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Population of bacteria in soil Dystrudepts under oil palm in the application of organic mulch and earthworm

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ABSTRACT

This Research aims 1) to study the effect of organic mulch and earthworms under oil palm plantation on the total of population bacteria is still scarce, 2)to analyze the effect of organic mulch, earthworm density and the interaction between Organic mulch and earthworm density on the total of population of bacteria. This research was carried out on May – August 2019. This research was 3 x 4 factorial experiment was placed according to a Split Plot Design with the basic design of Randomized Block Design, and each treatment was repeated 3 times. Organic mulch as the main plot were 3 types, namely: M1 (M. bracteata), M2 (oil palm empty fruit brunches/ OPEFB) and M3 (oil palm midrib). The density of earthworms as subplots consists of 4 levels, namely: C0 (0 worms/m^2), C1 (35 worms/m^2), C2 (50 worms/m^2) and C3 (65 worms/m^2). The data were analyzed using analysis of variance. If the treatment is significantly different, the treatment was tested by Duncan's at 5% significance level. The results showed that oil palm midrib organic mulch can increase the total population of fungi and bacteria compared to M. bracteata and OPFEB. The earthworms density 50 and 65 worms/m^2 can increase the total bacterial population compared to other earthworm densities. The combination of oil palm midrib with earthworms density 50 and 65 worms/m^2 can increase the total population of bacteria.

Keywords: Bacteria, Dystrudepts, Organic Mulch, Earthworm, Oil Palm

INTRODUCTION

Palm oil (*Elaeis guineensis* Jacq.) Is an important commodity in Indonesian palm oil industry. The palm oil industry has a strategic role, including the largest foreign exchange earner, adding people's economy sector and employment (Purba and Sipayung, 2017). The industries requires a lot of palm oil includes manufacturing sector is cooking oil, margarine, soap, cosmetics and pharmaceuticals (ITPC, 2013). Based on the importance of oil palm above, it is not surprising that the community and business continueally develop oil palm plantations in Indonesia.

Riau Province is one of the provinces in Indonesia be the center for Palm Oil production. Oil palm development in Riau is bigger than North Sumatra or Kalimantan (Directorate General of Plantation, 2016). The area of oil palm plantations in Riau in 2015 was 2,424,545 hectares (Central Statistics Agency of Riau Province, 2017) the production was reaching 8,059,846 tons (Directorate General of Plantation, 2016).

The expansion of oil palm plantations is mostly carried out on marginal lands, such as the acid mineral soil of Inceptisol. One of the great groups of Inceptisol acid mineral soils is Dystrudepts. Common problems in acid mineral soils are acid soil reactions (Wigena et al, 2009), low organic matter content, low nutrient availability and reserves, and high Al saturation (Suharta, 2010). Physical constraints on acid mineral soils, namely the density of soil mass (Bulk density) and the density of soil particles (Particle Density) are classified as high. This is due to low organic matter content, leads to soil compaction (Harahap et al., 2018). According to Al-Hadi et al, (2012) soil compaction reduces soil porosity and reduces infiltration rate. The higher the soil density in land, the greater the surface runoff will be (Sucipto, 2010). Plant roots cannot develop properly when it has compaction, so the absorption of water and plant nutrients is disturbed (Widodo and Kusuma, 2018). This condition results decrease in oil palm production and disruption of soil bacterial life.

Monoculture cultivation of crops such as oil palm plantations can reduce soil biodiversity. According to Widyati (2013), plants determine the composition, community and functional diversity of soil biota. The diversity of soil fauna in monoculture systems is low because the diversity of vegetation is very low. Intensive management through fertilization and pesticide application can disrupt functional diversity in the soil (Oktafiyanto, 2019). . According to Kosman and Subowo (2010), the high intensity of pesticide used depresses the population of soil fauna, including earthworms has high mobilization and sensitivity to environmental changes. Meijaard et al. (2018) added that intensive agriculture reduces the earthworm population by around 70.8-100%. The loss of the earthworm population also results in decreased soil aeration, increased soil density, decreased organic matter and microorganism populations (Kosman and Subowo, 2010).

Earthworm L. terrestris is an anesic group earthworm (Pelosi et al, 2009). Lumbricus terrestris lives in vertical holes that are semi-permanent, so they can be inhabited by worms for longer time (Richter, 2010). Earthworm activity has positive impact for soil, such as increasing the amount of macro pore space through vertical holes (Amirat et al, 2014). The presence of burrows in soil causes better aeration and drainage. In the end, earthworm activity can improves soil aggregation and structure, increase nutrient availability and improve soil productivity (Hanafiah et al, 2013).

Research on organic mulch applications has been widely conducted. According to Zahara et al. (2015) giving Mucuna bracteata mulch at a dose of 45 kg / plant can increase soil biodiversity. Wardati et al. (2015) added that the increasing of soil biodiversity was caused by availability of organic matter. The given organic mulch of M. bracteata can be a source of food and nutrition as well as a habitat for soil biota. OPEFB mulch as organic material able to improve soil biological, so aeration and infitration can be better. Better physical properties will facilitate the translocation of nutrients from the soil. According to Wiryono (2006), the combination of organic mulching with earthworms can increase soil fertility and root development. In addition, giving OPEFB mulch can also increase the earthworm population, which is around 517.3 ind / m2 (Sebayang et al, 2015). However, the effect of adding organic mulch and earthworms on soil biodiversity of Dsyrtrudepts under oil palm stands is still very limited.

This study aims to analyze the effect of organic mulch, earthworms and the combination of organic mulch between earthworm density on the total bacterial population.

MATERIALS AND METHODS

1.1. Research location

This research was conducted in experimental garden of the Faculty of Agriculture, Riau University, Binawidya Km Campus, 12.5 Simpang Baru Village, Tampan District, Pekanbaru. Coordinate 0º28'52.8 "N101º22'50.9" E. The soil type of the research area is Dystrudepts with the characteristics: alluvial plain physiography, flat topography (0 - 3%) and altitude 10 m above sea level. The climates in the study area were: type A (Schmidt and Ferguson) and D1 (Oldeman) (Nasrul et al., 2002).

The research location of oil palm plants have grown are 12 years old and productive plants. Soil biological analysis will be carried out at the Soil Laboratory of the Faculty of Agriculture, Riau University.

1.2. Experimental design

This research was conducted in 3x4 factorial experiment using a Split Plot Design with a basic randomized block design (RBD), each treatment was repeated 3 times. Organic mulch as the main plot (main plot) consists of 3 levels, namely: M1 (M. bracteata), M2 (Oil Palm Empty Bunches / TKKS), and M3 (Oil Palm Fronds / PKS). The dosage of each organic mulch is 150 kg / plant. The population of earthworms added as sub-plots consisted of 4 levels, namely: C0 (0 worms / m2), C1 (35 worms / m2), C2 (50 worms / m2) and C3 (65 worms / m2).

1.3. Research Implementation

a. Organic mulch preparation

Preparation of organic mulch is carried out by collecting Mucuna bracteata, EFB and Oil Palm Stems. Each type of organic mulch is chopped into smaller pieces using a chopping machine

b. Organic mulch application

Organic mulch application is done by evenly spreading the organic material in dish. The dosage for each type of organic material is 150 kg / stem. Organic mulch application is carried out the distance of 1.5 meters from oil palm trunk and width of 1 meter around the *piringan*. Application time 2 weeks after land clearing and liming.

c. Earthworm Applications

The earthworms used in this study were mature species of Lumbricuss terrestris. The application of earthworms is carried out around *piringan* that has been applied organic mulch. Earthworm application time is one week after organic mulch application.Aplikasi Cacing Tanah

d. Soil sampling

Soil sampling was carried out in the 1st month after the treatment application. Soil sampling was carried out in a composite manner at 0-20 cm depth in each experimental unit.

Composite soil samples were obtained by taking soil by soil sampler depth of 20 cm from the four cardinal directions (west, east, north and south) of each experimental unit (Figure 1). The soil sample is put into plastic bucket / basin to combined with the soil sample. After stirring, soil samples were taken by using the quarter method and put into plastic had been labeled. Soil samples are put into an ice box and taken to the laboratory.

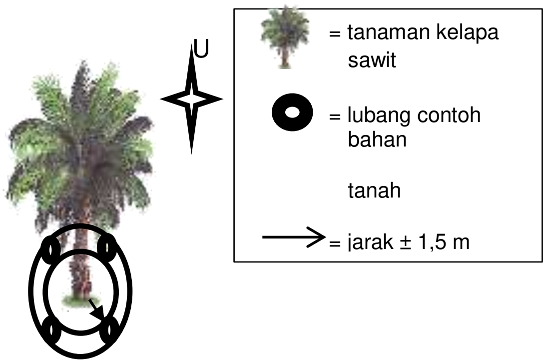

Figure 3.2. Land Sampling Plan

1.4. Research parameters

The total population of bacteria was calculated using the pour plate method using nutrient agar (NA). A total of 1g of soil samples were weighed then dissolved in 9 ml 0.85% NaCl solution and homogenized. An aliquot of 100 µl of soil solution with a dilution factor of 10-7-10-8 is poured into a petri dish and then the NA medium is poured into the petri dish. Incubation was carried out for 2 days and the number of colonies seen on the first and second days was counted. The growing colonies were counted and observed every day. The formula for calculating the total population of bacteria is as follows (Enriquez et al. 1995):

$$\text{Populasi bakteri (CFU/g tanah)} = \frac{\text{Jumlah koloni/cawan petri}}{\text{1 g tanah}} \times \frac{1}{Fp}$$

Keterangan :

CFU = *Colony Forming Unit* (CFU/g soil)

fp = the dilution factor in the colony counted petri dishes

1.5. Data analysis

Statistical analysis used factorial analysis of variance (ANOVA) RAK. If the treatment is significantly different then a further test is carried out with the Duncan Distance Test (UJD) at the 5% level.Analisis Data

RESULTS AND DISCUSSION

a. *Physical and Chemical Properties of Soil Dystrudepts under Oil Palm Stands*

Some of the physico-chemical properties of Dystrudepts soil under oil palm stands after application of organic mulch are shown in Table 1. The water content of soil treated with organic mulch EFB was higher than that of M. bracteata and oil palm fronds. Arsyad (2000) states that mulch above the soil surface can withstand the impact of rainwater droplets so that the soil aggregate remains stable and is protected from the crushing process so that mulching can prevent evaporation and water falling back to the ground. Soil temperature that was given straw mulch was higher, namely 26,500C higher than without mulching (Harsono, 2012). Soil pH that was given oil palm midrib mulch was higher than that of M. bracteata and oil palm fronds. Ullyta et al, (2018) reported that organic mulch can increase soil pH. pH affects nutrient absorption by plants (Heriansyah, 2019). The organic C content of M. bracteata is higher than other mulches. Utami and Handayani (2003) explained that giving organic matter can increase the C-organic content. Saputra (2017) states that the C-organic in oil palm land planted with M. bracteata is higher than without M. brcteata.

Table 1. Some Physical and Chemical Properties of Soil Dystrudepts under Oil Palm Stands after Application of Organic Mulch

Mulch	Water Content	pH	C Organic
M. bracteata	22.70	4.70	3.94
Oil palm empty bunches	24.44	5.09	3.19
Midrib	23.96	5.20	3.66

Source: Wawan et al, *2019*

The physico-chemical properties of soil Dystrudepts under oil palm stands after application of earthworm density are shown in Table 2. The water content of the soil was given an earthworm density of 65 individuals / m2 was higher than that of other earthworms. Soil pH given an earthworm density of 35 tails / m2 is higher than the density of other earthworms. C Soil organic matter which is given an earthworm density of 55 individuals / m2 is higher than that of other earthworms.

Table 2. Some Physical and Chemical Properties of Soil Dystrudepts under Oil Palm Stands after Earthworm Density Application.

Worm Density	Water Content	pH	C Organic
0 tail /m^2	20.44	4.90	3.29
35 tail /m^2	20.19	4.98	3.19
50 tail /m^2	26.10	5.15	3.94
65 tail /m^2	28.08	4.96	3.96

Sources: Wawan et al., *2019*

b. Total bacterial population

The results of variance showed the type of organic mulch treatment and the density of earthworms and their combination had a significant effect on the total population of soil fungi. The results of Duncan's continued test at the 5% level are shown in Table 3.

The total bacterial population after the application of organic mulch for oil palm fronds was higher than other treatments, namely 142.67 x 1010 CFU / g of soil (Table 3). This is because the organic mulch of oil palm fronds is low quality organic matter. Organic materials have high C / N ratio are more difficult to decompose, so they become available for longer and become nutrients for bacteria. Oil palm fronds have a high C / N ratio of 49.92%. The high C / N ratio results in immobilization, namely a process in which microorganisms decomposing organic matter utilize nutrients for their life activities (Yuniarti, 2014). According to Wicaksono et al, (2015) soil organic matter determines the total microorganisms in the soil. The higher of the organic matter, the total microorganisms in the soil will also increase.

Table 3.Total Bacterial Population (x 109 CFU / g of soil) in Organic Mulch Treatment and Earthworm Density.

Main Plot (Organic Mulch)	Subplot (Earthworm Density)				Average
	C0	C1	C2	C3	
M1	60,67 d	44,00 d	103,67 cd	66,67 d	68,75 b
M2	93,00 d	55,67 d	62,00 d	165,33 bc	94,00 b
M3	70,00 d	76,33 d	243,00 a	181,33 ab	142,67 a
Average	74,56 b	58,67 b	136,22 a	137,78 a	

Note: Numbers followed by different letters in the same column are significantly different based on the Duncan Distance Test at the 5% level

The total bacterial population after the addition of earthworm density of 50 individuals / m2 and 65 individuals / m2 was higher than other treatments, namely 136.22 x 1010 CFU / g soil and 137.78 x 1010 CFU / g soil. This is due to the nature of earthworms able to symbiosis with bacteria in their intestines. According to Hanafiah et al., (2013) earthworms are hosts for bacteria so they function as vectors (spreaders). Binet et al., (1998) reported the presence of earthworms can stimulate microbial activity. The conversion of the substrate to vermicompost by earthworms is reported to increase bacterial diversity (Gopal et a, 2017).

The total population of bacteria after giving organic mulch of oil palm fronds with earthworm densities of 50 individuals / m2 and 65 individuals / m2 were higher than other treatments, namely 243.00 x 1010 CFU / g soil and 181.33 x 1010 CFU / g soil. Meanwhile, the combination of Mucuna bracteata mulch treatment with an earthworm density of 35 individuals / m2 resulted in the lowest total mushroom population compared to other treatments, namely 44.00 x 1010 CFU / g of soil. Anexic earthworms feed on soil surface litter and create permanent burrows. In addition, earthworms also produce vermicompost can be found on the soil surface (Medina-Sauza et al, 2019). Kosman and Subowo (2010) reported that earthworms eat leaf litter and dead plant debris into small particles which are subsequently disintegrated by other soil organisms. The breakdown of organic matter into finer sizes and enzymatic processes in worm digestion makes organic matter easier for microorganisms to digest (Vidya et al, 2014). The impact of earthworms on bacteria can be seen in process of making vermicompost. Making vermicompost can increase the number and diversity of bacteria (Vivas et al, 2009). Gopal et al, (2017) reported that making coconut leaf vermicompost can increase bacteria as play a role in lipid metabolism and lignin degradation.

CONCLUSIONS

Based on the results of the research was conducted, the following conclusions can be drawn:

1. The organic mulch of oil palm fronds has higher total bacterial population than the organic mulch of M. bracteata and EFB.
2. The density of earthworms of 50 individuals / m2 and 65 individuals / m2 had higher total population of bacteria compared to the density of earthworms of 0 individuals / m2 and 35 individuals / m2.
3. The combination of organic mulch for oil palm fronds with an earthworm density of 50 individuals / m2 had higher total bacterial population than the other combinations, except for the

combination of organic mulch for oil palm fronds with worm density of 65 individuals / m2.

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