vegetable oil and is the largest foreign exchange earner for Indonesia's exports. In 2016 the volume of oil palm exports was 24,336,303 and in 2019 the volume increased to 30,232,555 (Directorate General of Plantations, 2020). In Jambi Province, oil palm is the only plantation commodity, and its development is relatively rapid. Data from the Director-General of Plantations (2020) informs that the area of oil palm plantations in Jambi Province is increasing yearly. In 2018 the area of oil palm plantations in Jambi Province was 1,032,145 Ha, with a production of 2,691,270 tons. In 2019, oil palm plantations reached 1,070,723 Ha, with a production of 2,891,336 tons. In 2020, the area of oil palm plantations reached 1,086,623 Ha, with the production of 3,096,621 tons.

Oil palm cultivation in Jambi Province is generally carried out on ultisol land because the area of ultisol land reaches 2,272,725 Ha or 42.53% of the total area of Jambi Province (BPN Jambi Province, 2011). Problems often faced in exploiting oil palm on ultisol land in Jambi Province, especially in smallholder plantations, are low production and productivity. In 2020, the productivity of oil palm in Jambi Province was 2.85 tons $Ha^{-1}$, much lower than the national productivity of 3.25 tons $Ha^{-1}$ (Directorate General of Plantations, 2020). This is because Ultisol is soil with low physical, chemical, and biological properties.

Oil palm productivity is closely related to flowering, pollination, and fertilization. Oil palm productivity is determined by the sex ratio, the ratio between the number of female flowers and the total number of flowers at a specific time (Harahap *et al.*, 2017). Therefore, increasing the number of flower bunches that can develop into fruit bunches will directly increase oil palm production and productivity. The process of flowering, pollination, and fruiting of oil palms is strongly influenced by two main factors: genetics and the environment. Soil fertility is one of the environmental factors that will affect the physiological process of oil palm plants.

According to Sidhu *et al*. (2009), conditions of nutrient deficiency in plants will affect the number and quality of male and female flower bunches of oil palm. Likewise, Harahap *et al*. (2017) stated that genetic and environmental factors strongly influence flower formation in oil palm plants

Considering that ultisol is land that has low fertility, it is necessary to increase the number of oil palm flower bunches by adding nutrients through fertilization. Generally, oil palm plants are fertilized with inorganic fertilizers. If inorganic fertilizers are used continuously, the soil conditions will be damaged and cause the soil to become harder, which in turn will interfere with growth and reduce crop production. According to Kasryno & Haryono (2012), the intensive use of inorganic fertilizers will cause soil degradation and environmental pollution and reduce plant productivity. Furthermore, Blanco-Canqui & Schlegel (2013) also stated that inorganic fertilizers, if used in the long term, can harden the soil and reduce the stability of soil aggregates. Therefore, one solution to overcome the adverse effects of inorganic fertilizers is to minimize the use of

inorganic fertilizers through the use of biofertilizers.

Using biofertilizers and inorganic fertilizers is one of the technologies that should be developed. Biofertilizers, often called microbial fertilizers, are live microbes that function as inoculants that can increase the availability of nutrients for plant growth (Simanungkalit, 2001).

One of the biofertilizers is Arbuscular Mycorrhizal Fungi (AMF), which can increase plant growth and production and tolerance to various environmental stresses. Previous studies have proven that in the presence of AMF, the absorption of nutrients by plants, especially phosphate, can be increased (Suparno *et al*., 2015; Cely *et al*., 2016; Revanna *et al*., 2018**;** Kartika *et al*., 2018), the occurrence of increased plant resistance to abiotic stress (Latef *et al.*, 2016; Santander *et al*., 2017; Haque & Matsubara, 2018; Evelin *et al.*, 2019); an increase in plant resistance to heavy metal stress (Bano & Ashfaq, 2013; Emamverdian *et al*., 2015; Gong & Tian, 2019); an increase in plant resistance to biotic stresses such as root pathogen attacks (Smith *et al*., 2010), able to control oil palm rot disease (Rini, 2001), and able to increase the competitiveness of coffee plants against weed disturbances (França *et al*., 2016).

Many studies on the role of AMF on oil palm plant growth have been carried out, such as the results of research by Phosri *et al.* (2010), Al-Karaki (2013), Kartika *et al*. (2016), Kartika *et al*., (2019), and Suryanto & Panjaitan (2021). The role of AMF as a biofertilizer on the flowering of oil palm plants has not been reported. Therefore, it is necessary to research how AMF affects the flowering of oil palm plants.

This study aimed to examine the role of AMF and inorganic fertilizers in increasing the production of oil palm flower bunches in Ultisol land.

## MATERIALS AND METHODS

This research was carried out on ultisol land in Semabu Village, Tebo Tengah District, Tebo Regency, Jambi Province, with coordinates 1.448038, 102.466714 from April to October 2020.

### Experimental Design

The experimental design used in this study was two-factor of Factorial Randomized Block Design with three replications. The first factor is the application of biofertilizers (indigenous AMF inoculation), which consists of two levels, without and with AMF. The second factor is the dose of inorganic fertilizer, which consists of 5 levels: no inorganic fertilizer, 25, 50, 75, and 100% recommended doses. There were 30 experimental units, and each experimental unit consisted of 4 plants, so the plants needed were 120 plants.

### The Stage of Experiment

### Land Clearing for Palm Oil Plantations

This research is follow-up research of Kartika *et al.* (2016) on oil palm plantations that are five years old. The land is planted with the 5-year-old oil palm and is clear of weeds. The plant has a spacing of 9 m x 9 m x 9 m with an equivalent triangle shape. The type of oil palm plant is the D x P (Tenera) variety.

**Arbuscular Mycorrhizal Fungi (AMF) Inoculation**

Isolates of indigenous mycorrhizal origin from marginal land (ultisol soils from ex-coal mines soil) obtained from Tebo Regency (Kartika *et al*., 2012) is *Glomus-sp. 16* used as inoculum. Isolates of AMF apply to oil palm seedlings three months before transplanting to the field (2014), with a 10 g per seedling dose.

**Fertilization**

Inorganic fertilizers in the form of Urea, SP-36, MOP, and Kiserrit apply in doses according to the recommendations for oil palm plants aged 3-8 years, Urea 2 Kg, SP-36 1.5 Kg, MOP 1.5 Kg, and Kiserrit 1 Kg per plant (PPKS, 2009). Fertilization applies using a stocking system, where the fertilizer applies on a disc at a distance of 1-3 meters. Urea, MOP, and Kisserit fertilizers apply twice after land clearing activities for oil palm plantations and four months after the first fertilization, while SP-36 fertilizers apply once after land clearing activities for oil palm plantations.

**UPKEEP**

Upkeep includes weeding, eradicating pests and diseases, and trimming the fronds. Pruning of fronds conduct after harvest, and the number of fronds is upkeep at 28-54 strands per plant. Trimming the fronds is done as short as possible so that fruit harvesting is not disturbed.

**OBSERVATION**

Observations conduct at six months on the number of sheaths, the percentage of broken sheaths, the number of male and female flower bunches, the percentage of male and female bunches, and the sex ratio per plant, as well as AMF colonization.

AMF root colonization was observed in the sample plant roots using the root staining technique of Kormanik & McGraw (1982), namely (1) Fresh roots were selected and washed with running water until clean. (2) Root samples were immersed in 10% KOH solution until the roots became clear. (3) The KOH solution is discarded, and the root samples wash with running water for 5-10 minutes. (4) Root samples were immersed in 5% HCl solution for 30 minutes. then the solution is removed by flowing it slowly. (5) Root samples were immersed in a staining solution (Trypan blue 0.05%) and heated on a heating plate for 10 minutes. (6) Trypan blue solution is discarded and replaced with Lacto glycerol solution for the destaining process. Next, the root sample is ready to be observed.

The percentage of root colonization calculate using the slide length method (slide length) from Giovanetti and Mosse (1980). At random, ten pieces of root with color were taken with a size of ± 1 cm and arranged in slide preparations. Root colonization is characterized by the presence of hyphae. vesicles. arbuscular or one of the three. Each field of view of the microscope shows signs of colonization, giving a symbol (+) and which is not (-). The number of fields of view observed is ten pieces per one root piece. The percentage of root colonization calculate using the formula:

$$\% \text{ colonization} = \frac{\Sigma \text{ field of view (+)}}{\Sigma \text{ field of view}} \times 100\ \%$$

**Data Analysis**

Observational data from all variables were statistically analyzed using the analysis of

variance, and if the results had a significant effect, continued with Duncan's test at level = 5%.

## RESULTS AND DISCUSSION

### Number of Sheaths per Plant per 6 Months

The statistical analysis showed no interaction between AMF biofertilizers and inorganic fertilizers on the number of oil palm sheaths, and the single factor did not show a significant effect. It indicates that differences may more influence the process of formation of the sheath in climatic conditions such as temperature, humidity, rainfall, and duration of irradiation than soil fertility conditions. According to Noferta *et al*. (2018), the formation and growth of the sheath a strongly influenced by internal factors, namely the genetics of the oil palm plant itself, and external factors, namely environmental factors such as temperature, humidity, rainfall, duration of irradiation and others. Furthermore, Harahap *et al*., (2017) explained that drought conditions due to a prolonged dry season would affect the flowering process of oil palm.

Table 1 shows that the number of sheaths of oil palm plants per plant for six months without AMF ranged from 9 to 11, while the plants with AMF ranged from 9.92 to 11.33. The amount if converted per year ranges from 18 to 22.66 pieces. The research results by Harahap *et al*., (2017) show that the number of oil palm flower bunches is around 24-25 bunches per plant per year, where the ratio between the number of female flower bunches and male flower bunches is different every year.

### Percentage of Broken Sheaths per Plant per 6 Months

The results showed that oil palm plants without AMF had the highest average percentage of broken sheath per plant for six months on the application of inorganic fertilizers at a dose of 100%, whereas in plants with AMF, it was achieved at the application of 50 and 75% inorganic fertilizer although it did not differ from the 25% inorganic fertilizer treatment (Table 2). This indicates that the application of AMF can reduce 25% to 50% of inorganic fertilizers. The application of AMF increased the number of high sheath ruptures at lower doses of inorganic fertilizers than those without AMF. Furthermore, it showed at various doses of inorganic fertilizers, plants without AMF had a lower percentage of broken sheath per bunch than plants treated with AMF, except for the application of 100% inorganic fertilizer. The number of sheaths per plant that is formed does not all grow, develop and break, but some do not develop (rot). With the increase in the percentage of damaged sheaths, the number of flower bunches (both male and female) will increase, so the number of fruit bunches is expected to increase.

**Table 1** The average number of oil palm sheaths per plant per 6 months on ultisol land in the treatment of AMF and inorganic fertilizers

| Treatment | Dosage of inorganic fertilizer (% recommendation) | | | | |
|---|---|---|---|---|---|
| | 0 | 25 | 50 | 75 | 100 |
| Without of FMA | 9.00 | 10.08 | 10.25 | 10.25 | 11.00 |
| With FMA | 9.92 | 10.25 | 10.25 | 11.33 | 10.33 |

**Table 2** The average percentage of a broken sheath of oil palm per plant per 6 months on ultisol land in the treatment of AMF and inorganic fertilizers

| Treatment | Dosage of inorganic fertilizer (% recommendation) | | | | |
|---|---|---|---|---|---|
| | 0 | 25 | 50 | 75 | 100 |
| Without FMA | 66.67 c<br>B | 69.44 c<br>B | 74.15 c<br>B | 78.05 b<br>B | 86.36 a<br>A |
| With FMA | 78.13 b<br>A | 82.93 ab<br>A | 90.24 a<br>A | 90.47 a<br>A | 84.70 ab<br>A |

Note: Numbers followed by lowercase letters according to row and capital letters according to the same column are not significantly different at the 5% level of the Duncan test (DMRT)

Table 2 indicates that in the treatment 0, 25, 50, and 75% recommendation of inorganic fertilizers if each treatment was added with AMF was able to increase sheath rupture respectively by 14.67, 16.27, 17.83, and 13.72 percent. In comparison, the addition of 100% recommended inorganic fertilizer, when added AMF decreased by 1.92%.

These results indicate that AMF can help the growth of oil palm plants and streamline the absorption of nutrients. With the AMF, the absorption of water and nutrients can increase because AMF forms a network of hyphae that will intensively help absorb water and nutrients. AMF can increase nutrient uptake, especially phosphate (Ortas & Akpinar, 2011; Bhattacharjee & Sharma, 2012; Watts-Williams *et al*., 2014), increasing plant resistance to drought stress kekeringan (Zhu *et al*., 2012; Zou *et al.*, 2013), heavy metal stress (Krishnamoorthy *et al*., 2015) and biotic stress, such as root pathogen attack (Sylvia & Chellemi, 2001), and controlling stem rot disease of oil palm trunks (Simanjuntak *et al.*, 2013).

In addition, with the presence of AMF, soil structure can improve (Leifheit *et al*., 2014). It can affect plant growth because AMF can produce growth-regulating substances such as auxins, cytokinins, and gibberellins, which plants need to stimulate the process of cell division, growth, and development of plants and the aging process. Augé (2001).

## Number of Oil Palm Male Flower Bunches per Plant per 6 Months

Table 3 shows that the number of male flower bunches formed will increase if the plants are not fertilized with inorganic fertilizers or the dosage is less, both on plants that are given AMF or not. The lack of availability of nutrients in the soil causes

**Table 3** The average number of oil palm male flower bunches per plant per year on ultisol land in the treatment of AMF and inorganic fertilizers

| Treatment | Dosage of inorganic fertilizer (% recommendation) | | | | |
|---|---|---|---|---|---|
| | 0 | 25 | 50 | 75 | 100 |
| Without FMA | 3.50 a<br>A | 3.20 a<br>A | 3.10 ab<br>A | 2.70 b<br>A | 3.00 ab<br>A |
| With FMA | 3.42 a<br>A | 3.00 bc<br>A | 3.25 ab<br>A | 2.75 c<br>A | 2.75 c<br>B |

Note: Numbers followed by lowercase letters according to row and capital letters according to the same column are not significantly different at the 5% level of the Duncan test (DMRT)

the formation of more male flower bunches than the number of female flower bunches.

In the application of inorganic fertilizer doses of 0 to 75%, the number of male flower bunches indicates no significant difference between without and with AMF. Still, at a dose of 100% inorganic fertilizers, the plants with AMF had fewer male flower bunches than those without AMF. The low of male flower bunches will increase the sex ratio so that the chances of forming fruit bunches are greater, consequently increasing oil palm production.

Khryanin (2002) research indicates that the presence of cytokinin and gibberellin hormones in plants greatly determines the formation of sex, where the work of these two hormones is also highly dependent on soil moisture conditions and the availability of nutrients, especially N, P, and K elements. The availability of nutrients, especially the elements of N, P and K as well as sufficient soil moisture conditions (80% - 90%), will increase the hormone cytokinin, stimulating female flowers formation. On the other hand, in relatively dry soil conditions, the hormone gibberellin will be induced, which stimulates the formation of male flowers.

**Number of Oil Palm Female Flower Bunches per Plant per 6 Months**

The highest number of female flower bunches per plant for six months was in oil palm plants without AMF, obtained in the treatment of 100% inorganic fertilizer and significantly different from other treatments. Meanwhile, in oil palm plants with AMF, the highest number of female flower bunches for six months was obtained with 75% inorganic fertilizer (Table 4). This means that AMF can reduce the use of 25% inorganic fertilizer with an increase in the number of female flower bunches by 29.33%. AMF can reduce the use of inorganic fertilizers because AMF can help increase the availability of nutrients, especially P. In ultisol land, inorganic fertilizers, especially P, will be bound mainly by Fe so that it becomes unavailable to plants. AMF produces phosphatase enzymes which can help the mineralization process of elements, and these nutrients release P nutrients bound by Fe to become available to plants.

Furthermore, oil palm plants will thrive with the availability of nutrients and assisted absorption by AMF hyphae. Adequate nutrition and hormone will stimulate female flower development and increase the number

**Table 4** The average number of oil palm female flower bunches per plant for six months on ultisol land in the treatment of AMF and inorganic fertilizers

| Treatment | Dosage of inorganic fertilizer (% recommendation) | | | | |
|---|---|---|---|---|---|
| | 0 | 25 | 50 | 75 | 100 |
| Without FMA | 2.50 d<br>B | 3.80 c<br>B | 4.50 bc<br>B | 5.30 b<br>B | 6.50 a<br>A |
| With FMA | 4.33 c<br>A | 5.50 b<br>A | 6.00 b<br>A | 7.50 a<br>A | 6.00 b<br>A |

Note: Numbers followed by lowercase letters according to row and capital letters according to the same column are not significantly different at the 5% level of the Duncan test (DMRT)

of fruit. Hindersah *et al*., (2021) stated that applying biofertilizers can reduce the dose of inorganic NPK fertilizers and increase the residual P available in the soil for other crops. Susanto *et al.*, (2020) reported the results of their research that nutritional conditions during the fruit development process will determine the number of oil palm fruit bunches, where the process of flowering stimulates the formation of the number of fruit bunches, fruiting, and development through optimization of the land. According to Corley & Tinker (2016), several factors that affect oil palm productivity are plant genetics, plant age, land fertility, and climate. Furthermore, Corley & Tinker (2016) also stated that a lack of nutrients would reduce female flower bunches production and decrease oil palm productivity.

Furthermore, in various applications of various doses of inorganic fertilizers, plants without AMF had a lower number of female flower bunches for six months than plants with AMF, except for the application of 100% inorganic fertilizer. AMF in marginal land conditions such as ultisols can provide nutrients, especially P, and its hyphae can expand the field of nutrient absorption. Allen *et al*. (1992) described that the mycorrhizal structure in plant roots could increase the area for metabolic exchange between the host plant and mycorrhizae. Furthermore, Allen *et al*. (1992) also stated that AMF also produces phosphatase enzymes so that they can absorb organic phosphate and convert it to inorganic P. The formation of phosphatase enzymes by AMF and plants will stimulate phosphatase activity on the root surface so that inorganic phosphate can be released from organic phosphate and is ready to be absorbed by plants through nutrient uptake mechanisms.

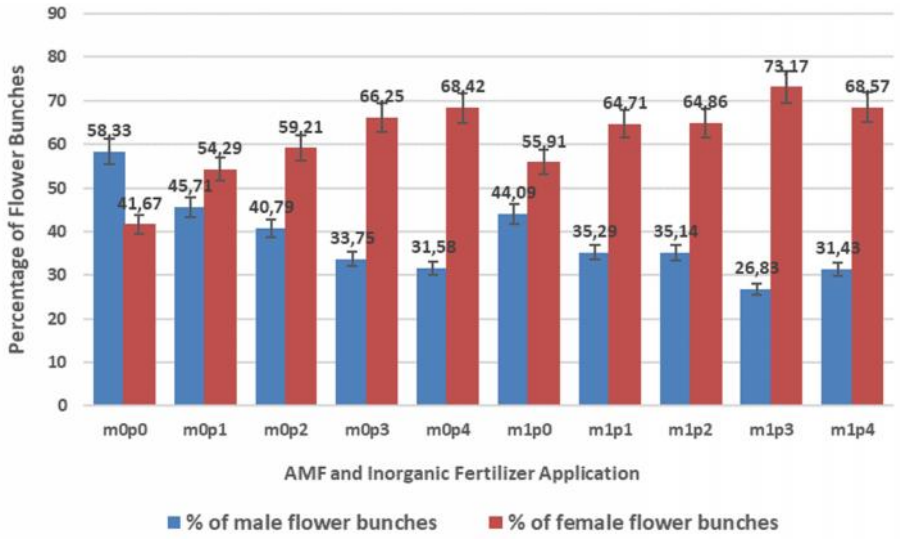
**Percentage of Oil Palm Male and Female Flower Bunches per Plant per 6 Months**

The average percentage of male flower bunches decreased with increasing doses of inorganic fertilizers for both plants treated with AMF or not. Meanwhile, the rate of female flower bunches continued to grow in line with the increase in the dose of inorganic fertilizers (Figure 1). Oil palm plants without AMF had the percentage of male flower bunches ranging from 31.58% to 58.33%, while female flower bunches ranged from 41.67% to 68.42%. In plants with AMF, male flower bunches ranged from 26.83% to 44.09%, while female bunches ranged from 55.91% to 73.17%.

The number of female flower bunches of oil palm increased higher than the number of male flowers in plants with AMF. It was due to the role of AMF, especially in Phosphor uptake. Baon (1999), explained if root is restricted, external hyphae of AMF will reach a distance of more than 10 cm from the root surface to find and take P. The presence of the P element functions as a storage and energy transfer for all plant metabolic activities, stimulating plants to form flowers and increasing the percentage of flower formation into fruit.

**Sex Ratio**

The results in Table 5 show that the average sex ratio of 5-year-old oil palm plants in applying biofertilizers and inorganic fertilizers ranged from 0.42 to 0.73. The sex ratio increased with increasing doses of inorganic fertilization both on and without




Description: m0p0 (Without biofertilizers and without inorganic fertilizers); m0p1 (Without biofertilizers and 25% inorganic fertilizers); m0p2 (Without biofertilizers and 50% inorganic fertilizers); m0p3 (Without biofertilizers and 75% inorganic fertilizers); m0p4 (Without biofertilizers and 100% inorganic fertilizers); m1p0 (Application of biofertilizers and without inorganic fertilizers); m1p1 (Application of biofertilizers and 25% inorganic fertilizers); m1p2 (Application of biofertilizers and 50% inorganic fertilizers); m1p3 (Application of biofertilizers and 75% inorganic fertilizers); m1p4 (Application of biofertilizers and 100% inorganic fertilizers)

**Figure 1** Percentage of oil palm male and female flower bunches in various combinations of AMF and inorganic fertilizer applications

**Table 5** Average of oil palm sex ratio per plant for six months on ultisol land in the treatment of AMF and inorganic fertilizers

| Treatment | Dosage of inorganic fertilizer (% recommendation) | | | | |
|---|---|---|---|---|---|
| | 0 | 25 | 50 | 75 | 100 |
| Without FMA | 0.42 d<br>B | 0.54 c<br>B | 0.59 b<br>B | 0.66 a<br>B | 0.68 a<br>A |
| With FMA | 0.56 c<br>A | 0.65 b<br>A | 0.65 b<br>A | 0.73 a<br>A | 0.69 ab<br>A |

Note: Numbers followed by lowercase letters according to row and capital letters according to the same column are not significantly different at the 5% level of the Duncan test (DMRT)

AMF application, and plants with AMF had a higher average sex ratio than plants without AMF. According to Harahap *et al*., 2017), producing female flower bunches that develop into oil palm fruit bunches is very important because it will determine oil palm production. Therefore, it is crucial to pay attention to the ratio of female flowers to the total number of flower bunches (sex ratio). Sitepu & Yenni (2021) showed the sex ratio in oil palms aged four years for several varieties ranged from 0.94 to 0.99, and in oil palms aged eight years varied from 0.53 to 0.73. It means that the sex ratio of oil palm plantations has decreased in line with the increasing age of the plant.

Oil palm with AMF increases the average sex ratio because AMF assists in the absorption of nutrients. With the development of oil palm plants, there will be an increase in the percent sex ratio. The results of Susanto *et al*., (2020)

research indicate that AMF will improve the nutritional conditions of oil palm plants to stimulate the flowering, fruiting, and development processes, especially in land optimization.

**AMF Colonization**

Table 6 shows that the plants with AMF were completely infected. While plants without AMF are slightly infected, there is a possibility of infection in the field, and this is because there are also AMF capable of infecting plants in the area. In contrast, in plants with AMF, the infection had occurred since AMF was given when it was still in the seedling phase, so it was infected when planted in the field.

AMF is a biofertilizer that can increase plant growth, production, and productivity, especially on marginal lands, which is caused by an increase in water and nutrient uptake due to AMF colonization in plant roots. The increase in water and nutrient absorption caused by AMF colonization is closely related to plant physiological processes, namely an improvement in hydraulic conductivity, an increase in leaf water potential, and an increase in the rate of water absorption per unit root length and per unit time (Kothari *et al*., 1990). The results of this study are relevant to several studies which concluded that the growth, yield, and uptake of macronutrients and some micronutrients by plants were due to the role of AMF (Dave *et al*., 2011; Bhattacharjee & Sharma, 2012; Watts-Williams *et al.*, 2014; Lu *et al*., 2015; Binu *et al*., 2015). Suhardi & Sumardi (1999) stated that the increase in nutrient uptake due to AMF colonization decreased the distance that nutrients reach the plant root surface. An increase in the average nutrient absorption and concentration in the nutrient uptake area and the occurrence of chemical changes in the properties of chemical nutrients, so that plant roots quickly absorb them.

## CONCLUSION

The interaction between the AMF and inorganic fertilizers increased the production of oil palm flower bunches on ultisol lands. AMF can save 25% on inorganic fertilizers and increase female flowers by 29.33%. The highest production of flower bunches at AMF and 75% inorganic fertilizers. Oil palm plants with AMF had a higher average sex ratio than plants without AMF. The average sex ratio in the application of AMF and inorganic fertilizers ranged from 0.42 to 0.73.

**Table 6** Average of AMF colonization on oil palm roots (%) in ultisol in the treatment of AMF and inorganic fertilizers

| Treatment | Dosage of inorganic fertilizer (% recommendation) | | | | |
|---|---|---|---|---|---|
| | 0 | 25 | 50 | 75 | 100 |
| With FMA | 1.33 a B | 1.33 a B | 1.67 a B | 2.33 a B | 1.67 a B |
| Without FMA | 100 a A | 100 a A | 100 a A | 100 a A | 100 a A |

Note: Numbers followed by lowercase letters according to row and capital letters according to the same column are not significantly different at the 5% level of the Duncan test (DMRT)

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