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GROWTH, YIELD AND POTENTIAL ABSORPTION OF CARBONDIOXIDE (CO_2) IN DAYAK ONION (*Eleuteherine americana* Merr) ON PEAT SOIL

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ABSTRACT

The opportunity for developing Dayak onion on peat soil in Palangka Raya City is quite large, the obstacle faced is the low soil fertility. In order for peat soil to produce optimally, it is necessary to improve its physical, chemical and biological properties by adding manure. The purpose of this study was to determine the growth, yield, and potential for carbon dioxide absorption of dayak onion plants given four types of manure on peat soil. This experiment used a Completely Randomized Design with four treatments and six replications. The treatments tried were chicken manure, swallow manure, cow manure, and goat manure. The results showed that the type of manure affected plant growth and yield. Dayak onion plants planted on peat soil given cow manure and goat manure grew significantly taller and had more leaves. The highest yield, biomass weight, stored carbon, and highest carbon uptake were obtained in Dayak onion plants grown on peat soil with cow manure 30 t ha^{-1}

Keywords : Dayak onion, carbon dioxide, types of manure, peat soil.

INTRODCUTION

Background

In Indonesia, there are several plants that are used empirically for traditional medicine, because they are considered more practical and have been passed down from generation to generation. Among the many medicinal plants that have been developed, especially in Central Kalimantan, is the Dayak onion plant (*Eleutherine palmifolia* (L.) Merr). Along with the increasing population and increasing public knowledge about the benefits of Dayak onions, demand is getting higher, so that Dayak onions have high economic potential and are feasible to be developed as industrial plants. Thus, the opportunity for the development of Dayak Onion plants on peat soil (Histosol) in Palangka Raya City is quite large. Peat soil in Palangka Raya is quite extensive, namely 132,315.2 hectares which includes sapric peat (Salampak *et al*., 2017).There are three terminologies used to describe the condition of organic matter in peats and peaty soils (Histosols). Fibric material represents an early stage in the degradation of organic materials during the production of peat. Two-thirds of the organic matter composed of vegetation fibres, which are conspicuous and clearly discernible. Sapric describes organic matter which less than one-sixth may be identified as original plant material. Hemic is a transitional element between the other two. Low pH, high cation exchange capacity, low base saturation, low content of K, Ca, Mg, P elements, and low content of micro elements (such as Cu, Zn, Mn, and B) are common characteristics of peat soils (Sasli, 2011). Consequently, the availability of plant nutrients is quite limited. In order for peat soils to yield optimally, their physical, chemical, and biological qualities must be improved by soil amelioration and fertilization.

Ameliorant is a material that is given to soil to improve its physical, biological, and chemical characteristics in order to promote soil fertility. To overcome excessive soil acidity, low soil fertility, and boost peatland production, peat soil is improved (Barchia, 2006). The application of chicken manure amendments to peat soil greatly enhanced the quantity of organic carbon in the soil (C). Organic matter is a source of energy for bacteria that create carbon dioxide through respiration. Soil microbes have a crucial role in increasing the availability of soil nutrients (Pelczar and Chan, 2005). The cultivation of medicinal plants treated with inorganic fertilizers is discouraged (Winarto, 2004) due to the chemical content of inorganic fertilizers. Inorganic fertilizers can leave chemical residues on medical plants and alter the pharmacological properties of medicinal plants when applied to them. Therefore, manure, which is an organic fertilizer, is an ideal addition to the planting medium for medicinal plants, as organic fertilizers are harmless and do not interfere with the pharmacological effects of medicinal plants.

Manure is an organic fertilizer that comprises macro elements, such as nitrogen (N), phosphate (P), potassium (K), calcium (Ca), and magnesium (Mg), and micro elements, such as manganese (Mn), iron (Fe), zinc (Zn), cobalt (Co), and

molybdenum (Mo), that plants require. Manure has a function in maintaining the balance of nutrients in the soil, since it has a long-lasting effect and is a repository of plant food. Furthermore, manure possesses natural characteristics and does not harm the soil (Andayani and La Sarido, 2013). The nutrients in manure vary based on the kind of feed, the age of the animal, and the digestive process (Andayani and La Sarido, 2013).

In a natural forest condition, peatlands work as carbon sequesters, so contributing to the reduction of greenhouse gases in the atmosphere, despite the fact that the tethering process is very slow, ranging from 0 to 3 mm of peat year^{-1}, or 0 to 5.4 ton of $_2$ ha^{-1} year^{-1} (Agus, 2009).

The effectiveness of peatland restoration is determined by the capacity to restore the function of forests and/or peatlands as suppliers of environmental services as carbon sinks and storage, hence mitigating environ-mental change by lowering CO_2 emissions. Reduction of CO_2 in the atmosphere is mostly the result of plants absorbing CO_2 through photosynthesis. Assimilation of CO_2 in the leaves is connected to the process of photo-synthesis. Photosynthesis or CO_2 absorption is a characteristic that is extremely susceptible to environmental effects, mainly light and CO_2 concentration, as well as plant parameters such as plant type and age, leaf type and age (Wiraatmaja, 2017). Peatlands are utilised for plant cultivation, ideally with carbon-absorbent plant species.

Through the mechanism of photosynthesis, Dayak onions are able to absorb atmospheric CO_2. The outcomes of photosynthesis are utilized for respiration, plant growth and development, and stored as biomass. Plant development will continue until the Dayak onions cease developing biologically or are harvested. The cultivation of peatlands will aid in the absorption of surplus CO_2 from the atmosphere.

Dayak onion plant has the potential to be developed as a biopharmaceutical raw material for industrial scale because it has a short lifespan of ± 3-6 months, so it has the opportunity to be developed on a wider scale, its lush leaves are expected to absorb carbon well. This study aimed to investigate the development and yield, as well as the capacity for carbon dioxide absorption, of Dayak onion plants grown in peat soil with four types of manure.

MATERIALS AND METHOD

This research was carried out from July to October 2021, encased under a plastic roof structure with a screened wall in the experimental sites of the Department of Agronomy, Faculty of Agriculture, University of Palangka Raya.

The materials used in this study were local varieties of Dayak onion bulbs obtained from local farmers with uniform sizes with a length of 5 - 6 cm and a diameter of 2 - 3 cm, manure (chicken, swallow, cow, goat), dolomite lime, peat.

The results of the analysis of the chemical properties of peat soil and manure are presented in Table 1.

Table 1 Chemical properties of peat soil, chicken manure, swallow, cow and goat manure and a mixture of peat soil and types of manure

Chemical properties analyzed	Peat	Type of manure				Peat + chicken	Peat + Swallow	Peat +cow	Peat+ goat
		Chicken	Swallow	Cow	Goat				
pH H_2O	2.67	7.50	6.73	6.49	7.24	5.75	5.31	5.48	5.78
C-org (%)	12.70	18.32	46.40	31.38	24.49	10.97	12.15	12.00	12.94
N-total (%)	0.75	2.12	7.33	2.12	1.79	0.78	1.31	0.94	0.85
P-total (mg/100g)	9.38	1.79	1.07	0.95	0.42	396.51	136.88	248.47	127.47
C/N	1.93	8.64	6.33	13.58	1.68	14.06	9.27	12.77	15.22

This research implemented a completely random design (CRD) with four treatments and six replications. Four varieties of dung were used as treatments: chicken, swallow, cow, and goat. Observed variables included plant height, number of leaves, number of tubers per clump, fresh weight of tubers per clump, tuber diameter, biomass weight, carbon storage, and carbon absorption.

Samples for the calculation of dry biomass were taken randomly 4 plants in each treatment that were 84 DAP (Days After Planting). To determine the dry weight of the plant, the cleaned Dayak onions were placed in a paper bag with a small labelled hole and then oven for 48 hours at 60°C.

Peat soil was taken from farmer's land in Kalampangan Village, Sebangau District. Soil samples were taken at a depth of 20 cm compositely from several sample points, combined and stirred until homogeneous. Then it is dried for one week and sifted to separate from roots and weeds.

Then the peat soil is put into polybags as much as 5 kg polybag^{-1}, based on the calculation of the volume of peat soil 0.4 g cm^{-3} with a polybag size of 30x30cm, and root penetration of 20 cm given dolomite lime with a dose of 4 t ha^{-1} equivalent to 25 g polybags^{-1}. The dose of manure applied 30 t ha^{-1} is equivalent to 188 g polybag^{-1}. The seeds used are of uniform size with a length of 5 - 6 cm and a diameter of 2 - 3 cm.

Calculation of carbon potential using Brown's approach (1986), namely the weight of dry biomass multiplied by the conversion factor (Brown *et al*., 1986; Murdiyarso *et al*., 2002), using the formula:

$$C = 0,5 \times W$$

Note: C = carbon (g); W = dry biomass weight of the kiln (g)

The ability to absorb CO_2 from the air by the Dayak onion plant is obtained by converting carbon using the Brown method (Morikawa *et al*., 2001; Basuki *et al*., 2004) with the formula, namely:

$$CO_2 = 44/12 \times C \text{ or } CO_2 = 3,67 \times C$$

Note : CO_2 = carbon dioxide ; C = Carbon

The collected data were analyzed using the F test of 5 and 1%, and if the F test results indicated a significant effect, the analysis was proceeded with the 5% honestly significance difference (HSD) test. The carbon potential and carbon dioxide uptake data were descriptively examined and displayed in graphs and tables.

Experimental implementation. Peat soil was taken from farmers' land in Kalampangan Village, Sebangau District as much as 5 kg polybag^{-1} and applied 4 t ha^{-1} of dolomite

lime, equal to 25 g.polybag^{-1}. The dosage of 30 ton of manure ha^{-1} is equivalent to 188 g each polybag. Conformingly prepared seeds are trimmed at one-third of their length, placed in the planting hole, and drenched with sufficient water. At 84 days after planting, plants are harvested by loosening the soil surrounding the Dayak onion bulbs, then grasping the leaf blade at its base and drawing it up carefully so as not to damage the tuber.

RESULTS AND DISCUSSION

Height and Number of Leaves of Dayak Onion Plants

The growth of plant height and number of leaves are plant growth variables that are easily observed as parameters to determine the effect of the environment or the effect of treatment on plants. The growth of plant height and number of leaves indicates the vegetative growth activity of a plant.

Based on Table 1, it appears that the growth of Dayak onion plant height that was given swallow manure at the beginning of growth was significantly higher than that of cow and goat manure, but along with increasing plant age up to the age of 84 DAP, the plant height of Dayak onion given swallow fertilizer significantly grew the lowest. Meanwhile, for Dayak onion plants that were given chicken, cow and goat manure did not show a significant difference.

Dayak onion plants applied swallow manure aged 14 DAP, that plant height grew faster because the N content in swallow manure was relatively high. The high N-total content of the soil will affect the availability of N for plants which stimulates plants to grow faster. Along with increasing plant age, the availability of N nutrients in peat planting media decreases (Table 1) so that plant growth is inhibited.

In accordance with the research results of Nasrudin *et al*. (2021) that the dose of POC based on swallow droppings did not significantly affect the parameters of plant height, number of plant leaves, number of tillers, number of tubers per plant, tuber diameter, tuber net wet weight per plant. plants, and the net dry weight of tubers per plant, but only significantly affected the number of tillers of 20 DAP. Mengel *et al.* (2001) stated that when macronutrients in the soil increase, the amount that can be absorbed by plants will also increase, accompanied by the formation of organic compounds in plant tissues.

The results of the analysis of swiftlet manure, obtained that the total N content is relatively higher than the total N content in chicken,

Table 2 The height of Dayak onion plants aged 14-84 days after planting (DAP) given four types of manure

Type of manure	Plants aged (DAP)					
	14	28	42	56	70	84
	---------- cm ----------					
Chicken (P1)	20.18 ab	29.75 b	36.20 b	42.10 ab	45.40 ab	48.95 b
Swallow (P2)	23.58 b	27.25 a	35.25 ab	39.13 a	43.33 a	47.18 a
Cow (P3)	18.75 a	29.78 b	38.75 b	44.78 b	46.13 b	49.33 b
Goat (P4)	18.85 a	26.65 a	34.08 a	43.58 b	46.88 b	49.83 b

Note: The numbers followed by the same letter in the same column are not significantly different in the HSD test 5%.

cow and goat manure. Nitrogen is an essential macronutrient that plants need in large amounts. The element nitrogen acts as a constituent of protein amino acids, enzymes, chlorophyll and plant hormones (Hanafiah, 2005), so as to improve plant vegetative growth (Hardjowigeno, 2007). Along with the increasing age of the Dayak Onion plants, the growth of plant height slowed down so that the plants that were given swiftlet manure grew significantly the lowest. The decrease in growth was due to reduced N elements in the growing media. The planting medium of peat+chicken manure with N-total content increased by 4%, peat+swiftlet manure, peat+cow manure and peat+goat manure decreased by 82, 11 and 52%, respectively. It can be seen that the total N content in the peat planting media + swiftlet manure decreased the most so that the plant height growth was hampered.

The application of cow manure had a significant effect on the number of Dayak onion leaves and was not significantly different from that of goat manure (Table 3). Cow manure has a moderate nitrogen content while goat manure is rather low. The availability of nitrogen plays a role in improving plant vegetative growth and protein formation (Harjowigeno, 2007). With the availability of sufficient nitrogen elements, plants will grow better. Muharam (2017) added the role of N, namely for the formation of plant vegetative organs such as roots, stems, leaves and branches so that the photosynthesis process increases and the photosynthate produced is higher.

Dayak Onion Yield and Yield Components

Photosynthesis is a metabolic process in plants to form carbohydrates from CO2 from air and water from the soil with the help of sunlight and chlorophyll. The main product Glucose (C6H12O6) formed is the main product of photosynthesis, although various other organic compounds are also produced (Wilson *et al*., 1966).

The application of cow manure resulted in tuber weight per clump, tuber diameter and leaf dry weight per clump of Dayak onion plants, although not significantly different from those given swiftlet manure and goat manure. The application of cow manure also gave the largest real tuber diameter value (Table 4). This is thought to be related to plant vegetative growth. Based on Table 2 and Table 3, the growth in height and number of leaves of Dayak onion plants that were given cow manure grew higher and the number of leaves was more. Leaves are the main organ for the process of

Table 3 The number of Dayak onion aged 14-84 days after planting (DAP) were given four types of manure

Type of manure	Plants aged (DAP)					
	14	28	42	56	70	84
	---------- sheet ----------					
Chicken (P1)	3.00	3.25 a	8.25 a	11.00 a	13.75 a	16.75 a
Swallow (P2)	2.00	4.00 ab	9.25 a	13.00 b	14.50 a	19.00 a
Cow (P3)	2.25	4.50 b	10.75 b	15.25 c	18.00 b	22.25 b
Goat (P4)	2.00	3.75 ab	9.75 b	13.50 b	16.75 b	21.25 b

Note: The numbers followed by the same letter in the same column are not significantly different in the HSD test 5%.

photosynthesis. With a large number of leaves and growing taller due to the application of cow dung fertilizer, the rate of photosynthesis takes place optimally, resulting in more photosynthate. Photosynthate is not only used for growth but also translocated to tubers as a shelter so that tubers are bigger. According to Wiryanta and Bernardinus (2002) cow dung contains N 2.33%, P_2O_5 0.61%, K2O 1.58%, Ca 1.04%, Mg 0.33%, Mn 179 ppm and Zn 70.5 ppm. The results of the analysis of the growing media (Table 3) showed that the total P in peat + cow dung was very high, with a high total P content the probability of available P was also very high. Elemental P is an essential part that plays a role in photosynthetic reactions, respiration and various other metabolic processes. Phosphorus is also part of the nucleotides and phospholipids that make up membranes (Lakitan, 2004). Another function of phosphorus is for the formation of flowers, fruits and seeds, adequate phosphorus for better root development and as energy storage and transfer (Harjowigeno, 2007).

Phosphate is needed by plants for the formation of adenosine di-and triphosphate (ADP and ATP) which is a source of energy for plant growth and development processes (Marschner, 1997). In addition, adequate P is very important to support the growth and development of vegetative and reproductive parts of plants; improve the quality of results; and plant resistance to disease. Thus, nutrient P management is one of the most important factors in increasing crop production (Andayani and La Sarido, 2013).

The results of the research by Sakti and Sugito (2018) that the application of cow manure 30 t ha^{-1} can increase plant growth, leaf area, tuber diameter and number of bulbs of shallot plants. Research from Mayun (2007), some application of cow manure with 30 t ha^{-1} has a significant effect on the growth and yield of tubers per hectare which is increasing both without mulch and with mulch.Research results Sriyanto *et al*. (2015) that the effect of cow manure is very significant on eggplant plant height at the age of 15, 30 and 45 days after planting, number of fruit per plant, fruit weight per plant, fruit length, significantly different. fruit length and fruit diameter. The highest fruit weight per plant was produced by giving cow manure 15 t ha^{-1} $plant^{-1}$ which was 17.26 grams while the lowest was 50 t ha^{-1} $plant^{-1}$ which was 2.42 grams.

Carbon Dioxide Absorption Potential

a. Dry Weight of Dayak Onion Plant Biomass

The highest dry weight biomass was Dayak Onion which was given cow manure followed by goat manure, chicken manure

Table 4 Bulb weight, number of bulbs, tuber diameter and leaf dry weight per clump of Dayak onions given 4 types of manure

Type of manure	Bulb weight (g $clump^{-1}$)	Number of tubers (number $clump^{-1}$)	Tuber diameter (cm)	Leaf dry weight (g $clump^{-1}$)
Chicken (P1)	29.50 a	6.75 a	2.17 ab	5.38 a
Swallow (P2)	28.50 a	8.25 b	1.32 a	6.25 ab
Cow (P3)	41.50 b	7.25 ab	2.90 b	8.00 b
Goat (P4)	32.00 a	6.50 a	2.08 ab	7.23 b

Note: The numbers followed by the same letter in the same column are not significantly different inthe HSD test 5%.

and the lowest was given swallow manure. The amount of dry weight in each treatment is directly proportional to the data in Table 4 where the weight of the tuber and the weight of the Dayak leek affect the dry weight of the biomass. The data on the weighing results of the dry weight test sample of Dayak onions are presented in Table 5.

Meriati's research (2018) showed data that the application of cow manure increased the growth and yield of shallots such as plant height (33cm), number of tillers per clump (8 tillers), number of tubers (8 bulbs), wet tuber weight (585.30 g) and dry tuber weight (481.53 g). Prasetyo (2014) with treatments, namely cow manure 90 t ha^{-1}, goat manure 60 t ha^{-1}, chicken manure 36 t ha^{-1} and NPK fertilizer 1 t ha^{-1} + chicken manure 20 t ha^{-1} against red chili plants. The results showed that the treatment of 90 t ha^{-1} of cow manure gave the highest fruit production, namely 302.58 g of $plant^{-1}$.

b. Biomass, Carbon Storage, and Carbon Dioxide Absorption

Pamoengkas *et al*. (2000) stated that biomass is the most often employed metric for describing and understanding plant growth. This is based on the fact that biomass estimation is reasonably simple to measure and represents the whole metabolic processes undergone by plants, making it a fairly realistic growth indicator when correlated with the overall performance of plant growth.The Dayak onion treated with cow dung had the greatest amount of biomass, carbon storage, and carbon dioxide absorption, followed by goat manure, chicken manure, and swallow manure (Table 5). The quantity of dry weight in each treatment is proportional to the information in Table 4.The carbon content in plants is influenced by the amount of plant biomass content; the greater the plant biomass content, the greater the carbon content, as shown in Table 5 of this study. The Dayak onions treated with cow manure produced the highest biomass, with a biomass yield of 6.60 t ha^{-1}, 3.0 t ha^{-1} of stored carbon, and 12.11 t ha^{-1} of carbon dioxide absorption. Table 5's results surpass those of Alpian (2014) study, which found that seedling gelam (*Melaleuca leucadendron*) vegetation had a biomass of 0.252-0.282 t ha^{-1}, stored carbon of 0.115-0.140 t ha^{-1}, and carbon dioxide emissions of 0.421-0.512 t ha^{-1}.

The present plant biomass reveals the potential for carbon mass, according to Hairiah and Subekti (2007). The mass of plant biomass influences the quantity of carbon mass and carbon dioxide absorption mass of each plant portion. In addition, the increase in biomass content will result in an increase in carbon mass and carbon dioxide absorption mass.

Table 5 Dry weight of biomass, stored carbon and CO_2 absorption of Dayak onions applied with manure

Type of manure	Dry weight of biomass $clump^{-1}$ (g)	Dry biomass (t ha^{-1})	Stored Carbon (t ha^{-1})	Carbon dioxide Absorption (t ha^{-1})
Chicken (P1)	34.88	4.65	2.32	8.53
Swallow (P2)	34.75	4.63	2.32	8.50
Cow (P3)	49.50	6.60	3.30	12.11
Goat (P4)	39.23	5.23	2.61	9.60

CONCLUSION

1. Dayak onion plants planted in peat soil and fertilized with cow dung grew higher and had more leaves than Dayak onion plants fertilized with swallow manure. The application of 30 t ha^{-1} of cow dung resulted in a tuber weight of 41.50 g $clump^{-1}$, a greater tuber diameter, and the greatest number of tubers on Dayak onion plants that had been fertilized with swiftlet manure, which had a smaller tuber diameter.
2. Onions planted on peat soil and fertilized with 30 t ha^{-1} of cow dung had the maximum biomass, carbon storage, and carbon sequestration at 6.6, 3.3, and 12.11 t ha^{-1}, respectively.

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