THE APPLICATION OF VARIOUS DOSES OF SOLID ORGANIC FERTILIZER TO IMPROVE THE PRODUCTIVITY OF *PAKCOY* (*Brassica chinensis* L.) IN THE LATOSOL SOIL

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ABSTRACT

According to the statistical data, there are 180.000 ha of soil per year turned into a non-agriculture soil. One of efforts to overcame that problem is by utilizing less productive soils in Indonesia, such as latosol soil whose area is equal to 84,63 million hectares. The latosol soil is generally spread in the mountainside and acidic. The use of organic waste such as water hyacinth and swallow waste as solid organic fertilizer can improve the growth of pakcoy plants. This research used complete random design of mono factor 5x4. The treatments given were fertilizer doses namely control (P1), 50 kg N of organic fertilizer/ha (P2), 100 kg N of organic fertilizer/ha (P3), 150 kg N of organic fertilizer/ha (P4), and 200 kg N of organic fertilizer/ha (P5). The observed parameters were the plant height, the leaves total, the leaves area, the gross weight, the dry matter content, and the plant chlorophyll level. The data were processed using variance analysis (ANOVA), if there was an influence, it was continued by using the Duncan's Multiple Range Test (DMRT) with the reliance level of 95%. This research was conducted at the greenhouse and Plant Ecology and Production Laboratory of Animal and Agriculture Faculty of University of Diponegoro on March to June 2019. The research results indicated that the organic fertilizer treatment of 150 kg N/ha gave the best response and could improve the plant height of 34%, the leaves total of 45,79%, the leaves area of 35, 98%, and the gross weight of 84% than the control.

Keywords: Water Hyacinth, Swallow Waste, Pakcoy, Organic Fertilizer.

INTRODUCTION

Latosol soil is one of soils that is often scattered in Indonesia, of which soil reaches of 84.6 million hectares (ha). The latosol soil is an acidic soil that is less prosperous because it experiences advanced washery and weathering so that the P of soil is organized as Al-P and Fe-P compounds (Suminar *et al*., 2017). High rainfall causes deficiency condition of P in the soil. The characteristic reparation of latosol soil can be done by adding the organic material. One of organic material sources is organic fertilizer that derives from natural material. Natural material that are decomposed produce organic acids, of which acids can form a chelation bond of Al and Fe ions; thus, it decreases the solubility of Al and Fe ions and also the availability of P is increasing (Sari *et al*., 2017).

Fertilizer is a substance that needed by plants to grow and increase the productivity. The fertilizer is divided into organic and inorganic fertilizers based on the basic material of making. The advantage of organic fertilizer is able to improve the less soil prosperity that is caused by inorganic fertilizer distribution. The organic fertilizer can be made through composting process. The composting process can take place aerobically that involves oxygen and anaerobic or without using oxygen in the process. The

advantage of anaerobic composting is the secondary results of liquid organic fertilizer, of which fertilizer can be used as advanced organic fertilizer.

Pakcoy plant (*Brassica chinensis* L.) is a plant that has high economical values and contain of essential substances which are needed by body. The consumption of household per capita towards *pakcoy* has increased in 2013 as many as 1.304 kg to 1.408 kg in 2014 and 2.086 kg in 2015 (General Directorate of Horticulture, 2017). However, the productivity of *pakcoy* plants had decreased because of less soil prosperity, of which prosperity is caused by inorganic fertilization continuously and also pest attack. The *pakcoy* plants production in Indonesia from 2009 to 2012 has decrease as many as 10,75% (Directorate of Vegetable Plants and Ornamental Plants, 2014). The production of *pakcoy* in 2013 was 635.728 tons, and then declines to 5,23% in 2014 and becomes 602.468 tons and it declines again as many as 0,38% on 2015 to 600.188 tons (General Directorate of Horticulture, 2016).

One of alternative efforts to increase the soil prosperity is by doing a composting as well as plants protection effort. The fertilizer that used is an organic fertilizer that has high organic material contents so that it can repair the soil quality. The material, which can be used as organic fertilizer, are swallow waste and water hyacinth. The swallow waste can be used as organic fertilizer because it contains of C-organic of 50,46%, N total of 11,24%, and C/N ration of 4,49, pH 7,97, P 1,59%, K 2,17%, Ca 0,30%, and Mg 0,01% (Talino *et al*., 2013). The swallow waste is used to improve the N level of organic fertilizer because the content of N in swallow waste is much higher than the other livestock wastes. Cow manure has nutrient contents of 1,30% N, 0,58% P_2O_5, 2,15% K_2O, 0,99% Ca, 0,52% Mg, and 13,5% of C-organic, while the nutrient element contents of chicken manure are 2,21% N, 2,98% P_2O_5, 2,05% K_2O, 1,06% Ca, 0,63% Mg, and 12,3% of C-organic (Adeniyan *et al*., 2011), and the nutrient element contents of goat manure are 2,10% N, 0,13% P_2O_5, 1,97% K_2O, 1,64% Ca, 0,60% Mg, and 39,9% of C-organic (Samekto, 2006).

The addition of water hyacinth on the making of organic fertilizer aims to improve the organic material on the fertilizer because the organic material contents of water hyacinth are very high. The selection of water hyacinth as the material of fertilizer making has advantages other than as utilization of aquatic weeds as well as an effort to control the aquatic weeds so that the population can be controlled; thus, it cannot destruct the territorial waters ecosystem. The water hyacinth (*Eichhornia crassipes*) has organic material contents of 78,47%, C-organic 21,23%, N total 0,28%, P total 0,0011%, and K total 0,016% (Pramushinta, 2018). The organic fertilizer enriched with *Trichoderma harzianum* mushroom can improve the soil microbes to speed up the composting, take care of the soil prosperity and the microbes will stay alive an active in compost (Kalay *et al.* 2016). The purpose of this research is to find out the influence of solid organic fertilizer distribution from swallow waste and water hyacinth towards the productivity of *pakcoy* by giving the organic fertilizer in appropriate doses.

RESEARCH METHOD

Time and Place

This research was conducted during 4 months from March 2019 to June 2019. This research was conducted at the *Green House* and Plant Ecology and Production Laboratory, Animal and Agriculture Faculty of University of Diponegoro.

Tools and Materials

The tools that used in this research were analytical balance, plastic, rubber, knife, shovel, scissor, sieve, bucket, hoe, *trash bag,* mortar, grinder, spoon, *kjeldahl flask,* porcelain cup, cover cup, small Erlenmeyer, big Erlenmeyer, measuring cylinder, volumetric pipet, pipette, electric stove, digital biuret,

destilator, oven, funnel, Whatman filter paper, cuvette, beaker glass, oven, fume hood, hose, stationaries, and camera.

The material used in this research were pakcoy seeds. Water hyacinth, swallow waste, inoculant of *Trichoderma harzianum*, cow waste, zeolite, rice, plastic, tray, rice husk, and latosol soil from *Agrotechnopark* of Animal and Agriculture Faculty of University of Diponegoro.

Research Design

This research used Complete Random Design (*RAL*) of mono factor, in which it consisted of 6 treatments with 4 repetitions. Those factors were the doses of organic fertilizer that consisted of control (P1), 50 kg N of organic fertilizer/ha (P2), 100 kg N of organic fertilizer/ha (P3), 150 kg N of organic fertilizer/ha (P4), and 200 kg N of organic fertilizer/ha (P5). The observed parameters were the plant height, the leaves total, the gross weight, the dry matter contents, the leaves area, and the leaves chlorophyll level.

The Making of Organic Fertilizer

The makings of solid organic fertilizer using basic material of swallow waste and water hyacinth were (1) Tools and material preparation, (2) The making of organic fertilizer by shriveling up the water hyacinth that had been cut so that it had small size during 3 days, then it was added by swallow waste (1:3) and the inoculant of *Trichoderma harzianum* as decomposer in the anaerobic composting process during 21 days. The finished composting results were marked using crumb texture and not foul-smelling, mixed by cow waste and zeolite that had been mashed up (1:1:1). That mixture were homogenized and printed with *pelleter* tool and then it was dried without using direct sunlight until the water level was at least 12 %, (3) The seedbed of *pakcoy* was for 2 MST, (4) The preparation of planting media was latosol soil and rice husk (2:1) with the weight total of 3,525 kg/*polybag,* (5) The transplanting was after 2 weeks of seeding, (6) The application of fertilizer was based on the treatment doses, (7) The cultivation included of watering and weeding weeds, and also (8) The *pakcoy* harvesting was after 4 MST.

Laboratory Analysis

The basic laboratory analysis involved of the organic fertilizer to find out the real doses of each plant. The observation variables were pH, the contents of N, P, K, C Organic, Organic Material, C/N ratio, and metal contents of the fertilizer.

Data Analysis

All of the obtained data were tested by using variance analysis (*ANOVA*) and if there was a treatment influence toward the response, it was continued by *Duncan's Multiple Range Test* (DMRT) test with the reliance level of 95%.

RESULTS AND DISCUSSION

Fertilizer Basic Analysis

Departing from the laboratory test results, it was obtained that the nutrient contents of solid organic fertilizer from swallow waste and water hyacinth were in accordance with the Standard of SNI

19-70302004 and Decree of Minister of Agriculture (*Permentan*) Standard of No.70/*Permentan*/ SR.140 /10/2011, of which results were as the following:

Table 1. The Substances Content of Organic Fertilizer and Swallow Waste and also Water Hyacinth

No	Parameters	Organic Fertilizer of Swallow Waste and Water Hyacinth	Standard of SNI 19-70302004	Decree of Minister of Agriculture (*Permentan*) Standard of No.70/ *Permentan*/SR.140/10/2011
1.	Nitrogen	2,168%	0,4%	
2.	Phosphate	1,3916%	0,1%	> 4 %
3.	Potassium	1,393%	0,2%	
4.	Organic Material	45,137%	27-58%	-
5.	C/N ratio	12,075	10-20	10-25
6.	C organic	26,179%	9,8 – 32%	≥ 12 %
7.	Cadmium (Cd)	0 ppm	-	< 2 ppm
8.	Heavy Metals Iron (Fe)	496 ppm	-	< 9000 ppm
9.	Lead (Pb)	4 ppm	-	< 50 ppm

The analysis results that had been done indicated that the parameters of organic fertilizer contents that had been tested were nitrogen of 2,168%, phosphate of 1,3916%, potassium of 1,393% ($N+P_2O_5+K_2O$ = 4,9526%), C organic of 26,179%, organic material of 45,137%, and C/N ratio of 12,075, in which those were in accordance to the standard of SNI 19-70302004 and the Decree of Minister of Agriculture (*Permentan*) Standard of No.70/*Permentan*/ SR.140 /10/2011; thus, the obtained organic fertilizer had complex nutrients and good quality of organic fertilizer. According to Yuniwati *et al*. (2012) who asserted that good organic fertilizer had compost characteristics that had experienced thorough weathering, in which the characteristics were brownish color, odorless, low water level, and also had the nutrient contents based on the standard. The good organic compost fertilizer also should have heavy metal content below the maximum specified standard. The organic fertilizer of swallow waste and water hyacinth had the heavy metal contents of Cd 0 ppm, Fe 496 ppm, and Pb 4 ppm. Those metal contents were below the maximum standard of heavy metal content based on the Decree of Minister of Agriculture (*Permentan*) Standard of No.70/*Permentan*/ SR.140 /10/2011, so the organic fertilizer had been in accordance with the established standard and it was safe to be applicated on the plants.

The Parameters Observation Results

Based on the *ANOVA* and *DMRT* tests on the growth and productions parameters of *pakcoy* plants, it was obtained the results as follow:

Table 2. The Values of F-Test in The Observed Parameters

Variance Sources	TT	JD	LD	BB	KBK	KK
Treatment	10,28**	18,20**	3,22*	5,00**	$0,36^{ns}$	$0,71^{ns}$

Description: TT = Plant Height, JD = Leaves Total, LD = Leaves Area, BB = Gross Weight, KBK = Dry Matter Content, KK = Chlorophyll Level, ** = Very Significant; * = Significant; ns = not significant.

The Plant Height (TT)

Base on the parameter of plant height observed after 4 MST, it was obtained the results as follow:

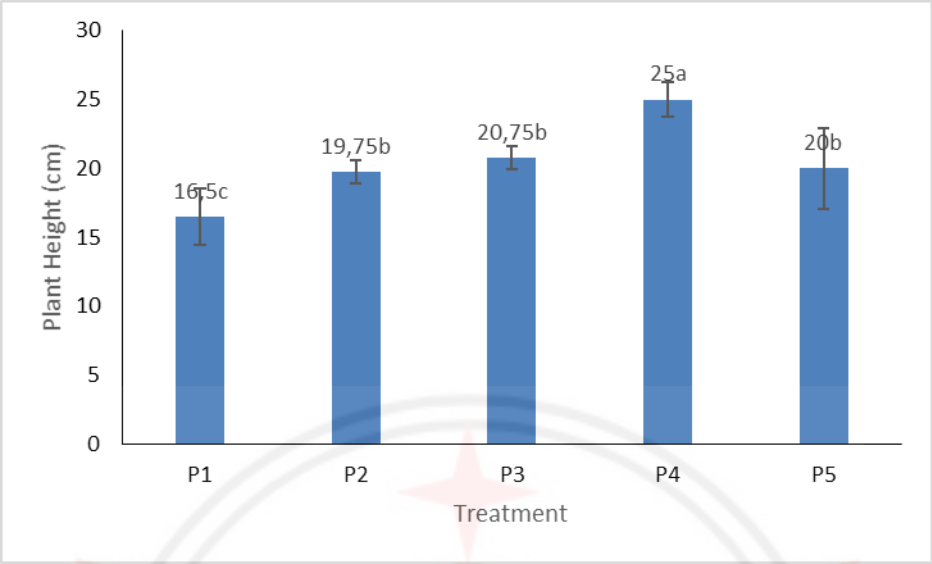

Figure 1. The Graphic of The Plant Height of *Pakcoy* 4 MST

The data analysis results showed that the average of plant height in the treatment of P1 (without fertilizer) showed the lowest results as many as 16.5 cm. The treatment of P1 (without fertilizer) showed the lowest plant height average because the plants did not get supplies of nutrients through the composting, in which it could push ahead the growth of plants. Yuliatin *et al*. (2018) proposed that fertilizer had important role in plants cultivation especially for pushing ahead the growth and improving the productivity. The average result of the best plant height was shown in the treatment of P4 (150 kg N of organic fertilizer/ha), in which it produced the average plant height of 20 cm and it was significantly different from the other treatments. It was because the nutrient needs of *pakcoy* plants were optimally fulfilled in the treatment of P4 (150 kg N of organic fertilizer/ha). This was in line with the Abdillah *et al*. (2017) statement who stated that the nutrient available were sufficient for the needs of plants in a balanced state and it could improve the vegetative growth and the production results of kalian plants. The growth improvement of *pakcoy* plants was very significant (P>0,05).

The Leaves Total (JD)

Based on the parameter of leaves total observed after 4 MST, the results were as follow:

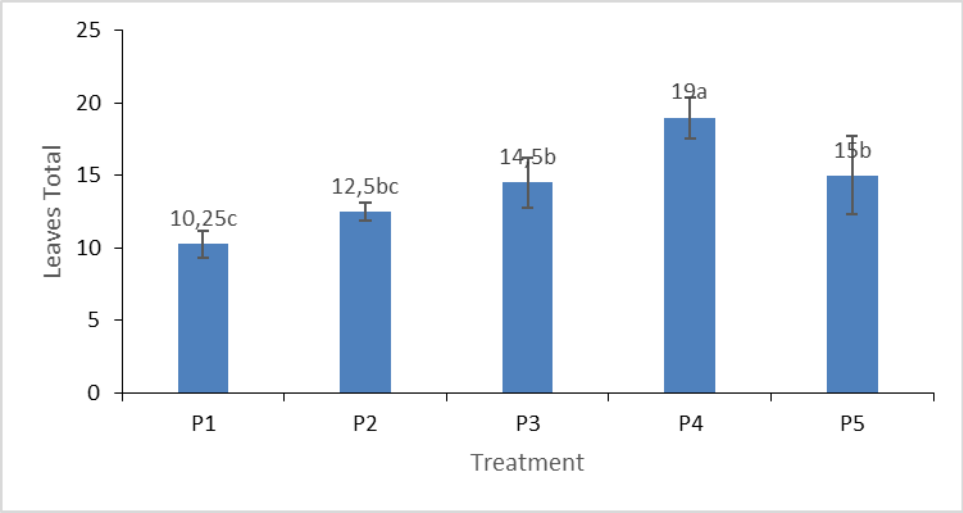

Figure 2. The Growth Graphic of The Total Leaves of *Pakcoy* 4 MST

The data analysis showed that the average results of leaves total in the treatment P1 (without fertilizer) had the lowest result. The average results of the best leaves total were shown in the treatment P4 (150 kg N of organic fertilizer/ha). The addition of doses in the treatment P5 (200 kg N of organic fertilizer/ha) gave the average results of leaves total that was decreased than the treatment P4 (150 kg N of organic fertilizer/ha). According to Wijayanto *et al*. (2016), the plant growth was not optimal because there was Liebig Minimum Law and the Shelford Tolerance Law in the concept of limiting factors namely the state of approaching or exceeding the tolerance threshold of a condition, resulting in not optimal plant growth. The leaves total on the treatment P4 (150 kg N of organic fertilizer/ha) showed the best results and it was significantly different from the other treatments because the N nutrient that were needed by *pakcoy* plants for the vegetative growth had been fulfilled optimally. According to Kurniawan *et al*. (2017), *pakcoy* plants were broad leaf vegetables that needed more N nutrients to reach the vegetative phase and also influenced on the quality and quantity of the *pakcoy* plants. The growth improvement of *pakcoy* plants was very significant (P>0,05).

The Leaves Area (LD)

Based on the parameter of leaves area observed after 4 MST, the results were as follow:

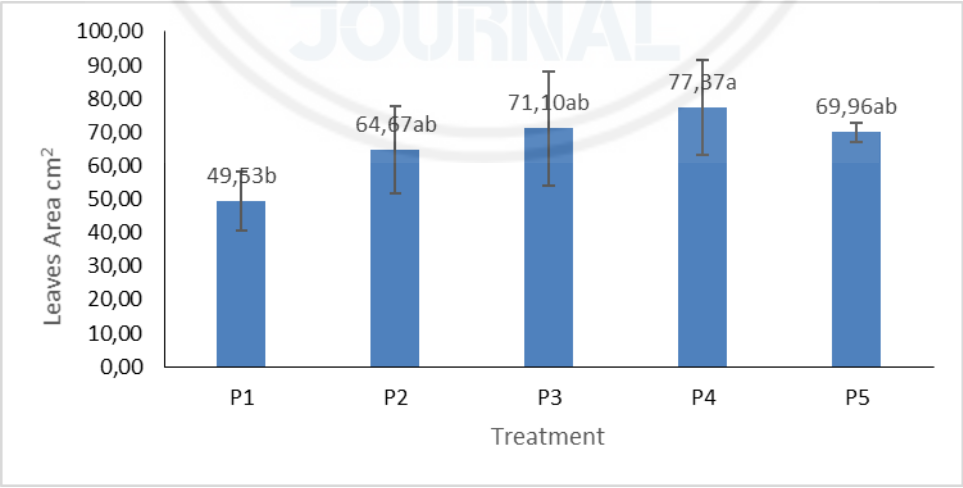

Figure 3. The Growth of Leaves Area of *Pakcoy* 4 MST

The data analysis showed that the lowest average result of leaves area was in the treatment P1 (without fertilizer) with the result of 49.525 cm^2 and it was significantly different from the treatment P4 (150 kg N of organic fertilization/ha). The application of organic fertilizer in various doses could improve the leaves area of *pakcoy*. It was because the organic fertilizer could supply the nitrogen element, of which element was used by the plants for pushing ahead the growth. The application dose of organic fertilizer with the most optimal of plant height average result was in the treatment of P4 (150 kg N organic fertilizer/ha). Based on Pramitasari *et al*. (2016) who asserted that the distribution of organic fertilizer based on the needed doses of plants would give significant influence toward the expansion of leaves especially on the width and the leaves area. The growth improvement of *pakcoy* plants was significant (P>0,05).

The Plant Gross Weight (BB)

Based on the parameter of gross weight observed after 4 MST, the results were as follow:

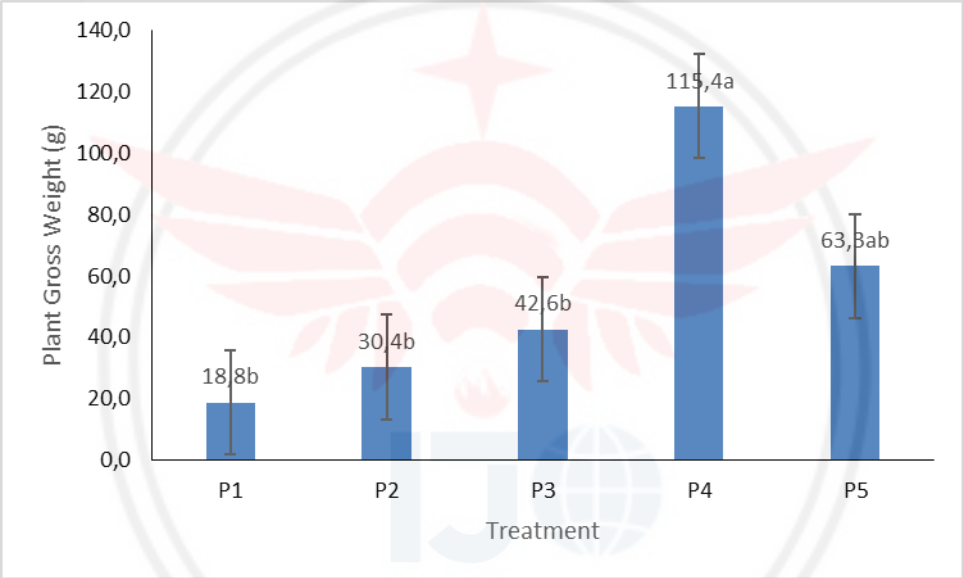

Figure 4. The Graphic of Gross Weight Production of *Pakcoy* 4 MST

The data analysis results showed that the average results of lowest plant gross weight were in the treatment P1 (without fertilizer), P2 (50 kg N of organic fertilizer/ha), and P3 (100 kg N of organic fertilizer/ha). The treatments of P4 (150 kg N of organic fertilizer/ha) and P5 (200 kg N of organic fertilizer/ha) were the treatments with the best gross weight because both of them had large leaves area. Fitriana *et al*. (2016) postulated that the more surface area of the leaves, the more photosynthate results from photosynthesis, so it caused greater fresh weight of the plants. The improvement of *pakcoy* plant production was very significant (P>0,05).

The Dry Matter Content of Plant (KBK)

Based on the parameter of dry matter content observed after 4 MST, the results were as follow:

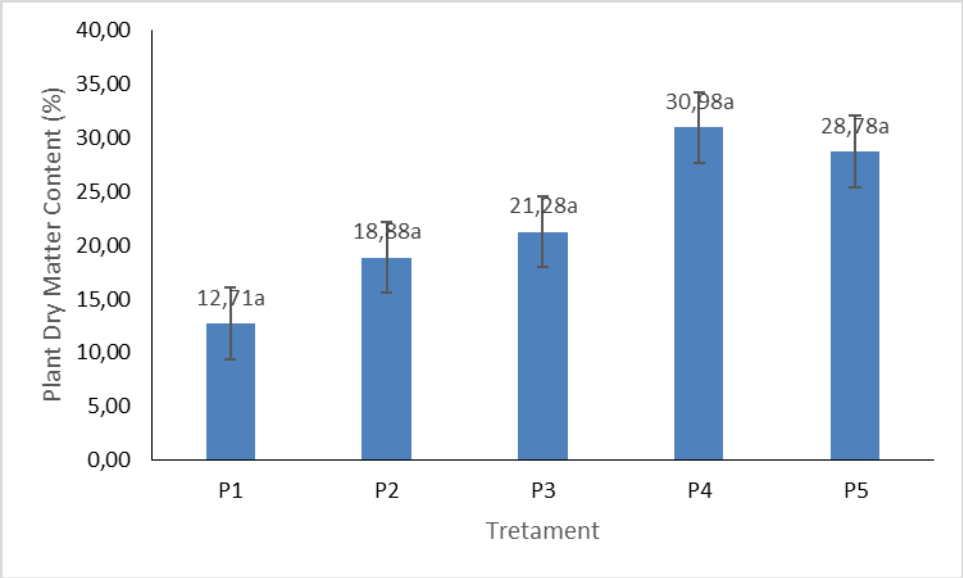

Figure 5. The Production Graphic of Dry Matter Content of *Pakcoy* 4 MST

The data analysis indicated that there were no significant differences of the dry matter content on all of the treatments. The improvement of *pakcoy* plants production was not significant (P>0,05).

The Chlorophyll Level of Leaves (KK)

Based on the parameter of chlorophyll level observed after 4 MST, the results were as follow:

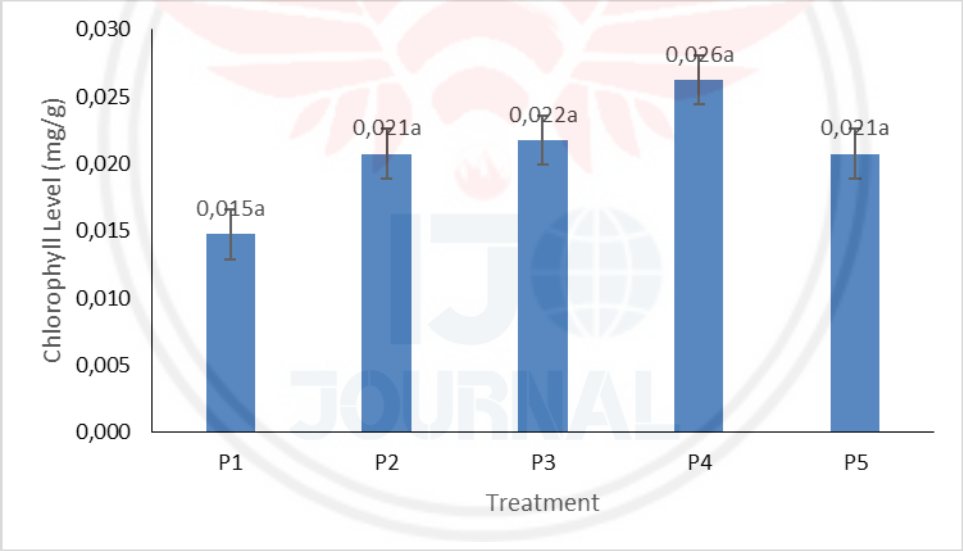

Figure 7. The Graphic Production of Leaves Chlorophyll Level of *Pakcoy* 4 MST

The data analysis results showed that there were no significant differences of chlorophyll level in all of the treatments. The improvement of *pakcoy* plants production was not significant (P>0,05).

CONCLUSION

The application of solid organic fertilizer from swallow waste and water hyacinth is able to improve the productivity of *pakcoy* plants. The application of organic fertilizer of swallow waste and water hyacinth

with the doses of 150 kg N of organic fertilizer/ha in the latosol soil can give the best results in each treatment and it is significantly different from the treatments of plant height and the leaves total.

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