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Response of Immature Oil Palm Growth and CO_2 emission on Intercropping System After Replanting

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ABSTRACT

One of the problems in smallholder oil palm plantations was the financing for replanting and loss of revenues during immature oil palm period. One alternative to the problem was the development of an adaptive plant system through intercropping crops planted among immature oil palm crops. The research was conducted in banjar seminai village, dayun subdistrict, siak regency, Riau Province on May to October 2017. The study used a factorial randomized block design with three replications. Annual crops treatment consists of corn, soybean, eggplant and chili. The results showed that there was positive response of oil palm height on intercropping systems. Corn intercropping plants increased the height of oil palm crops. The intercropping plants had no significant effect on the number of leaf midrib and the width of oil palm canopy. Monoculture oil palm crops without intercropping produced average emissions of 8.78 t CO_2 $ha^{-1}yr^{-1}$. Oil palm intercrop with eggplant and soybean produces the highest CO_2 emissions of 10.4 and 10.2 t CO_2 $ha^{-1}yr^{-1}$, while oil palm in intercrop with chili produced the lowest CO_2 emissions of 8.66 t CO_2 $ha^{-1}y^{r-1}$.

Keywords: annual crops, CO_2 absorption, oil palm plantations, plant system

INTRODUCTION

The palm oil industry was one of the main industries that drived economic and strategic wheels in Indonesia. Economically oil palm crop began to be replanted after 25 years age and above. At this time some oil palm plantations in Riau Province have been more than 25 years old. Therefore, oil palm plantation replanted activities need to be done. According Manurung *et al.* (2015), around 53% of the total area of oil palm plantations in Riau Province is still awaiting rejuvenation due to capital constraints and replanting plant material. Replanting was an unproductive old crop replacement with new plants. Replanting become very important to maximize production. According to PPKS (2008), the main consideration for oil palm replanting were: (1) The age of the plant that will and has reached the economical age of about 25 years old, with low productivity or under 13 tons of FFB $ha^{-1}year^{-1}$; (2) The higher of oil palm tree the more difficult to harvest; (3) With new plants, new production

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will be higher. According to Pahan (2012) and Manurung *et al*.(2015), the problems faced by farmers to do the replanting was related to the need for investment and operational costs. The constraints faced by smallholders in replanting were limited capital for replanting, fear of losing income sources during replanting, lack of knowledge of farmers about replanting techniques and lack of access to certified seedlings.

The problem of financing and loss of income during the oil palm replanting, it need to find a solution. One alternative was the development of an adaptive plant system through intercropping plants grown among immature oil palm plants. According to Suwondo dan Saputra (2012), rejuvenation with the intercropping model is to combine oil palm plants with annual crops as a substitute for land cover crops. This model will provide beneficial added value (Armaini *et al*. 2012). According to (Manurung *et al*. 2015), intercropping models after replating can increase income before oil palm plants produce (0-3 years). Furthermore Suherman *et al*. (2018), the application of intercropping after replanting is an effort to optimize land by utilizing open space between oil palm plants.

MATERIALS AND METHODS

The research was conducted in banjar seminai village, dayun subdistrict, siak regency, Riau Province on May to October 2017. Raw materials used were 1 year old of immature oil palm, seeds of corn, soybean, eggplant and chilli, manure, fertilizer (Urea, TSP and MOP). The tools used were farming tools, GPS, Infrared Gas Analyzer (IRGA) LI-820 model, LICOR Inc. computer.

The study used a factorial randomized block design with three replications. The intercropping treatment consists of corn, soybean, eggplant and chili. Each experimental unit consisted of 10 plant samples. The experimental area was 4 800 m² with 400 m² of each experimental plot (Figure 1). The design model used was:

$$Y_{ijk} = \mu + A_i + T_j + €_{ijk} \quad (1)$$

with:

Y_{ijk} = observation response on i-level of plant type treatment, and j-level of repeat

μ = average

Ai = influence response of i-level of plant type treatment

Tj = influence response of j-level of repeat

$€_{ijk}$ = error

Land clearing was done by tractor, then dolomite lime sown. Seeding of chili and eggplant seeds taked 40 days. The spacing of intercropping were 40cmx40cm. (chili and eggplant), 80cmx40cm (corn), and 25cmx40cm (soybeans). Observations

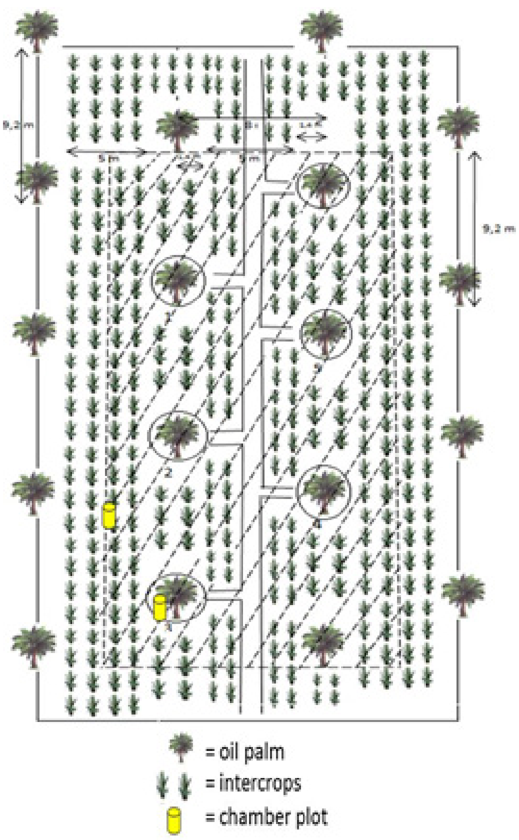

Figure 1 Experiment Layout.

and measurements of oil palm growth were carried out on variables: plant height, number of leaf midrib and canopy width.

Measurements and observations of CO_2 emissions were carried out using the infrared gas analyzer (IRGA) device model LI-820, LICOR Inc. USA with a covered chamber. The chamber used was made of PVC pipe with 25 cm diameter and 25 cm height. Emission measurements were conducted once a month in the morning and afternoon. The length of measurement for each point was ± 150 seconds (2.5 minutes). The linear relationship between measurement time and CO_2 concentration was used to calculate the CO_2 flux according to Madsen *et al*. (2009).

RESULTS AND DISCUSSION

Growth of Oil Palm Crops

The growth of oil palm plantations, until the third month of observation showed good results. Growth of immature oil palm plants in the intercropping model is shown in Figure 2-5. There was positive response of oil palm height on intercropping systems. The intercropping of corn significantly affected the plant height of oil palm. The planting of the intercrops did not significantly affect the addition of palm leaf and wide palm oil canopy (Table 1, 2, 3). These results are supported by the results of the study of Syakir *et al*. (2015) that the rejuvenation model with intercropping in the form of corn had a significant effect on the height of young oil plants aged 3 and 6 months after planting.

The high response of oil palm plants through the pattern of intercropping with corn is caused by the activity of microorganisms in the roots of corn plants that can support the growth of oil palm plants. Corn root contains endophytic microorganisms which can help provide plant phosphorus (Hafsan *et al*. 2017), and produce IAA growth hormone that can be used for plant growth (Retnowati *et al*. 2018). Furthermore Misbahuddin *et al*. (2018), states that the increased activity of microorganisms in the rhizosphere region is strongly supported by optimum soil

Figure 2 Oil palm + corn.

Figure 3 Oil palm + soybean.

Figure 4 Oil palm + eggplant.

Figure 5 Oil palm + chili.

Table 1 Oil palm height among intercropping plants

Crops	Month (cm)			Average cm $month^{-1}$
	1	2	3	
Oil palm	145.6	164.4	186.7b	13.7b
Oil palm + chili	148.7	169.5	191.8ab	14.4ab
Oil palm + eggplant	146.9	165.1	192.6a	15.9ab
Oil palm + corn	142.4	165.4	196.7ab	17.4a
Oil palm + soybean	147.7	165.6	191.2ab	14.5ab

Noted: the numbers followed by the same letter are not significantly different according to the F test of 0.05 level.

Table 2 Number of Oil palm midrib among intercropping plants

Crops	Month (unit)			Average unit $month^{-1}$
	1	2	3	
Oil palm	9.2	11.9	13.7	1.5
Oil palm + chili	9.2	11.8	13.8	1.5
Oil palm + eggplant	9.2	11.8	13.6	1.5
Oil palm + corn	9.2	12.1	13.8	1.5
Oil palm + soybean	9.2	11.9	13.8	1.5

Table 3 Canopy width of Oil palm among intercropping plants

Crops	Month (cm)			Average cm $month^{-1}$
	1	2	3	
Oil palm	56.5	66.8	91.7	11.7
Oil palm + chili	57.5	67.4	91.4	11.3
Oil palm + eggplant	56.3	66.5	92.2	12.0
Oil palm + corn	56.7	67.2	91.4	11.6
Oil palm + soybean	56.8	66.7	92.3	11.8

temperature conditions. The corn plant used in the intercropping system has a wider canopy compared to other commodities so that it can improve the microclimate around the oil palm plantations. According to Manurung *et al*. (2015), replanting with intercropping models using corn plants will produce oil palm plants with equitable growth.

The Effect of Intercropping on CO_2 Emissions in Oil Palm Plantations

The planting of monoculture palm oil without intercropping plants resulted in average CO_2 emissions of 8.78 t CO_2 $ha^{-1}yr^{-1}$. Planting intercrops can increased CO_2 emissions in oil palm plantations. Oil palm intercrop with eggplant and soybean produces the highest CO_2 emissions of 10.4 and 10.2 t CO_2 $ha^{-1}yr^{-1}$. While oil palm in intercrop with chili produced the lowest CO_2 emissions of 8.66 t CO_2 $ha^{-1}yr^{-1}$ (Table 4).

Increased of CO_2 emissions in oil palm crops with intercropping plants can be attributed to root activity from intercropping plants. Roots were a preferred place for

Table 4 Influence of intercropping plants on oil palm CO_2 emission

Treatments	CO_2 fluxes ($mg^{-1}m^{2-1}min^{-1}$)			Avg	CO_2 fluxes (t $ha^{-1}yr^{-1}$)			Avg
	Month-1	Month-2	Month-3		Month-1	Month-2	Month-3	
Chili	50.30	32.98	35.23c	39.50c	9.57	627	6.70c	7.51c
Oil palm + chili	49.59	43.28	43.70bc	45.52bc	9.43	8.23	8.31bc	8.66bc
Eggplant	51.56	52.08	31.71c	45.12bc	9.81	9.91	6.03c	8.58bc
Oil palm + eggplant	51.72	56.97	53.36b	54.02b	9.84	10.84	10.15b	10.28ab
Corn	47.57	49.63	53.36b	50.19bc	9.05	9.44	10.15b	9.55b
Oil palm + corn	47.41	61.10	43.03bc	50.51bc	9.02	11.62	8.19bc	9.61b
Soybean	50.72	54.37	42.14bc	49.08bc	9.65	10.34	8.02bc	9.34bc
Oil palm + soybean	47.41	59.27	57.90bc	54.86b	9.12	11.28	11.02bc	10.47ab
Empty area	52.82	71.77	79.82a	68.14a	10.05	13.66	15.19a	12.97a
Oil palm	49.51	46.83	42.15bc	46.17bc	9.42	8.91	8.02bc	8.78bc

Noted: the numbers followed by the same letter are not significantly different according to the F test of 0.05 level many microbs compared to bulk soil (Peterson 2003). It increased microbial population and microbial activity around roots. This increased as a result of high concentrations of nutrition, C-labile and the influence of root exudates (Kuzyakov *et al*. 2000; Misbahuddin *et al*. 2018). Increased of population and microbial activity resulted in increased microbial respiration and CO_2 production (Subke *et al*. 2004).

CONCLUSION

There was positive response of oil palm height on intercropping systems, intercrops did not significantly affect the number of midrib and the width of oil palm canopy and intercrops had affected on increasing CO_2 emissions in immature palm plantations

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