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Control of Frond Number and Root Pruningto Improve Growth and Development of Palm Oil (*Elaeis Guineensis* Jacq) for 6 Months

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Abstract: ***This study aims to determine the effect of frond number and root pruning on yield and root development of oil palm. The research was conducted for 6 months,from February 2018 to August 2018. Itwas carried out at the farmer field in Petapahan village, Tapung District, Kampar Regency, Riau. Root was analyzed at the Plant Ecophysiology Laboratory, Faculty of Agriculture, University of Riau. This research was conducted experimentally using Split Plot Design.Treatments were grouped based on different ages (5 years, 10 years and 15 years). The main plot was frond pruning (p_1 = normal 0%, p_2 = light pruning 25%, and p_3 = hard pruning 50%), whilesubplotwereroot pruning (a_1 = 75%, a_2 = 50%, and a_3 = 25%). Data were analyzed statistically using analysis of variance and continued by Duncan's multiple distance test at the 5% significance level. The results showed that the frond pruning affected the root dry weight and the number of secondary roots, while the root pruning affected the primary root numbers, primary root length, secondary root numbers, secondary root length, and tertiary root numbers.***

Keywords: Palm oil, frond pruning, root pruning

1. Introduction

Development of the oil palm business (Elaeis guineensis Jacq.) In Indonesia has been very rapid. According to the Plantation Office of Riau Province (2016), the area of oil palm plantations in Riau Province in 2015 reached 2.4 million hectares. Therewas the largest oil palm plantation in Indonesia. Various efforts to maximize fresh fruit bunches production of oil palm have been developed, but efforts related to physiological aspects, especially root development, less carried out. In order to increase oil palm crop production, it is necessary to manage canopy and roots based to Bocher's theory.The teory explained that growth periodicity occurs because of the feedback control between the upper part of the plant and roots then synchronous with the conditions of the growing place.

Increasing production of oil palm is very closely related to plant age. According to Lubis (2009), the productivity of oil palm plants depend on various age of plants. If the age composition of juvenile and old plants are wide, so the productivity are low. The age variation of this plant changes every year so that it affects the achievement of productivity.

Oil palm production must be balanced by the management of canopy and roots. Tjitrosoepomo (2009) suggests that roots are the main part in addition to stems and leaves. According to Sunarko (2007), controlling of leaf surface area is needed to balance between photosynthesis capacity (including for leaf tissue respiration) and fulfillment of transpiration requests. In addition, if the water and nutrient do not become a barrier, the net assimilation rate is determined by the intensity of light reaching the lower frond.

The cutting of oil palm fronds is related to the interception of light by the canopy which is very important for plant growth, biomass production and in plant growth models (Awal et al., 2011). The yield of bunches has a positive correlation with the amount of light radiation that received by the plant canopy (Squire, 1984). The yield capacity of oil palm plants is determined by the number, size of the canopy, and leaf area as the surface of photosynthesis. Hardon et al. (1999) reported that there was a positive correlation between leaf area and the yield of oil palm in the same species.

Regulatingof leaf surface area is needed to balance between net photosynthesis and fulfillment of transpiration requests. The relationship between the two processes is dynamic and increasingly complicated because of the influence of differences in plant age, rainy, and dry seasons (Verheye, 2010).

In addition to canopy management, the root is the main vegetative organ that supplies water, minerals, and essential ingredients for plant growth and development. Roots have a very important role, but often the roots weren’tcontrolled because they do not appear on the surface (Gardner and Pearce, 1991). Controlled root will affect the development of the plant. Changes in this level of normality (increase or decrease) are indicative of changes in the overall level of plant fertility (Baluska et al., 1995). In wheat plants, cutting roots will disturb the opening and closing of the stomata so that the leaves of the plant were wilt but after 15 days after pruning root of the plant will be normal again (Shou-chen et al., 2010). This study aims: 1). Knowing the interaction effect of frond and root pruning on the production and development of oil palm roots, 2). Knowing the single effect of root pruning on the production and development of oil palm roots. 3) Knowing the single effect of the number of fronds on the production and development of oil palm roots.

2. Research Methodology

This research was conducted in February 2018 until August 2019 for 6 months. This research was carried out in a community-owned garden in Petapahan village, Tapung Kapaten District, Kampar, Riau. Root was analyzed at the Laboratory of Plant Physiology, Faculty of Agriculture, University of Riau.

The plants used in this experiment were DxP palm oil from the seeds of the Marihat Palm Oil Research Center, North Sumatra, that cultivated of 5 years, 10 years and 15 years. The tools to be used in the field include knives, scissors, tractors, meters and plastic bags.

This research was experiment, using Split Plot Design. This study consisted of 9 combinations of treatments, which was grouped at 3 different age types: 5 years, 10 years, and 15 years; so that 27 plots were obtained. The main plot wasfrond pruning (P) which consisted of 3 levels: p_1 = normal (0% pruning), p_2 = light pruning (25% pruning), and p_3 = hard pruning (50% pruning). The subplot was root pruning (A) which consists of 3 levels: a_1 = 75% root pruning, a_2 = 50% root pruning, and a_3 = 25% root pruning.

3. Results and Discussion

In table 1, frond pruning affects the dry weight of roots while root pruning does not affect the wet weight and dry weight of roots. Frond pruning gave significant differences on root dry weight are due to the occurrence of biomass accumulation as a result of differences in the number of midribs present. Whereas in the root pruning treatment there is no real difference because each plant has the same density for plant growth besides environmental factors such as water availability also affect the growth of new roots.

There was a significant difference in the main plot between $p_0$frond pruning (normal) and p_3 (hard). This occurred due to the disturbance of sunlight reception. The use of light as an energy source in plants has 3 important factors, there were: intensity, quality, and photoperiodity. Regulations on the number of frond can provide differences in palm oil yield (Nope and Sudirman, 2014). Root pruning plot had no effect on the root wet weight and dry weight. It was seen that the percentage of root pruning 75%, 50% and 25% did not affect significantly. Root growth is strongly influenced by the soil physics. As results of root pruning, it will change the soil structure and soil pores, so that the soil water content also changes. Because the soil is a place for growing roots of oil palm plants and there were interaction between water and plants, it gives the same growth between all of percentage of root pruning. Soils that have a high density had low length of root. Russel (1977) argued that soil density decreases the macro pore space and root penetration was inhibited.

In table 2, frond pruning did not significantly affect the number and length of primary roots, but root pruning had significant effect on the number and length of primary roots.There was no significant difference in frond pruning at various treatments for the number and length of primary roots. It caused by lower part of the root plant didn't response on root growth. Photosynthesis in plants requires sufficient light and water (Razali et al., 2011). Until now, there has been no information about the number of oil palm frond that need to be maintained continuously or different between the rainy and dry seasons in order to achieve optimum number of frond.

There were significant differences in root pruning between 75% and 50% root pruning with 25% in the number and length of primary roots.Root pruning causedroot cutted, soit was trigger to develop more primary roots.It was good for plant growth and development and also good for water and nutrientabsorptions. Root pruning is the practice of reducing the root system part. The method of root pruning can increase the growth of new lateral roots (Pourmajidian et al. 2009).

Root pruning plays a role in increasing lateral root through increasing the number of new lateral roots and can reduce the concentration of cytokinin hormones. At the pruned root, the cytokinin concentration was decreased, causing the transport of auxin hormones from the apical meristem to the roots and stimulate lateral root growth (Campbell et al. 2003; Allen et al. 2003). Root pruning can stimulate lateral root growth in 7-month-old *melinjo* seedlings (Wulandari et al. 2013) and 2 months (Pamujianto 2014). The addition of the number of roots and the number of root branches due to rootpruning affect the root biomass. Root pruning in pea plants can stimulate new branching roots (Cazenave et al., 2014). Pruning of roots can stimulate the initiation of roots, thereby increasing the growth of new lateral roots (Pourmajidian et al., 2010). In wheat plants, root growth is influenced by water conditions and nutrients (Elazab et al., 2016). In hyperaccumulator plants, *Noccaea caerulescens*, pruning of roots and shoots affected plant nutrient uptake (Thibault et al., 2015). Pruning of roots and stems affected nitrogen nutrient uptake in *Amorphous fruticosa*plants (Yolima, 2011).

In table 3, frond pruning in various treatments had no significant effect on the number and length of secondary roots while root pruning had a significant effect on the number and length of secondary roots, and the number of tertiary roots. Difference in root pruning is correlated to the percentage of pruning area, it causeddifference root numbers that appears.Root pruning 75% and 50% had significant difference with 25% root pruning. This difference is caused by cut off roots in the oil palm area provided an opportunity for the growth of secondary and tertiary roots. The growth of the roots is also occured as the results of crumbly soils. It was happened becauseactivity of root pruning, so the availability of water in the soil increased and new roots were grew. The emergence of these new roots caused absorption of nutrients more effectively. Compaction of soil caused disturbed tree roots and eventually crop productivity will be decreased (Matangaran et. al., 2010). According to Karyudi et al. (1986), lateral root will provide root hairs to absorb water and nutrients from the soil.Pruning roots can increase the growth of new lateral roots (Pourmajidian et al. 2009). Lateral roots form new branching roots due to accumulation of auxin hormones (Tranvan et. al., 2000). Pruning roots can cause water stress conditions in plants (Setiadi 2009), soconcentration of hormone cytokinin was decreased causing the transport of auxin hormones from the apical

meristem to the roots and stimulate the growth of lateral roots (Campbell et al. 2003; Allen et al. 2003).

4. Conclusion

From the results, it can be concluded that 25% frond pruning has a good effect on the growth and development of oil palm plants,while the 75% and 50% root pruning gave the best growth of primary root length, primary root numbers, secondary root number, and secondary root length, and tertiary root numbers.

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Table 1: Single effect of frond and root pruning on wet and dry weight of oil palm root

Treatments	Wet weight (g)		Dry weight (g)	
Main plot				
p_1	3,68	a	1,56	ab
p_2	4,43	a	1,72	b
p_3	3,35	a	1,39	a
Sub plot				
a_1	4,40	a	1,65	a
a_2	3,95	a	1,60	a
a_3	3,11	a	1,42	a

The numbers that followed by the same letters in a column showed no significant difference based on LSD test at 5% significance level (wet weight) and 10% (dry weight).

Table 2: Single effect of frond and root pruning on numbers and lenght of oil palm primary root

Treatments	Numbers of primary root		Length of primary root (cm)	
Main plot				
p1	4,67	a	49,89	a
p2	4,78	a	58,72	a
p3	5,70	a	63,91	a
Sub plot				
a1	6,30	b	65,11	b
a2	5,74	b	72,57	b
a3	3,11	a	34,84	a

The numbers that followed by the same letters in a column showed no significant difference based on LSD test at 5% significance level.

Table 3: Single effect of frond and root pruning on numbers of secondary root, length of secondary root, and numbers of tertiary root

Treatments	Number of secondary root		Length of secondary root (cm)		Numbers of tertiary root	
Main plot						
p1	60,19	b	150, 61	a	324,22	a
p2	46, 85	a	129, 69	a	276,11	a
p3	64,96	b	154,67	a	366,63	a
Sub plot						
a1	68,11	b	157,77	b	350,85	b
a2	70,52	b	181,50	b	428,22	b
a3	33,37	a	95,71	a	187,89	a

The numbers that followed by the same letters in a column showed no significant difference based on LSD test at 5% significance level.