Response of Immature Oil Palm Growth and CO₂ emission on Intercropping System After Replanting

Hariyadi*, Purwanto Mohammad Yanuar Jarwadi, Diniaty Rosa, Mulyadi Tri, Kurniawati Ani

IPB University, Bogor 16680, Indonesia.

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 CO₂ ha⁻¹ yr⁻¹. Oil palm intercrop with eggplant and soybean produces the highest CO₂ emissions of 10.4 and 10.2 t CO₂ ha⁻¹ yr⁻¹, while oil palm in intercrop with chili produced the lowest CO₂ emissions of 8.66 t CO₂ ha⁻¹ yr⁻¹.

Keywords: annual crops, CO₂ absorption, oil palm plantations, plant system

INTRODUCTION

The palm oil industry was one of the main industries that drove 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

*Corresponding author: Department of Agronomy and Horticulture, Faculty of Agriculture, IPB Universiy, Bogor 16680, Indonesia. Email: hariyadiipb@rocketmail.com
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 replanting 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 semainai 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 chili, 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:

\[ Y_{ijk} = \mu + A_i + T_j + \varepsilon_{ijk} \]  

with:

- \( Y_{ijk} \) = observation response on i-level of plant type treatment, and j-level of repeat
- \( \mu \) = average
- \( A_i \) = influence response of i-level of plant type treatment
- \( T_j \) = influence response of j-level of repeat
- \( \varepsilon_{ijk} \) = 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.](image)
and measurements of oil palm growth were carried out on variables: plant height, number of leaf midrib and canopy width. Measurements and observations of CO₂ 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 CO₂ concentration was used to calculate the CO₂ 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
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         |

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         |

The Effect of Intercropping on CO₂ Emissions in Oil Palm Plantations

The planting of monoculture palm oil without intercropping plants resulted in average CO₂ emissions of 8.78 t CO₂ ha⁻¹ yr⁻¹. Planting intercrops can increased CO₂ emissions in oil palm plantations. Oil palm intercrop with eggplant and soybean produces the highest CO₂ emissions of 10.4 and 10.2 t CO₂ ha⁻¹ yr⁻¹. While oil palm in intercrop with chili produced the lowest CO₂ emissions of 8.66 t CO₂ ha⁻¹ yr⁻¹ (Table 4).

Increased CO₂ emissions in oil palm crops with intercropping plants can be attributed to root activity from intercropping plants. Roots were a preferred place for corn plants will produce oil palm plants with equitable growth.
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 CO2 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 CO2 emissions in immature palm plantations

ACKNOWLEDGEMENT

We would like to thank the Ministry of Research and Technology Ministry of Higher Education and LPPM Bogor Agricultural University for providing this research funding.

REFERENCES

Armaini, Ariani E, Yoseva S, Anom E. 2012. Optimalisasi produksi kedelai (Glysine max (L.) Merril) pada kebun kelapa sawit di lahan gambut dengan aplikasi beberapa komposisi pupuk dan pemberahan tanah. J Agrotek Trop. 1(2):11-15.

Hafsan, Nurfikmah, Hariyadi Y, Sukmawaty E, Aziz IR, Muthadiin C, Agustina L, Natsir NA, Ahmad A. 2017. Potensi bakteri endofit dari Zea mays L. sebagai pengehasil fitase. Di dalam: Prosiding Seminar Nasional Biology for Life. Gowa: Jurusan Biologi, Fakultas Sains dan Teknologi, UIN Alauddin. Makassar (ID). hlm. 1-5.

Kuzyakov Y, Friedel JK, Stahr K. 2000. Review of mechanisms and quantification of priming effects. Soil Biol Biochem. 32:1485-1498.

Madsen R, Xu L, Claassen B, McDermitt D. 2009. Surface monitoring method for carbon capture and storage projects. Energy Procedia. 1(1):2161-2168. doi:10.1016/j.egypro.2009.01.281.

Manurung LP, Hutararat S, Kaswaring S. 2015. Analisis model peremajaan perkebunan kelapa sawit pola plasma di Desa Meranti Kecamatan Pangkalan Kuras Kabupaten Pelalawan Provinsi Riau. J Sorot. 10(1):99-113.

Misbahuddin M, Aryanti E, Purnamasari E, Permanasari I, Irfan M, Arminudin AT. 2018. Emisi CO2 pada perkebunan kelapa sawit (Elaesis guineensis Jacq.) yang ditumpangsari dengan tana- man pangan fase berbeda di tanah mineral. J Agroteknol. 8(2):31-36.

Pahan I. 2012. Panduan Lengkap Kelapa Sawit Manajemen Agribisnis dari Hulu hingga Hilir. Bogor (ID): Penebar Swadaya.

Peterson E. 2003. Importance of rhizo-deposition in the coupling of plant and microbial productivity. Eur J Soil Sci. 54:741-750.

PPKS. 2008. Panen pada tanaman kelapa sawit. Medan (ID): PPKS.

Retnowati Y, Wirangsi DU, Putri SHE. 2018. Potensi penghasilan hormon IAA oleh mikroba endofit akar tanaman jagung (Zea mays L.). Gorontalo (ID): universitas Negeri Gorontalo.

Subke JA, Hahn V, Battipaglia G, Liner S, Buchman N, Cotrufo MF. 2004. Feedback interaction between needle litter decomposition and rhizosphere activity. Oecologia. 139:551-559.

Suherman C, Soleh MA, Nuraini A, Anissa NF. 2018. Pertumbuhan dan hasil
tanaman cabai (*Capsicum* Sp.) yang diberi pupuk hayati pada pertanaman kelapa sawit (*Elaeis guineensis Jacq.*) TBMI. J Kultiv. 17(2):648-655.
Suwondo, Saputra SI. 2012. Perkebunan kelapa sawit berkelanjutan untuk kesejahteraan masyarakat. Pekanbaru (ID): UR Press.

Syakir M, Herman M, Pranowo D, Ferry Y. 2015. Pertumbuhan dan produksi tanaman serta pendapatan petani pada model peremajaan kelapa sawit secara bertahap. J Littri. 21(2):69-76.