

Effectiveness of Organic Fertilizer on Growth and Production of Cabbage Plant (*Brassica oleraceae*)

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Abstract

Research on the effectiveness test of organic fertilizer contains 18% C - Organic growth and production of cabbage was conducted from October 2017 to April 2018. This research aims to examine the effectiveness of organic fertilizer on the growth and yield of cabbage plants. The method of this research used a randomized block design, which consisted of 9 treatments and 3 replications. The location of the research was on dry soil at Dusun Jeding, Junrejo Village, Batu (1000 m asl). Result of soil analysis before the research with pH neutral, low N, higher P₂O₅, low CEC (Cation Exchange Capacity), and low C-organic, as well as clay loam. The results of the research showed that the application of organic fertilizer significantly affects on plant height, numbers of the leaf, width of canopy, diameter of the crop, and weight of yield. The dose of 800 kg/ha produces a net weight of 24.9 t/ha by the highest value of RAE 408.35. However, the application of Petroganik fertilizer 500kg/ha, it produces a net weight of 18.10 t/ha by RAE value 256.28. Application of the recommended fertilizers (Urea 200, ZA 250, SP-36 250, and KCl 200kg/ha) and organic fertilizer 500-800 kg/ha could increase the growth and production of cabbage by B/C Ratio 2.61. It can be concluded that organic fertilizer "Bukit Daun" was effective in increasing the growth and yield of cabbage.

1. INTRODUCTION

Cabbage (*Brassica oleracea*) is one of the vegetable plants that become a priority for its production to be increased (Firmansyah and Sri, 2003). In general, cabbage is cultivated by

the farmer on the upland at the altitude of 1.000–2.000 meters above sea level (asl) with highly intensive soil cultivation, therefore it tends to face the risk of degraded land as a result of high erosion. Besides that, markets

that could absorb most of the cabbage production are in big cities. The high demand for cabbage has not been balanced with cabbage production at the domestic level.

Based on the need for nutrients, cabbage requires more nitrogen than other nutrients Pracaya, (2007). According to Mulyono (2009) cabbage requires more fertilizer due to this crop absorbs more nutrients, especially nitrogen and potassium. According to Subhan (2014), phosphate plays in stimulating molybdenum absorption by the plant and affects the quality of the cabbage.

According to data from the Central Bureau of Statistics, the Republic of Indonesia (2010), the farming area of cabbage in East Java covered 9,993 ha. The farming area decreased in comparison within 2009 that reached 10,748 ha. From year to year, the farming area of cabbage in Indonesia tended to decrease; therefore it required an effort to overcome the problem by utilizing the yard.

According to Anonim (2011), the application of artificial fertilizer and pesticide on cabbage beyond the threshold may contribute a negative effect on the quality of production, living things, and environmental pollution that have a worse impact on the ecosystem.

To overcome various negative impacts because of conventional agricultural activities, the attention of the peoples in the world start to move to agriculture environmentally safe. An alternative to overcome the problem is developing organic farming as a system that could maintain harmony among components of the ecosystem continuously and everlasting. Such organic farming relies on nutrients through organic fertilizer and other natural inputs, such as microbe. In order to develop biotechnology in this organic farming, research institutions and colleges take a part through researches on the microorganism, which could provide nutrients and control diseases. The real implementation that can be perceived by the farmers is through organic fertilizer.

An excellent planting medium is one of the requirements to increase the production of

plants. By combining planting medium and biofertilizer, the plants will grow well due to a sufficient amount of nutrients are available. According to Sarief, S (1989), organic matters could improve soil quality. By applying organic fertilizer, it is expected that organic fertilizer will not only bring about the positive effect for the soil, but also for the growth and productivity of the plants. Besides that, the application of organic fertilizer may not leave behind a chemical residue as in chemical fertilizer due to the part of the cabbage, which is consumed is the crop (leaf). Therefore, it is expected that the amount of the exported commodity of cabbage will increase and give profit to the farmers. In turn, human beings as the main consumers of cabbage will be more unimpeded to consume cabbage due to it contains no chemical residue that may harm human health. According to Suryana, N, K. (2008) a plant will thrive if the nutrients needed are available sufficiently and suitable for absorption by roots.

Cabbage requires macronutrients such as Nitrogen, Phosphor, and Potassium that play important roles in increasing the yield and quality of cabbage. Cabbage also requires micronutrients such as Cu, Mo, Zn, B, Fe, and Mn, which are generally found in complementary liquid fertilizer, for instance, organic fertilizer.

The recommended fertilizer application from Vegetable Research Center (2017) for cabbage is organic fertilizer, such as cow manure 30 t/ha, sheep manure 20 ton/ha, or straw compost 18 t/ha. Artificial fertilizers include urea 100 kg/ha, ZA 250 kg/ha, TSP or SP36 250 kg/ha and KCl 200 kg/ha. Nevertheless, the farmers tend to apply fertilizer, which is unsuitable with the recommendation, but only based on their ability, so that in order to make the fertilizer application to be more effective and efficient, agrotechnology inputs are required and one of them is the application of organic fertilizer.

Now more entrepreneurs that produce organic fertilizer contain both macro and micronutrients. To obtain the distribution

license, the fertilizer should follow the effectiveness test. Objective of the research was to study effectiveness of organic fertilizer on growth and yield of cabbage (*Brassica oleraceae*)

2. MATERIALS and METHODS

Materials of the Research

Materials used in the research include: soil cultivator, means of production: organic fertilizer that has been examined, seeds of cabbage and pesticides, as well as tools to maintain the plants, such as a sprayer, water hose, and watering can.

The result of the analysis of nutrient of the observed organic fertilizer, which was conducted by the Research Institute and Development of Agriculture is presented in Table 1.

Table 1. Nutrients Contain in Organic Fertilizer.

No	Parameter of test	17.06.861.K.P.541
1	pH H_2O	7.3
2	Water Content(%)	16.73
3	Additive Material (%)	0.00
4	Grain Size	96.64
5	C-Organic (%)	18.41
6	N - Total (%)	1.22
7	C/N Ratio	15
8	P_2O_5 - total (%)	2.23
9	K_2O - total (%)	1.56
10	Fe - total (Ppm)	6641
11	Mn - total	534
12	Zn - total(Ppm)	215
13	Pb - total (Ppm)	17

The research was conducted at one of central productions of cabbage in East Java, Dusun Jeding, Junrejo Village, Junrejo Subdistrict, Batu, from October 2017 to April 2018. Results of analysis on soil before the research (Table 2) show pH neutral, moderate to high level of K, low N, very high P_2O_5 , low CEC (Cation Exchange Capacity), and low C-organic, as well as clay loam.

Table 2. Results of Analysis on Soil with Effectiveness Test of Organic Fertilizer on Cabbage

Type of Analysis	Value	Level
Water content	4,21	
pH - H ₂ O	6,8	Neutral
K soil	5,5	Moderate-high
C-organic (%)	1,73 %	Low
N - total (%)	0.08 %	Very low
P ₂ O ₅ (ppm)	170,01 ppm	Very high
K-available (me/100 g)	0,41	Moderate
Mg-dd	2,01	Moderate
Ca-dd	12,08	High
Na	0,25	Low
CEC (me/100 g)	14,85	Low
Texture :		
- Sand(%)	38 %	
- Dust (%)	32%	Clayey loam
- Clayey(%)	30%	

Source: Soil Laboratory of AIAT, East Java, 2018

Method of the Research

Method of the research used Randomized Block Design that comprises of 9 treatments and 3 replications (Table 3). The experimental plot/seedbed was adjusted with land area, each treatment comprises of 3 seedbeds. Each replication requires 27 seedbeds for 9 treatments of fertilizer and seedbed for the surrounding border. The implementation of the research should be concerned with statistical rules and experimental design.

Stages of Activity

Land Preparation, land is hoed and plowed with 20-30 cm depth and made the seedbed with 90 cm x 720 cm size on average or adjusted in accordance with the research and land area. Manure is applied before planting by spreading it over the seedbeds evenly and mixed. Furrowing is made between plots of treatment as plot divider.

Table 3. Combination of Treatment for Single Fertilizer and Organic Fertilizer on Cabbage.

Treat	Type and Dose of Fertilizer (kg/ha)					
	Urea	ZA	SP36	KCl	Petroganic	Organic Fertilizer
A	0	0	0	0	0	0
B	200	250	250	200	0	0
C	200	250	250	200	500	0
D	200	250	250	200	0	300
E	200	250	250	200	0	400
F	200	250	250	200	0	500
G	200	250	250	200	0	600
H	200	250	250	200	0	700
I	200	250	250	200	0	800

Notes: Combination of treatment by dose of fertilizer based on nutrient content

Planting. Plant spacing was arranged in 60 x 50 cm. was used to plant 3-4 weeks seedling and have 4-5 leaves by digging the planting holes in accordance with the given spacing by using dibble, and then remove the plants from the polybags. After the seeds are completely transplanted to the seedbed, and then watered them.

Fertilizer Application (Soil Banking). Tested organic fertilizer was applied as recommended 600 kg/ha. Artificial fertilizers used 200 Urea kg/ha, 250 ZA kg/ha, 250 SP 36 kg/ha and 200 KCl kg/ha. Each plant also added 4 g Urea + 9 g ZA, 9 gr SP 36 and 7 g KCl.

Maintenance. Maintenance includes daily watering, in the morning and in the afternoon. Weeding (loosen the soil and heap up the soil around the stem base) is done at 2 and 4 weeks. Pest and disease was controlled with pesticide.

Harvest Time, cabbages are harvested at 81 - 105 dap with characteristics as follow: outer edges of the crop leaves at the top part of the crop have rolled out and turn to purple, while the inner part was solid.

Parameter of Observation

Observation was started at 21 days after planting (DAP) by interval once a week. The observed parameters include non-destructive and destructive (yield component)

observation, such as: plant height, numbers of leaf, diameter of canopy, diameter of crop and net weight of crop.

Data Analysis

The collected data was analyzed by analysis of variance (ANOVA). The difference between treatments was tested by Least Significant Difference test (LSD 0.05). B/C analysis was applied to find out the economic benefit on cabbage cultivation.

Effectiveness of organic fertilizer was approached using Relative Agronomic Effectiveness (RAE) method. RAE is the comparison between the increase yields due to specific fertilizer application and the increase yields due to standard fertilizer application multiplied by 100. RAE equation is as follows.

$$RAE = \frac{\text{Yield of the tested fertilizer-control}}{\text{Yield of the standard fertilizer-control}} \times 100\%$$

3. RESULTS

Plant Growth

Organic fertilizer application by dose 700 to 800 kg/ha along with inorganic fertilizer application as recommended by Vegetable Research Center (treatment H and I) produce the highest numbers of the leaf. The application of such dose showed no significant difference with dose 400 to 600 kg/ha.

The lowest height of the plant was found on the control and without the application of organic fertilizer (A and B), and the plant height was 37.4 cm. The highest plant height (44.4 cm) was found by the application of organic fertilizer with a dose of 800 kg/ha, and it did not show a significant difference to dose 700kg/ha. Plant height by the application of organic fertilizer at 300 to 400 kg/ha, parallel with plant height by the application of comparative fertilizer of Petroganic with dose 500kg/ha, and plant height was 41-42 cm. The application of Petroganic.

Table 4. Effectiveness of organic fertilizer treatment to cabbage plant growth

Treatment	Number of Leaf (Blade)	Height of Cabbage (cm)	Canopy of Crop Cabbage (cm)
A	24.07 c	37.40 e	38.40 e
B	24.73 bc	37.73 e	38.47 e
C	24.87 bc	41.80 cd	40.13 bcde
D	24.13 c	40.93 d	39.60 de
E	25.53 abc	41.40 d	39.80 cde
F	26.00 abc	42.07 bcd	41.33 bcd
G	26.60 ab	42.93 bc	42.93 ab
H	27.67 a	43.40 ab	42.70ab
I	27.80 a	44.40 a	45.33 a
KK (5%)	4.76	2.51	14.86

The smallest width of the cabbage canopy (38 cm) was shown on the control and on inorganic fertilizer application without organic fertilizer application. The application of organic fertilizer by dose 300 to 800 kg/ha showed canopy width for about 40 cm to 45 cm. Canopy width on the comparative fertilizer application of Petroganik by dose 500 kg/ha did not show any difference with the application of organic fertilizer by dose 300 to 500 kg/ha.

Yield Component

The diameter of the small crop was shown on the control without fertilizer application and showed no significant difference with inorganic fertilizer application without organic fertilizer application. The organic fertilizer application by dose 300 -500 kg/ha showed no significant difference, on the diameter of the crop, with the control and without organic fertilizer application.

The net yield of the crop means that the green parts have been removed and ready to consume. The net yield of the crop on the control without fertilizer application was just 8,3 t/ha, and it did not show a significant difference with the application of chemical fertilizer without organic fertilizer and added with 300 kg/ha chemical fertilizer.

The addition of organic fertilizer by dose 400 to 800 kg/ha gave the highest yields,

which did not show a significant difference, but higher than the control or the standard fertilizer. Yield from the application of dose 400 - 800 kg/ha was parallel with the yield by the addition of 500kg/ha Petroganic (Table 5).

Table 5. The effectiveness of organic fertilizer treatment to cabbage yield.

No	Treatment	Diameter Cabbage Crop	Net Weight ton/ha
1	A	21.80 c	8,34 d
2	B	23.67 bc	12,15 dc
3	C	25.40 ab	18,10 abc
4	D	23.33 bc	13,54 bcd
5	E	25.73 ab	19,17 ab
6	F	26.17 ab	21,69 a
7	G	26.27 a	21,63 a
8	H	26.37 a	23,26 a
9	I	26.43 a	24,90 a
	KK (5%)	8.58	20.22

Pest and Disease

Planting maintenance in the field has been conducted intensively. Pests and diseases observation were done periodically until the harvest time, and control should be concerned with the economic threshold. Therefore, the growth and production of cabbage will not be disturbed by plant pest infestation. Result of observation on plant pest during in early planting was the infestation of *Phyllophaga* sp. that attack faster, but it can be controlled. The former infested plant will be replaced by the new ones, so that it will grow well and parallel with other plants, which are not infested.

Relative Agronomic Effectiveness (RAE) Value

All treatments using organic fertilizer had RAE >100. The highest RAE was shown by the application of organic fertilizer by dose 800 kg/ha with a value of 408.35. Low RAE (136.8) was shown by the application of organic fertilizer at dose 300 kg/ha, while for the comparison, the application of Petroganic 500kg/ha was 256.28. All treatments with the addition of organic fertilizer by doses 400 -

800 kg/ha showed higher RAE than the comparative treatment (Table 6).

Result of analysis on simple farming operation showed the application of the recommended fertilizers (Urea 200, ZA 250, SP-36 250 and KCl 200kg/ha) and organic fertilizer 500-800 kg/ha will be able to increase growth and production of cabbage by B/C Ratio 2.61. It can be concluded that organic fertilizer was effective to increase of cabbage growth and yield (Table 7).

Table 6. RAE Values on Effectiveness of Organic Fertilizer on Cabbage

Petroganic	Organicfertilizer	Net Weight of RAE
-	-	-
500	-	256.28
-	300	136.38
-	400	284.25
-	500	350.34
-	600	348.72
-	700	372.82
-	800	408.35

Table 7. Simple Farming Analysis of the Effectiveness of Organic Fertilizer on cabbage.

	Treatment A	Treatment B
Land lease	1,200,000	1,200,000
Total Workforce	1,000,000	1,250,000
Total Production Facilities	4,480,000	7,160,000
Total cost	4,840,000	9,560,000
Cabbage Yield (t/ha)	8.34	12.15
Kg / ha	8,340	12,150
Selling Price (Rp/kg)	1,500	1,500
Selling Results (Rp)	12,510,000	18,224,000
Net Income (Rp)	7,670,000	8,664,000
B/C Ratio	1.58	0.91

Treatment C	Treatment D	Treatment E
1,200,000	1,200,000	1,200,000
1,400,000	1,400,000	1,400,000
7,410,000	7,460,000	7,560,000
9,810,000	9,860,000	9,960,000
18.10	13.54	19.17
18,100	13,540	19,170
1,500	1,500	1,500
27,150,000	20,310,000	28,755,000
17,340,000	10,450,000	18,795,000

1.77	1.06	1.89	
Treatment F	Treatment G	Treatment H	Treatment I
1,200,000	1,200,000	1,200,000	1,200,000
1,400,000	1,400,000	1,400,000	1,400,000
7,660,000	7,760,000	7,860,000	7,960,000
10,060,000	10,160,000	10,260,000	10,360,000
21.69	21.63	23.26	24.90
21,690	21,630	23,260	24,900
1,500	1,500	1,500	1,500
32,535,000	32,455,000	34,890,000	37,350,000
22,475,000	22,295,000	24,630,000	26,990,000
2.23	2.19	2.40	2.61

4. DISCUSSION

Fewer numbers of the leaf on the control and on a low dose of organic fertilizer application, 300 kg/ha, showed significant difference with the application of organic fertilizer at dose 400 to 800 kg/ha (Table 4). 500kg/ha showed no significant difference with the application of organic fertilizer by dose 400 to 600 kg/ha (Table 4). According to Kubat, J, J. Klir and D. Pova (2003), that the combination of fertilization between organic fertilizers and inorganic fertilizers can increase nitrogen uptake by cultivated plants in various types of land and varieties. The results of soil analysis showed that the pH of the soil was neutral, According to that Smillie, J. and G. Gershuny (1999), soil pH affected nutrient availability in the soil. Nutrients in many soils are available at pH 6.2 - 6.8.

The wide canopy was shown by the application of organic fertilizer at dose 600 to 800 kg/ha, and the canopy width is about 42-45 cm (Table 4). A. Prakash and A. Adholeya (2014) cited that on *Cymbopogon winterianus* plants where the application of chicken manure results is in higher canopy weight.

According to Ratna D. I. (2012), increasing leaf area is an attempt by plants to efficiently capture light energy for photosynthesis normally in conditions of low light intensity. The increase in leaf area is caused by organic fertilizer providing the nitrogen needed by plants for its growth. According to Humadi. F. M. and H. A. Abdul Hadi (2008), plants have

certain limits to the concentration of nutrients. The inhibition of leaf growth is caused by the accumulation of nutrients by leaves causing the water to be absorbed into the accumulation of nutrients so that the leaves are damaged like burning. The biggest diameter crop was derived from organic fertilizer treatment by dose 600-800 kg/ha, and it showed no significant difference with the application of Petroganic fertilizer by dose 500 kg/ha (Table 4). Chicken manure at certain doses meets nutrient requirements, therefore that plant growth and its production are optimal Saragih. F, R. Sipayung, and F. Sitepu. (2015).

The availability of organic fertilizer will also be able to increase the levels of soil organic. Therefore, the soil is looser, better roots, and optimal metabolic processes will affect the yield of plants. The application of organic fertilizer contains nutrients in amounts that are not large, but the addition of organic matter into the soil can have a positive effect on the efficiency of nitrogen in plants so that nitrogen absorption will be more effective (Barbarick. K. A (1996). The provision of 10 tons of cow manure/ha produces growth and yield of Caisim plants (Fitriyanti. W, (2017) and (Sompotan. S, 2013), giving doses of 5 tons/ha of cow manure, 10 tons/ha, and 15 tons/ha can improve the yield of mustard plants.

5. CONCLUSION

The application of organic fertilizer will increase numbers of leaf, plant height, width of canopy, and yield component: diameter of crop and net weight of crop significant.

Organic fertilizer by dose 800 kg/ha will produce net weight 24.9 t/ha by B/C Ratio 2.61 and the highest value of RAE is 408.35. The application of Petroganic fertilizer by dose 500kg/ha as comparison may produce net weight of crop 18.10 t/ha and RAE value is 256.28. Therefore, organic fertilizer is effective cabbage crop ($p:0.05\%$).

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