The Growth of Agarwood Plants on the Different Canopy Covers Level and Fertilizer in Oil Palm Plantation

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Abstract. The development of agar wood plants in oil palm plantation requires the forestry techniques in order to obtain maximum production. In an oil palm stands, the age of plant will affect the height, diameter, population and stands density. The older age of an oil palm stands will affect the canopy cover on the forest floor. Agar wood plants are semi-tolerant growth and oil palm can be used as shade. Unilak has an oil palm plantation area of 10 hectares around the campus with 10 years old and 20 years old. The soil condition at the study is Podsolik Merah Kuning (PMK) which poor nutrient and needs fertilization to increase soil fertility. This study aims to find out the effect of age of oil palm stands and fertilization for optimal growth. The split plot design with 2 main plots of the age of palm tree ( 10 years old and 20 years old) and five kinds of fertilizing sub plot (without fertilizer, 40 gram/plant of NPK, 80 gram/plat of NPK, 120 gram/plant of NPK and 180 gram/plant of NPK were used. The results of this research showed that the age of palm tree (canopy cover) treatment gave non-significant influence on the growing of agar wood until it reaches 4 months of growth. The canopyy cover by 10 years old of oil palm tree produce the best response on height (15 cm) and diameter (0,4 cm) growth of agar woods..Fertilizing treatment did not give any significant influence on the heigh and diameter growth of agarwood plants until reach 3 months. The interaction by 10 years old of palm with fertilizing gave non significant results.

Keywords: Agar wood plants, palm oil, canopy cover, fertilizer

1. Introduction
A Unilak oil palm stand has the potential to be developed with agroforestry system that will plant with crops of gaharu-plants. The oil palm planted spread in several locations. Oil Palm stands near the UPT Agriculture, beside of Faculty of Administration, around the arboretum of forestry faculty and along the main road Lancang Kuning University. The total area is ± 10 ha. Based on the condition, oil palm planted in Lancang Kuning University has different stands age. 20-year-olds oil palm stands around the UPT Agriculture, while 11 years old beside of Faculty of Administration and around the arboretum of forestry faculty and along the main road Lancang Kuning University. The older palm oil plants have few densities and affect the size of the canopy cover, so that the entry of sunlight on the forest floor will be reduced. With the character of the semi-tolerant agar wood planting, it is necessary the influence of oil palm trees or the age of the oil palm above it.

Agar wood-planting was done by comparing the growth of the different age of oil palm stands around the Lancang Kuning University by ± 20 years old (around UPT agriculture) and ± 11 years old (beside Faculty of Administration). Agar wood-planting that semi-tolerant species will get a shade or shade from stands above it. Fertilization is an effort and optimizes the growth of agar wood plants. The type
of soil at the study was PMK where less fertile or low pH, so the cultivation of agarwood-planting requires fertilizer to improve soil fertility.

This study aims to know the effect of shade level by age of oil palm stands and fertilization levels by agroforestry combination of oil palm and agarwood-planting, so that the growth can be optimal. Fertilizer is added into agarwood-plants to optimize growth. This research is expected to be useful as information about forestry technique on agroforestry of gaharu-plants among oil palm stands.

2. Method

This research was conducted in December 2016 until April 2017. Materials were gaharu-planting (*Aquilaria malacensis* Lamk) from 12 months old natural seedlings, labels, hoes and machetes, NPK fertilizer, poles, lux meter, pH meter, sewing meter and caliper.

**Treatments**

This research was designed with Split Plot design with main treatment is shade level by age of oil palm plantation (10 years and 20 years old) and fertilization as plot small treatment. Fertilization treatment of 5 levels of 0 grams, 40 grams, 80 grams, 120 grams and 160 grams. NPK fertilization is done on each plant per period every 3 months, with treatment of five replications. Gaharu-planting from 4 meters oil palm stands.

**Measurements:**

1. Agarwood-planting high of growth (cm).
2. Agarwood-planting stem diameter (cm).
3. Environment: Percentage of crown cover and canopy openness (%), temperature, light humidity, light intensity, soil pH and altitude.

**Statistical analysis.**

The growth data of agarwood-planting is tabulated and averaged on treatment and replication. Analysis of variance (anova) was done on every measured parameter to determine the significance of difference between means of treatments. Means for each parameter were separated by Duncan’s Real Differences Test.

3. Result

The results of analysis of variance (anova) in Table 1 and Table 2 shows that the treatment of canopy cover by the different age of oil palm stands, fertilization and interaction did not give a significant effect on the increase in diameter and high of agarwood-planting until of 4 months.

**Table 1.** The results of analysis of variance (anova) increase the diameter of agarwood-planting until of 4 months.

| Analisis sidik ragam | Db  | JK  | KT  | Uji F test | Sig (95%) |
|----------------------|-----|-----|-----|------------|-----------|
|                      |     |     |     | FHit       | FTab5%    |
| Blok                 | 4   | 296,52 | 74,13 |
| Umur Sawit           | 1   | 92,48 | 92,48 |
| Error (a)            | 4   | 157,72 | 39,43 |
| Pemupukan            | 4   | 369,92 | 92,48 |
| Umur Vs Pemupukan    | 4   | 135,52 | 33,88 |
| Error (b)            | 32  | 3140,24 | 98,1325 |
| Total                | 49  | 4192,40 |

Information:

Ns = Not significantly different at 95% confidence level.
Table 2. The results of analysis of variance (anova) increase the high of agarwood-planting until of 4 months.

| Analisis sidik ragam | Db | JK | KT | Uji F test | Sig (95%) |
|----------------------|----|----|----|------------|----------|
|                      |    |    |    | F Hit      | F Tab5%  |
| Blok                 | 4  | 0,0548 | 0,0137 | 0,3981 | 2,67 | Ns |
| Umur                 | 1  | 0,0800 | 0,0800 | 2,3247 | 4,15 | Ns |
| Error (a)            | 4  | 0,0740 | 0,0185 |       |       |    |
| Pemupukan            | 4  | 0,0928 | 0,0323 | 0,6742 | 2,67 | Ns |
| Umur x Pemupukan     | 4  | 0,0400 | 0,0100 | 0,2906 | 2,67 | Ns |
| Error (b)            | 32 | 1,1072 | 0,0346 |       |       |    |
| Total                | 49 | 1,3688 |        | | |

Information:
Ns = Not significantly different at 95% confidence level.

The result of increase diameter of agarwood-planting until of 4 months can be seen in Figure 1 and Figure 2 below:

Figure 1. Diameter of agarwood-planting until of 4 month under oil palm stands of 10 and 20 years old

The increase in the diameter of agarwood-planting under 10-year-old palm stands is greater than the increase in the diameter of agarwood-planting under 20-year-old palm stands. The fertilizer on agarwood-planting under 10-year-old oil palm stands increase in diameter between 0.22 cm and 0.40 cm, while in 20-year-old stands of oil palm between 0.18 cm and 0.26 cm.
The high growth of agarwood-planting under 10-year-old oil palm stands is greater than 20-year-old oil palm stands. The fertilizer on agarwood-planting under 10-year-old oil palm stands increase in diameter between 10 cm and 15 cm, while in 20-year-old oil palm stands between 4.2 cm and 14.4 cm. Although the effect by statistical is not real, but agarwood-planting under 10-year-old oil plant stands have higher growth than 20-year-old stands. The growth at 10 years are 0.308 cm and 11.4 cm, while the 20-years old is 0.228 cm and 8.68 cm. When visually, agarwood-planting was under 10-year-old oil palm stands have a higher and larger appearance than 20-years-old.

4. Discussion

The plot (1) was located near Faculty of Administrative (10-years-old oil palm stands) at U 00 ° 34¹ 36.49¹¹ with 30 m dpl (2) the UPT Agricultural (20 years old oil palm stands) at U 00 ° 34¹ 25.97¹¹ with 38 m dpl. Topography was flat, yellow podzolic soil. In table 3, there are different vegetation and microclimate between 10- and 20 years old oil palm stands.

| Vegetation and microclimate | Oil palm stands |
|-----------------------------|----------------|
| 1 Vegetation                | 10 years old   | 20 years old |
| - high (m)                  | 7              | 4            |
| - diameter (cm)             | 70             | 57           |
| - canopy cover (m2)         | 28,26          | 78,5         |
| 2 Canopy cover              | 4              | 4            |
| - length (m)               | 0,7 (4,375%)   | 9,4 (58,75%) |
| - canopy cover (%)          |                |              |
| 3 Light intensity (Luxmeter)| 1,065,5        | 354,68       |
| 4 Temperature (°C)          | 39,7           | 36,58        |
| 5 Humidity (%)              | 47,7           | 54,3         |
| 6 Soil pH                   | 6,2            | 5,4          |

Source: Primary Data 2017
Growth of plants influenced by genetic factors and several environmental factors i.e. climate (temperature, humidity, sunlight and others), soil conditions or nutrients contained therein. Sunlight is a source of energy plays a role in the process of plant photosynthesis. Agarwood-planting known to have a slow growth, at the time of semi-tolerant, so in the cultivation of special treatment is required to growth. Sri Haryati (2010) writes that the leaves are the center of photosynthesis where sunlight captured and absorbed by the leaves through chlorophyll. At high light intensity it can decrease the rate of photosynthesis due to the rapid photo-oxidation of chlorophyll so as to damage chlorophyll, but the intensity of light that is too low will also limit photosynthesis and tend to be more widely used than stored. In the research of Suhartati and Wahyudi (2010), the 9-month-old agarwood-planting can growth 76 cm height, while the age of 12 months can growth 104 cm. Growth phase of agarwood-planting at the age of 3-9 months, agarwood -planting require shade or lower light intensity less than 40%. Oil palm leaf cover did not affect the increase until of 4 months (tables 2 and 3) was suspected because the seedlings were planted in a 12-month-old with a diameter of ± 0.65 cm and a high of ± 69 cm. Suhartati (2013) writes that agarwood-planting 12 months will change of nature from semi-intolerant to intolerant that greater light intensity.

Based on vegetation and microclimate, the temperature and humidity is 36.58 °C and 54.5% in 20-years-old oil palm stands, lower than the age of 10 years -old oil palm stands ie 39.7 °C and 47 , 7%. The different of temperature and humidity was caused by canopy coverings so % in 20-years-old oil palm stands that sunlight does not reach the ground. The percentage of canopy cover was inversely proportional with the light intensity. If the percentage of canopy cover is low, so the intensity of the light is high. The percentage of crown cover and light intensity at 10-year-old palm stands was 4.375% and 1,065.5 lux, while the age of 20 years was 58.75% and 354.68 lux. The greater the intensity value of incoming light, the greater the light is absorbed by the plant. Agarwood-planting in the middle of palm trees ± 4 meters and get full sunlight. Tourney & Korstia in Simorangkir (2000) suggest that the growth of plants diameter related the rate of photosynthesis proportional to the amount of sunlight intensity and respiration. Marjenah (2001) suggests that stem diameter growth is faster in open areas than in shelter so that open plants tend to be short and stocky. Inhibition of stem diameter growth due to photosynthetic product and solar spectrum less stimulates hormone activity in the process of meristem cell formation toward stem diameter especially at low light intensity (Daniel in Milliang, 2011). The measurement of soil pH between 5.4 - 5.6, so it is categorized acid. The optimal soil pH for plants is about 5.6 to 8. In acid soil, the P element will be bound by Al and Fe, so it is not available to the plants (Kartasaputra, 2005). If the soil pH is lower than 4.0, there is an increase of Al3 + in the soil solution and physically damaging the root system causing the growth to be inhibited (Leiwakabessy, 2003). Hardjowigeno (2003) suggests that acid soils can cause P elements to be absorbed because they are bonded by Al, Fe and Mn to become unavailable to plants.

According to Hardjowigeno (1987), NPK nutrients are needed plants because it can improve growth and simplify the physiological process. Low soil fertility requires additional nutrients to change their physical and chemical properties. Fertilizer will provide better compared with plants that are not fertilized. NPK fertilizer is an inorganic material, when added to the soil or plant will add nutrients and can improve the physical, chemical and biological properties of soil or soil fertility. Nitrogen (N) element is useful the process of forming chlorophyll, photosynthesis, protein, fat and other organic compounds. Phosphorus (P) elements are useful for forming roots, protein base ingredients, strengthening plant stems and assisting assimilation and respiration. The element of potassium (K) is useful for the formation of proteins, carbohydrates and helps the various physiological processes of plants. Suhartati (2010) writes the dose of NPK 150 grams / plant can increase the diameter 34.5% and 77.65% high. Furthermore Suhartati (2013) states that with a spacing of 4 m from oil palm trees and the provision of 159 grams of NPK fertilizer per plant will significantly increase the diameter and height of gaharu-producing plants. Mile (2004) showed that inorganic compound NPK 30 gram with combination of liquid bokashi fertilizer did not give significant difference to the growth of sengon
until the age of 4 months. After the second fertilization, the dose is raised to 100 grams and combined with liquid bokashi fertilizer then the results become significantly different at the age of 8 months. The NPK fertilizer response at higher seedlings is more optimal than the increase in seed diameter due to vertical growth faster than the horizontal growth (Lewenussa 2009 in Prastyaningsih 2014).

The acid soil in oil palm area needs to be neutralized with calcium (high pH or alkaline). Suhartati (2010) stated that the calcium with a dose of 1 kg / plant can increase 125% diameter and 42.5% high, neutralize soil acidity from pH 4 to pH 6. Hardjowiguna (1987) reported that neutral soil pH can facilitate the absorption of elements Nutrient by plants, reduce toxic elements and accelerate plant growth. Suhartati (2013) states that fertilization of gaharu plants is done at the age of 1, 2 and 3 years with the dosage of NPK fertilizer in the first year 50 gr, second year 100 gr and third year 150 gr per tree. In addition, compost fertilizer can be used with a dose of 10 kg per planting hole and dolomite for soil that has acid soil pH. Dolomite is given together with basic fertilizer before planting, with doses of 150 to 250 g per planting.

Many factors affect the slow growth of diameter and high of seedlings of agarwood-planting. In chemical properties, soil physical properties also affect plant growth. The soil structure provides better growth compared to solid soil structures. The soil with a clay texture is different from the good sandy clay sand soil (Aris, 2011). The result of soil observation in the research location shows that the physical soil under the stand of palm trees 20 years more clay, whereas in the stand of 10 year old palm is more crumbly.

5. Conclusion

1) Canopy cover with the different of age of oil palm stands was not significant at the increase in diameter and high of agarwood-planting at 4 months of age.

2) NPK fertilizer with different doses has no significant effect on the increase of diameter and high of growths the 4-month agarwood-planting.

3) The interaction of the age oil palm stands with NPK fertilizer had no significant effect on the growths of diameter and height of the 4-month agarwood-planting.

4) Diameter gain at the age 10 years of the oil palm stands with 80 gr fertilization of 0.4 cm, while the high increase in fertilization 0 gr is 15 cm.

5) The best diameter gain at the age of palm 20 years with 0 gr fertilization is 0.24 cm, while the high increase in fertilization 0 gr is 14.4 cm.

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