J. Appl. Environ. Biol. Sci., 7(11)38-42, 2017

ISSN: 2090-4274
Journal of Applied Environmental and Biological Sciences
www.textroad.com

The Sequestration Rate of Carbon dioxide on *Jelutung* (*Dyera lowii* Hook. F.) Tillers in Central Kalimantan

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Received: July 4, 2017
Accepted: September 22, 2017

ABSTRACT

This research aimed to (a) quantify the carbon dioxide (CO_2) sequestration rate of *Jelutung* tillers (*Dyera lowii* Hook. F); (b) measure the fluctuation of CO_2 sequestration rate of *Jelutung* tiller in time period between 06.00-06.30, 12.00-12.30 and 15.00-15.30 Western Indonesian Time (WIB); (c) analyse the biomass stock and organic carbon of the tiller. The CO_2sequestration rate of the tiller was measured by using mulching method (*chamber*) in the size of 50 cm x 50 cm x 30 cm and the CO_2 concentration analysis used Gas Cromatography. The CO_2 sequestration rate was measured in the period of time by CO_2 sampling interval at the 5^{th}, 10^{th}, 15^{th}, 20^{th}, 25^{th} and 30^{th} minute. The analysis on the biomass and organic carbon stock of the *Jelutung* tillers used gravimetric method. The research showed that the average CO_2 sequestration rate of *Jelutung* tillers was as much as 0.349 mg/m^2/ minute or 20 mg/m^2/hour. The highest fluctuation of CO_2 sequestration rate occurred between 15.00-15.30 WIB. The stock potential and organic carbon of the tiller were 37.06 g/$m^2$and 21.10 g/m^2 respectively.
KEYWORDS: *Jelutung* tillers, carbon dioxide, sequestration rate, time period

INTRODUCTION

Carbon dioxide (CO_2) gas is one of green-house gas which concentration increase is the highest in the atmosphere compared to the green-house gases with the average content of CO_2 as much as 387 ppm [1]. The increase of CO_2 gas in the atmosphere has bad impact toward the climate on earth that triggers the instability of the earth atmosphere having effect on all aspects of life on earth. There have been may attempt to diminish the increase of CO_2 gas concentration in the atmosphere; one is to utilize the natural character of the plant through photosynthesis process. Photosynthetic is a transformation of CO_2 gas and water (H_2O) through various metabolism processes in chlorophyll-contained leaves by the sun to be carbohydrates, and oxygen [2,3]. The carbohydrate result ($C_6H_{12}O_6$) can be used by the plant for growing.

Jelutung (*Dyeralowii* Hook. F.) is a plant species, in the family of *Apocynaceae* which can be found growing in peat forest. This type dominates the tracks with the characteristics the thickness of the peat layer is medium to deep for about 100 cm, the land is only flooded in rainy season, the type of shallow peat (*sulfohemist*) to the deep peat land[4]. Acording to Bastoni, *et al.*[5], the growth of *Jelutung* is relatively fast in its nature condition with increment growth and tree diameter between 1.5-2.0 cm/year. Meanwhile, there are some *Jelutung*s which are cultivated with semi-intensive maintenance with the increment growth and diameter for about2.0-2.5 cm/year.According to Ceulmen & Sauger in [2], the plant with a rapid growth has high photosynthetic rate, but it does not mean that it always happens. The photosynthetic rate has an effect on the CO_2amount absorbed by the plant, the higher the photosynthetic rate, the higher amount of CO_2will be absorbed. The research on the measurement of CO_2amount absorbed by several plant species has been massively and generally conducted at the tree stage, meanwhile the research on the CO_2sequestration rate on the tiller stage is seldom.

The Objective of Study

The objective of the study is (a) to measure the CO_2sequestration rate of *Jelutung* tillers, (b) to measure the fluctuation of the CO_2sequestration rate of *Jelutung* tiller at 06.00-06.30, 12.00-12.30 and 15.00-15.30 Western Indonesian Time (WIB); (c) to analyse the biomass stock and organic carbon of *Jelutung* tillers.

METHODS

Location and Time of Research

The research location was in Palangka Raya, Central Kalimantan, the CO_2 concentration analysis was conducted at the Environment Research Laboratory of Jakenan, Pati, Central Java and the biomass analysis and organic carbon conducted at the Laboratory of Forestry Product Technology, Agriculture Faculty, University of Palangka Raya. It took place from March to April 2017.

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Research Tools and Material

The research material comprised: *Jelutung*tillers (*Dyera lowii* Hook. F.)at the age of ± 3 month, sand, water, paper envelop and label. The tools were 4 mulching units (chamber) sized 50 cm x 50 cm x 30 cm (equipped with dry battery, fan, and thermometer), Gas Cromatography, syringe, digital caliper, meter, 50 cm ruler, oven, desiccator, ash furnace, ash dish, pails, analytical scale and blender.

Research Procedure

A. The Measurement of CO_2 Sequestration Rate of *Jelutung* Tiller (*Dyera lowii* Hook. F.)

The measurement of CO_2 sequestration rate of *Jelutung* tiller used the mulching method (*chamber)*. The numbers of mulching units used were 4 items consisting of 2 mulching units with *Jelutung* tillers and 2 mulching unitas the control (without tiller). The CO_2 gas sampling at 4th unit used *syringe* (size 10 ml),which was conductor per period of time such at 06.00-06.30, 12.00-12.30and 15.00-15.30Western Indonesian Time within the interval on the 5th, 10th, 15th, 20th, 25th and 30th minute. The CO_2 gas sampling inside the mulching unit during 1 (one) month was conducted in4stages for 4 weeks. Each week the sampling taken was as many as 36 CO_2 gas samples therefore the total of CO_2 gas taken by using *syringe* would be as many as 144 samples. All of the samples were sent to the Environment Research Laboratory of Jakenan, Pati, Central Java to have CO_2 gas concentration to be analysed using *Gas Cromatography* tool. The measured parameter during the CO_2gas sampling was based on the outer temperature around the research location and the temperature inside the mulching unit per sampling period and interval of time.

The data resulted from the analysis using *Gas Cromatography* then being calculated with the CO_2 sequestration rate inside the mulching units by applying the formula suggested by Khalil*, et. al*.[6]:

$$F = \frac{dc}{dt} \times \frac{Vch}{Ach} \times \frac{mW}{mV} \times \frac{273,2}{273,2 + T}$$

Where :

F = CO_2sequestration rate of the tiller (mg/m^2/minute)
dc/dt = The CO_2concentration difference per time unit (ppm/minute)
Vch = Box Volume (m^3)
Ach = Box width/area (m^2)
mW = CO_2molecule mass (gr)
mV = CO_2Molecule volume (22,41 L)
T = Average temperature during the gas sampling of (^{o} C

The CO_2sequestration rate of *Jelutung* tiller is difference of the CO_2 sequestration rate inside the tiller mulching unit and the control CO_2 sequestration rate (without tiller) with the formula as follows:

$$Fb = F - K$$

Where :

Fb = CO_2sequestration rate of *Jelutung* tiller (mg/m^2/minute)
F = CO_2sequestration rate in the mulching unit consisting the *Jelutung* tiller (mg/m^2/minute)
K = CO_2sequestration rate in the control mulching unit/without tiller (mg/m^2/minute)

B. Analysis on Biomass Stock and Organic Carbon

The analysis on biomass stock and organic carbon at root, stem and leaves of the *Jelutung* tiller was conducted by using gravimetric method at the Laboratory of Forestry Product Technology, Agriculture Faculty, University of Palangka Raya.

RESULTS AND DISCUSSION

The CO_2Sequestration Rate of *Jelutung*Tiller (*Dyera lowii* Hook. F.)

The research result shows that the average of CO_2 sequestration rate of *Jelutung* was as much as 0.349 mg/m^2/minute or 20 mg/m^2/hour. Compared to the CO_2 sequestration rate of other tiller at the same age, they were classified in same lower category. This is the data of several researches of CO_2 sequestration rate from several types of tillers, as in the Table 1.

Table 1. Several result of the research on CO_2Sequestration Rate of Tiller.

No	Type of Tiller	CO_2Sequestration Rate(mg/m^2/minute)	Source
1.	Red Palm Tree (*Cyrtostachys lakka* Becc.)	1.370	Ludang (2015)
2.	Lemongrass (*Cymbopogon citratus*)	1.350	Ludang (2015)
3.	Cananga Tree (*Canangium odoratum* (Lamk.) Hook. dan Thorms. (Lat.))	1.220	Ludang (2015)
4.	Papaya (*Carica papaya* L.)	0.640	Ludang & Junaedi (2015)
5.	Jackfruit (*Artocarpus heterophyllus* Lam.)	0.150	Ludang & Junaedi (2015)

From the table above, it shows that the average of CO_2 sequestration rate of *Jelutung*tiller is far lower than those of the tillers of Red Palm, Lemongrass, Cananga and Papaya. However, it is slightly higher than the CO_2 sequestration rate of jackfruit tiller. Each type of plant has its own ability in fixating or sequestrating CO_2 from the air. The difference is affected by the leaf width, the leaf relative thickness, stomata numbers, plant age and environmental factors[7]. According to Gardner, *et. al*.in[8] and Mangkoedihardjo [9], the fixation determinant variables of CO_2 by the plants related to the plant growth are the temperature and environmental CO_2 concentration. The change in the temperature and the environmental CO_2 concentration bring effect to plant productivity and its ecosystem. It occurs because around 90% of the plant dry mass coming from CO_2 fixation in photosynthetic process.

The Fluctuation of CO_2 Sequestration Rate

The average fluctuation of CO_2 sequestration rate in *Jelutung*tiller based on the measurement period (06.00-06.30, 12.00-12.30 and 15.00-15.30 Western Indonesian Time/WIB), indicates a growing pattern along with the extending measurement time. The fluctuation graphic of CO_2 sequestration rate of *Jelutung* tiller is as in Figure 1.

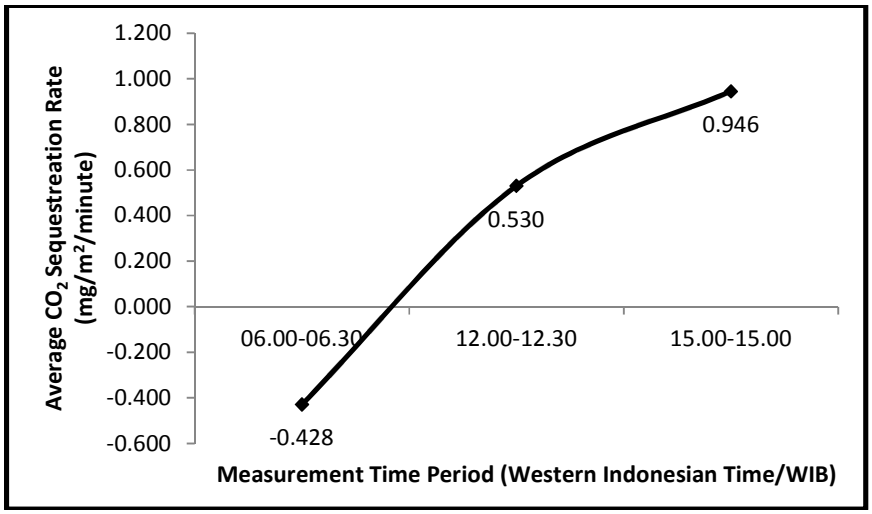

Figure 1. The average fluctuation of CO_2sequestration rate of *Jelutung* tiller based on the measurement time period.

Figure 1 shows that the average of CO_2sequestration rate around 06.00-06.30 WIB decreased as much as -0.428 mg/m^2/minute, and then increased at 12.00-12.30as much as 0.530 mg/m^2/minute and increased again at 15.00-15.30 WIB as much as 0.946 mg/m^2/minute. The pattern of the fluctuation average of CO_2sequestration rate of *Jelutung* tiller was influence by the fluctuation pattern of the average temperature inside and outside the mulching unit around the research location. The fluctuation graphic of the average temperature inside and outside the mulching unit around the research location based on the measurement time period is as in Figure 2.

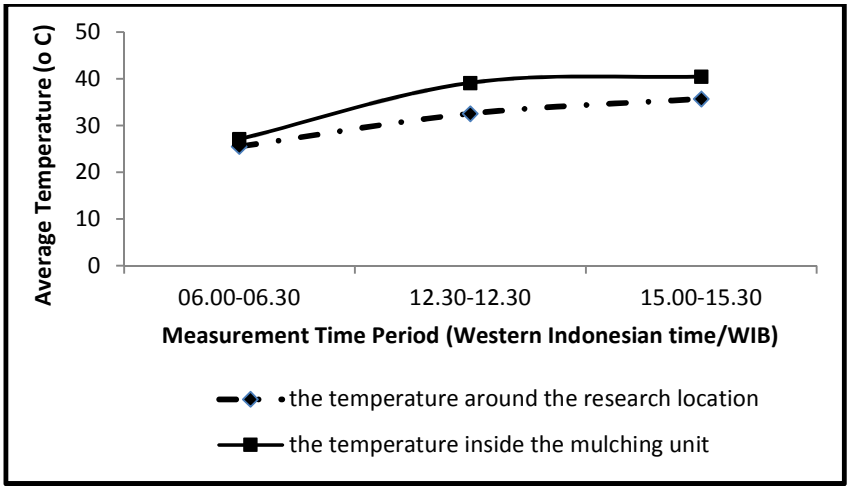

Figure 2. The fluctuation of the average temperature inside and outside the mulching unit around the research location based on the measurement time period.

Figure 2 shows that the temperature fluctuation inside and outside the mulching unit around the research location were almost similar to the fluctuation of CO_2 sequestration rate of *Jelutung* tiller (Figure 1). The higher the temperature inside and outside the mulching unit around the research location resulted in the higher CO_2 sequestration rate. At 15.00-15.30 WIB the sun rays at the research location was quite strong therefore influencing the temperature rise inside and outside the mulching unit around the research location. Acording to Gardner, *et. al*.in[8], the determinant variable of the environmental CO_2 fixation related to the growth of the plant were the temperature and the environmental CO_2 concentration. Ludang & Junaedi [8], the temperature range inside and outside the mulching unit around the research location had important role in fixating CO_2 through photosynthetic process, the higher the temperature inside and outside the mulching unit around the research location caused the higher fixated amount CO_2. In the photosynthetic process, temperature has effect to the enzyme process in chloroplasts therefore influencing the CO_2 fixation to produce carbohydrates [10].

Biomass Stock and Organic Carbon

Biomass is a total amount of living materials on the surface of tree parts which defined in tonne unit of dry mass per width area, around 50% biomass is composed of carbon [11,12]. The biomass composing components of trees consist of the biomass of root, stem, branch, leaves, flower and fruit.

The result of the research shows that total average of biomass stock of *Jelutung*tiller is as much as 37.06 g/m^2. Komponen cadangan biomassa paling tinggi terdapat pada bagian batang sebesar 17.56 g/m^2, root as large as 14.94 g/m^{2}and the lowest biomass stock found in the leaves as much as 4.56 g/m^2. The biomass component of plant depicts the result of photosynthetic process distributed to the stem, root and leaves. According to Hairiah,*et. al.*[13], the sequestration of CO_2 gas from the air through photosynthetic which then resulted in carbohydrates and distributed to all plants parts (root, stem, leaves) and eventually be piled inside the plant.

The average of organic carbon stocks of *Jelutung* tiller is as much as 21.10 g/m^{2}with details such as stem component 10.25 g/m^2, root 8.18 g/m^{2}and leaves 2,. g/m^2. The highest organic carbon stock is found in the stem of *Jelutung* tiller. It is because most of the photosynthetic result being stored in the stem. Acording to Haygreen & Bowyer [14], generally the wood composing substances are mostly stored in the stem, including the organic carbon, which works as the most dominant wood composing element in the stem.

CONCLUSION AND SUGGESTION

Conclusion

a. The average of CO_2 sequestration rate of *Jelutung* tiller at the age of ± 1 month is as much as 0.349 mg/m^2/minute or 20 mg/m^2/hour
b. The fluctuation of CO_2 sequestration rate of *Jelutung* tiller gets higher in responding to the extension of measurement time period
c. The average of biomass stock and organic carbon of *Jelutung* tiller is as much as 37.06 g/m^{2}and 21.10 g/m^2 respectively. The component in the stem has the highest biomass stock and organic carbon compared to the root and leaves part.

Suggestion

The research on the respiration process on the *Jelutung*tiller has not yet been conducted. The data is essential to calculate the nett of CO_2sequestration rate.

ACKNOWLEDGMENT

We would like to thank to (1) the Ministry of Research, Technology and Higher Education (2) the Rector of the University of Palangka Rayaand (3) the Research Institute and Outreach Program of the University of Palangka Raya. This research is financially supported by BOPTN budget year 2017.

REFERENCES

1) Sukmawati, T, Fitrihidajati, H., dan Indah, K. N. 2015. The Carbon Dioxide Sequestration in Urban Forest Plant in Surabaya. *Jurnal LenteraBio*, 4(1), pp. 108-11.

2) Hidayati, N., Mansur, M. & Juhaeti, T., 2013. Variation in Carbon Dioxide Sequestration (CO2) of the Trees di "*ecopark*", Cibinong and its Relation to the greenhouse gas mitigation. *Buletin Kebun Raya*, 16(1), pp.38–50.

3) Mangkoedihardjo, S. 2007. Phytotechnology integrity in environmental sanitation for sustainable development. Journal of Applied Sciences Research, 3(10):1037-1044.

4) Bastoni. 1997. Understanding the Land Characteristic and Peatland Forest Distribution to Rehabilitate the Logged Over Area. *Proseeding Ekspose Hasil-hasil Penelitian Balai Teknologi Reboisasi Palembang*. Palembang.
5) Bastoni, Nugroho, A. W., Azwar, F., Imanullah, A. & Suparman, M. 2010. Research Report: The Utilization of peatland for *Jelutung* (*Dyera lowii*) based on the *agrosilvofishery* Pattern. Balai Penelitian Kehutanan Palembang. Palembang.
6) Khalil, M. A. K., R. A. Rasmussen & M. X. Wang ang L. Ren, 1991. Methane emission from rice field in China. *Enviromental Science Technology*. (25), pp. 979-981.
7) Salisbury, F.B. & C.W. Ross, 1995. Physiology of Plant. Bandung. Penerbit ITB.
8) Ludang, Y. & Ajun J. 2015. The role of plant tillers toward carbon dioxide sequestration. *Journal of Agriculture and Food Technology*, 5 (2) : 15-20.
9) Mangkoedihardjo, S. 2007. Leaf Area for Phytopumping of Wastewater. Applied Ecology and Environmental Research, 5(1): 37-42.
10) Ginting, C. 2009. The Interaction Between the Increased Carbon Dioxide Concentration and Temperature Toward The Plant Growth.*Buletin Ilmiah INSTIPER*, 16 (I), pp. 23-31.
11) Brown, S. 1997. Estimating biomass and biomass change of tropicalforests a primer. FAO Forestry Paper 134. FAO, Rome.
12) Mangkoedihardjo, S. 2002. Waterhyacinth leaves indicate wastewater quality. Biosains, 7(1): 10-13.
13) Hairiah, K., Ekadinata, A., Sari, R.R. &Rahayu, S. 2011. Second Edition: Practical Guide in Carbon Stock Measurement from the Land Stage to Landscape. Word Agroforestry Centre.
14) Haygreen, J. G. & Bowyer, J. L. 1996. Introduction: Forest Crops and Wood Science. Translated by: Sutjipto A. Hadikusumo. Editor : Soenardi P. Gadjah Mada University Press.