

The Response of Cocoa Seedling (*Theobroma cacao* L.) Growth To Vermicompost And Terralyt – Plus Application

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ABSTRACT

The production of Cocoa in Indonesia is still relatively low, reached an average of 532.17 kg ha⁻¹, while Ivory Coast has reached 1.5 tons ha⁻¹ in 2013. One of the efforts to support the development of the cocoa plant is a breeding use of organic fertilizers, Vermicompost is an organic fertilizer that has a lot of nutrients and safe for plants and contains many microorganisms that needed land. While of effort to improve the performance of microorganisms in the soil by *terralyt-plus*. The research was conducted at the experimental farm of the Faculty of Agriculture and Animal Husbandry, University of Muhammadiyah Malang with an altitude of 560 meters above sea level, which held for 3 months. Research compiled using factorial randomized design consisting of two (2) factors. The first factor is vermicompost consists of 3 levels, namely: D₀ = 0g/plant; D₁ = 200g/plant and D₂ = 400g/ plant. The second factor is *Terralyt-plus* comprises 3 levels: T₀ = 0 ml/polybag, T₁ = 20 ml/polybag, and T₂ = 40 ml/polybag continued BNJ test with a level of 5%. Vermicompost fertilizer dosage of 400g/plant with the addition of *Terralyt-plus* 40ml / plants is the best treatment in all parameters of the cocoa plant (*Theobroma cacao* L.). Results from this study are in treatment plant height, a number of leaves and total leaf area were significantly different interactions occur while the stem diameter and the amount of chlorophyll there is no real interaction.

Keywords: *Vermicompost, Terralyt-plus, Cacao*

INTRODUCTION

Increased acreage of cocoa (*Theobroma cacao* L.) in Indonesia is very high. In 2012 an increase in acreage of cocoa into 1,774,464 ha and at the end of 2013 into an area of 1,852,943 ha (CBS, 2013). The problems that arise from the cocoa plant is a low productivity. Data from (Directorate General of Plantation, 2011) Indonesian cocoa production is still relatively low at an average of 532.17 kg ha⁻¹, while the Ivory Coast had reached 1.5 tons ha⁻¹.

To support the development of the cocoa crop in order to work well, the initial step of cocoa cultivation is prepared planting material in nurseries. One of the fertilizers used in plant breeding is vermicompost fertilizer. Vermicompost fertilizer or so-called vermicompost manure produced by a former maintenance worm

(Purba et al, 2014).Vermicompost an organic fertilizer that is safe for the soil and plants because worms can improve the unification of organic matter below the soil surface, increasing the amount of water stored in the soil aggregates, improve water infiltration, aeration and increases the activity of microorganisms (Rekhina., 2012).

The amount of nutrient availability on vermicompost fertilizer must be balanced with the work of soil microorganisms, the efforts to improve the performance of microorganisms in the soil by adding *Terralyt-plus*. Soil microorganisms can help the process of vermicompost fertilizer to composed so that it can optimally absorb by plants.

According to Aluko and Oyedele (2005), *Terralyt-plus* is an electrolyte that serves as recondition of soil texture and soil microorganisms multiply the work. According to the IITA (1981) chemical

analysis of *Terralyt-plus* showed that *Terralyt-plus* of 0.02% containing N, P, of 0.02% K, 5.6% Na, 0.47% 0.21% Ca, 0.25% Zn, 0.62% Cu, 0.57% Co, 0.21% Cd, 0.24% 0.38% Ni and Cr. The increased activity of microorganisms in the soil, the land has improved its effect on plants is to multiply the plant roots so that the absorption of ions in the soil can be optimized.

RESEARCH METHODS

The research was conducted at the experimental farm of the Faculty of Agriculture and Animal Husbandry, University of Muhammadiyah Malang with an altitude of 560 meters above sea level, which was conducted over three months, starting on January 19, 2017, until April 20,

2017. The equipment used includes a shovel, hoe, trowel, term sliding, manual scales, rulers, stationery, gloves and polybag size of 30x20 cm. The materials used are the seeds of cacao (*Theobroma cacao* L.) var. Lindak (bulk) 3 months old, vermicompost, *Terralyt-plus*, and soil. Research compiled using factorial randomized block design consisting of two (2) factors. The first factor is Vermicompost which consists of three levels, namely: D0 = 0 g / plant; D1 = 200 g / plant and D2 = 400 g / plant. The second factor is *Terralyt-plus* which comprises 3 levels, namely T0 = 0 ml / polybag, T1 = 20 ml / polybag, and T2 = 40 ml / polybag. Repeated three (3) times, and each repetition of each three (3) samples. So get a combination of treatments as follows:

Table 1. Treatment Plant Nursery Provision Code Cocoa

No.	Treatment code	Information
1.	D0T0	Without treatment (control)
2.	D0T1	Terralyt 40 ml without the addition of vermicompost
3.	D0T2	Terralyt 60 ml without the addition of vermicompost
4.	D1T0	200 g without the addition of vermicompost Terralyt
5.	D1T1	Vermicompost terralyt 200 g and the addition of 40 ml
6.	D1T2	Vermicompost terralyt 200 g and the addition of 60 ml
7.	D2T0	400 g without the addition of vermicompost Terralyt
8.	D2T1	Vermicompost terralyt 400 g and the addition of 40 ml
9.	D2T2	Vermicompost terralyt 400 g and the addition of 60 ml

Implementation Research

a. Preparation Media of Plant

The media planting an appropriate mixture of soil and vermicompost treatment. Land taken a part top soil then wind dried, then sieved using 2 mm sieve. After that, land and vermicompost mixed or stirring until blended according to treatment and then put in a polybag size 30x20 cm with a thickness of 0.08 mm and drilled about 18 holes. Each polybag contains 10 kg of media.

b. Applications of *Terralyt-plus*

Application of *Terralyt-plus* done 1 (one week) before the removal of the cocoa plant in a polybag. Award-plus terralyt using the formula 1: 100 dilution (*Terralyt-*

plus : water) in 100 ml of water which contained 1 ml *Terralyt-plus*. In this research using *Terralyt-plus* applications as follows 0 ml, 40 ml and 60 ml.

c. Displacement Plants In polybag

Displacement planted in polybags performed after application *Terralyt-plus* the growing media for one week already to applied. Growing media indwelling of week *Terralyt-plus* is meant that the active substance could revolutionize the growing media and soil microorganisms increase the performance derived from the provision of vermicompost.

d. Preparation of Auspices Nursery

Preparation auspices own nursery starts with selecting the shade nursery

material that is parent. Parent then mounted on *polybags* which used as a growing media. Then coupled with the installation of plastic-UV (Ultra Violet) which is mounted on exposed of parent to avoid direct rain, which can cause cocoa plants to become dry and shrivelled than cocoa seedlings from direct solar radiation.

e. Maintenance

Maintenance performed include Watering, Weed Control, and Cleanup parent. Watering is done every day with intervals of watering 2 times a day morning and afternoon. Overall weed control before planting and during the seeding is done manually. Parent cleaning does once a week for one variable interval of observations.

Variable Observations

Data were collected for vegetative variables are non-destructive (without damaging the crop) and destructive (crop damage) conducted periodically at intervals of one week during the three (3) months. The observed variables include:

- a. High Added Seeds (cm)
High Added seed was measured every 1-week observation by using a ruler. Measurement limit is determined at the base of the stem to the growing point.
- b. Added Stem diameter (cm)
Measure the increase in diameter rods made every 1 week for 12 weeks using a calliper. Determination of measurements carried out under the first section that appears.
- c. Added Number of Leaves
Counters in the number of leaves are done when the leaves open completely. Observations were made at intervals of 1 week after treatment *Terralyt-plus* treated.
- d. Added Total leaf area (cm²)
Observation of leaf area increases implemented at intervals of 1 week. Added total leaf area is done using the formula:

$LOGY = 1,904LOGX - 0,495$ (Gardner, Pearce and Mitchell., 1991).

Information :

LOGY = Leaf area

LOGX = Length of leaf

0,495 = Konsatnta reduction

e. The amount of chlorophyll (mg-l)

The amount of chlorophyll measured using spectrophotometry. Extraction of chlorophyll using standard methods that have been perfected by McKinney and Arnon (2006) is 1 gram of fresh leaf tissue weighed. Destructed leaves were done by means of a mortal and hammer, acetone was added 10 ml of the function that the network is homogeneous.

Chlorophyll concentration based on the wavelength calculated by the equation McKinney and Arnon:

The concentration of chlorophyll a = $12.7 \times A663 - 2,69 A645$

The concentration of chlorophyll b = $22.9 \times A645 - 4,68 A663$

Chlorophyll total = $20.20 \times 8.02 \times A663 + A645$ or $A652 / 34.5 \times FP$

Information :

A663 = Absorbance Value wavelength 663

A645 = Absorbance Value wavelength 645

A652 = Absorbance Value wavelength 652

RESULTS AND DISCUSSION

1. High Added Plant

High cocoa plant (*Theobroma cacao* L.) vermicompost fertilizer treatment and *Terralyt-plus* showed no real interaction. Separately vermicompost fertilizer treatment and treatment *Terralyt-plus* shown in Table 2.

(Table 2.) Vermicompost fertilizer dosage of 400 gr/plant significantly different with vermicompost fertilizer dosage of 200 gr/plant and treatment 0 gr/plant. Vermicompost fertilizer dose treatment appears significantly different at week 5 (16.75) to week 11 (29.62).

Table 2. Average plant height increment due cocoa plant growth responses seed (*Theobroma cacao* L.) against the application of vermicompost and *Terralyt-plus*.

Treatment	Plant height (cm)										
Dose Fertilizer Vermicompost	1WAP	2WAP	3WAP	4WAP	5WAP	6WAP	7WAP	8WAP	9WAP	10WAP	11WAP
0 grams	4,88a	6,41a	7,43a	8,65a	12,30a	13,39a	16,45a	18,09a	19,32a	21,42a	22,98a
200 grams	5,27a	6,88a	7,88a	9,16a	13,40a	15,37b	16,88a	19,58b	20,02a	22,30a	23,80a
400 grams	5,48a	7,33a	8,43a	9,49a	16,75b	18,89c	22,08b	24,03c	26,09b	27,83b	29,62b
Terralyt-plus											
0 ml	5,23a	6,67a	7,74a	8,88a	13,58a	14,86a	17,09a	19,89a	20,60a	22,63a	24,39a
40 ml	5,23a	7,15a	8,21a	9,40a	14,72a	16,86a	19,99a	21,37a	22,93a	24,75a	26,28a
60 ml	5,18a	6,79a	7,79a	9,03a	14,15a	15,93a	18,33a	20,44a	21,89a	24,16a	25,76a
HSD α 5%	0.70	0.96	1.02	0.85	1.14	1.43	1.46	1.48	2.26	2.40	2.41

Description: The figures are accompanied by the same letters in the same column indicate no significant at α HSD test 5%

While *Terralyt-plus* treatment was not significantly different in the type of treatment. This shows vermicompost fertilizer dosage of 400 g/plant is the best treatment. N instrumental element stimulates overall growth of plant nurseries, the plant height also increased compared with the media of plant without compound fertilizer. In accordance with the opinion of Sinabariba et al., (2013) stated that with the addition of nitrogen to the soil can stimulate an increasingly active meristematic tissue divide thus spurring the growth of plant height, especially cocoa seedlings.

2. Added Diameter

Based on the results of analysis of variance increase stem of diameter at the

cocoa plant (*Theobroma cacao* L.) intangible interaction between vermicompost fertilizer treatment and *Terralyt-plus*, the average gain is displayed on the trunk diameter (Table 3).

(Table 3) Vermicompost different dosages of unreality in all treatments, as well as the treatment *Terralyt-plus*. The best treatment for the increase in diameter trunk is vermicompost fertilizer treatment 400 gr/plant, and *Terralyt-plus* 60 ml/plant. The development of stem diameter is influenced by the availability of nutrients P and K. P elements play a role in stimulating cell division and enhance plant cell tissue. While nutrient K plays a role in strengthening the cocoa seedlings trunk.

Table 3. Mean stem diameter increase due to the growth response of plants seeds of cacao (*Theobroma cacao* L.) against the application of vermicompost and *Terralyt-plus*.

Treatment	Diameter (cm)										
Dose Fertilizer Vermicompost	1WAP	2WAP	3WAP	4WAP	5WAP	6WAP	7WAP	8WAP	9WAP	10WAP	11WAP
0 grams	0,15a	0,20a	0,25a	0,43a	0,50a	0,56a	0,58a	0,75a	0,87a	1,16a	1,41a
200 grams	0,16a	0,21a	0,25a	0,45a	0,52a	0,57a	0,59a	0,76a	0,88a	1,16a	1,42a
400 grams	0,17a	0,24a	0,30a	0,45a	0,53a	0,58a	0,60a	0,74a	0,89a	1,17a	1,45a
Terralyt-plus											
0 ml	0,16a	0,19a	0,25a	0,43a	0,50a	0,56a	0,58a	0,73a	0,86a	1,16a	1,42a
40 ml	0,16a	0,23a	0,26a	0,43a	0,52a	0,57a	0,58a	0,74a	0,88a	1,16a	1,43a
60 ml	0,16a	0,24a	0,29a	0,47a	0,52a	0,58a	0,61a	0,77a	0,91a	1,17a	1,44a
HSD α 5%	0.09	0.08	0.17	0.25	0.27	0.24	0.04	0.07	0.07	0.05	0.07

Description: The figures are accompanied by the same letters in the same column indicate no significant at α HSD test 5%.

This is in accordance with Munawar (2011) states that plants that lack the

element of P and K cause the stem into a small diameter. This is presumably due to

the availability of sufficient nutrients to the growing media which resulted in the smooth process of translocation of nutrients that occurs in the trunk. The circulations in accordance with the opinion of Irmayanti (2012), that the translocation of assimilates in the growth phase, mostly used for the formation and development of vegetative organs such as leaves and stem elongation. So that the plant is focusing only on stem elongation and the formation of new leaves. The highest value in the treatment of

vermicompost fertilizer dose of 400 gr/plant with a mean (1.45 cm) at 11 WAP was not significantly different with vermicompost fertilizer dosage of 200 gr/plant (1.42 cm) and 0 gr/plant (1.41 cm). Similarly, treatment *Terralyt-plus* 60 ml with the highest rates (1.44 cm) at 11 WAP did not differ significantly with treatment similar to the treatment of different stages *Terralyt-plus* 40 ml (1.43 cm) and *Terralyt-plus* 0 ml (1.42 cm) at 11 WAP.

Table 4. Average total leaf area increase as a result of the growth response of plants seeds of cocoa (*Theobroma cacao* L.) against the application of vermicompost and *Terralyt-plus*.

Treatment	Total leaf area (cm ²)				
	7	8	9	10	11
	Weeks After Planting				
Vermicompost 0/gr and <i>Terralyt-plus</i> 0/ml	17,20a	18,57a	19,10a	24,15a	26,75a
Vermicompost 0/gr and <i>Terralyt-plus</i> 40/ml	19,46a	20,72ab	23,05ab	25,34ab	31,33ab
Vermicompost 0/gr and <i>Terralyt-plus</i> 60/ml	20,18a	23,04ab	24,19ab	25,36ab	30,86ab
Vermicompost 200/gr and <i>Terralyt-plus</i> 0/ml	21,11a	23,03ab	22,87ab	25,61ab	30,96ab
Vermicompost 200/gr and <i>Terralyt-plus</i> 40/ml	21,59ab	24,37bc	25,41b	25,55ab	38,23bcd
Vermicompost 200/gr and <i>Terralyt-plus</i> 60/ml	21,37ab	23,07ab	25,36b	28,83abc	38,16bcd
Vermicompost 400/gr and <i>Terralyt-plus</i> 0/ml	20,10a	23,58ab	23,31ab	24,52a	30,01ab
Vermicompost 400/gr and <i>Terralyt-plus</i> 40/ml	26,61c	31,00d	33,09c	35,01c	47,01d
Vermicompost 400/gr and <i>Terralyt-plus</i> 60/ml	26,61bc	29,43cd	32,85c	32,91bc	45,95cd
HSD α 5%	4.99	5.49	6.10	7.94	9.79

Description: The figures are accompanied by the same letters in the same column indicate no significant at α HSD test 5%.

3. Added Total Size Leaf

Based on the results of analysis variance totalled increase leaf area of cacao plant (*Theobroma cacao* L.) interaction between vermicompost fertilizer treatment and *Terralyt-plus* in a week (7 until 11 weeks) is shown in (Table 4). Value-added total leaf area were significantly different were there on a combination of injury (vermicompost fertilizer dose of 400 gr/plant + *Terralyt-plus* 40 ml) and not different significant 47,01cm² with treatment (vermicompost 200 gr/plant + *Terralyt-plus* 40 ml) 38.32 cm² and significantly different from the treatment (vermicompost fertilizer 400 gr/plant + *Terralyt-plus* 0 ml) 30,01cm² and

the lowest rate in the control treatment (0 gr/plant + *Terralyt-plus* 0 ml) 77.16 cm².

The interaction between fertilizer vermicompost and *Terralyt-plus* against the leaf width allegedly caused by the element potassium contained in the content of vermicompost fertilizer and *Terralyt-plus* that play a role in photosynthesis, translocation of carbohydrates and synthesis. The presence of high potassium element in *Terralyt-plus* so photosynthesis can work well so that the growth of cocoa seedlings especially in the number of cocoa leaves and total leaf area can be driven. This is consistent with the opinion of Yourtchi, Hadi, and Darzi (2013) which states vermicompost combined with

nitrogen fertilizer able to improve the vegetative growth of the plants.

4. Added Number of Leaves

Based on the number of leaves of the cocoa plant (*Theobroma cacao* L.) in the analysis of variance in all ages showed their interaction at week 6 to week 11 (appendix 6). Average analysis of the growing number of comparative tests HSD leaves with 5% α shown in (Table 5).

Based on the analysis of the average in the number of leaves on (Table 6) vermicompost fertilizer dosage of 400 grams and the addition of 40 ml *Terralyt-plus*

plus different real at week 6 and week 10, with similar treatment. As for the dosage of fertilizer vermicompost 400 grams and the addition *Terralyt-plus* 40 ml is not significant effect on the treatment of fertilizers vermicompost 400 grams with the addition *Terralyt-plus* 60ml, dosages of 200 grams with the addition *Terralyt-plus* 40 ml, dosages of 200 grams with the addition *Terralyt-plus* 60 ml and a dose of 400 grams without additional fertilizer *Terralyt-plus* in week 7, 8, 9 and 11.

Table 5. Average increase the number of leaves due to seed the growth response of cocoa plants (*Theobroma cacao* L.) against the application of vermicompost and *Terralyt-plus*.

Treatment	number of leaves					
	6	7	8	9	10	11
Weeks After Planting						
Vermicompost fertilizer dose and <i>Terralyt-plus</i>						
vermicompost 0 g and <i>Terralyt-plus</i> 0 ml	6,33ab	6,75a	7,83a	8,92a	9,42a	10,00a
vermicompost 0 grams and <i>Terralyt-plus</i> 40 ml	5,08a	6,08a	7,25a	8,17a	9,25a	10,25a
vermicompost 0 grams and <i>Terralyt-plus</i> 60 ml	6,58ab	6,92ab	7,83a	8,67a	10,08a	11,33a
vermicompost 200 grams and <i>Terralyt-plus</i> 0 ml	6,00a	7,25ab	8,00a	8,83a	9,83a	10,67a
vermicompost 200 grams and <i>Terralyt-plus</i> 40 ml	8,00b	9,33c	9,75b	11,00bc	12,33c	13,25cd
vermicompost 200 grams and <i>Terralyt-plus</i> 60 ml	6,58ab	7,50b	8,25ab	9,42ab	11,17b	12,25c
vermicompost 400 grams and <i>Terralyt-plus</i> 0 ml	6,83ab	7,92bc	8,67ab	9,42ab	10,25a	11,50b
vermicompost 400 grams and <i>Terralyt-plus</i> 40 ml	10,00c	10,92d	11,92c	12,50c	14,00d	15,58d
vermicompost 400 grams and <i>Terralyt-plus</i> 60 ml	8,67b	9,4cd	10,42bc	11,00bc	12,17c	13,00cd
HSD α 5%	1.13	0.68	0.88	1.02	1.40	1.43

Description: The figures are accompanied by the same letters in the same column indicate no significant at α HSD test 5%.

This is reinforced by the opinion Sintia, (2012), which suggests that the N sufficient for growth will provide good plant growth, one of which is the growth of plants. So with the growth of the plant stem length will affect the number of stem segments where the discharge leaves. Of vermicompost manure sample analysis has been done there are nutrients in the form of N by 1% adbk, adbk P by 0.59%, 0.26% K and C-organic adbk amounted to 14.80% adbk which is able to be absorbed optimally

by the cocoa plant. This caused by supply of nutrients contained in the compost P and N nutrients that play a role in protein synthesis, so that the N elements directly affect the supply of food in the cells.

5. Total of Chlorophyll

Based on the results of variance analysis separately average amount of chlorophyll a, chlorophyll b and total chlorophyll shown in (Table 6.)

Based on the analysis of variance parameters number of chlorophyll (a), chlorophyll (b) and the total chlorophyll vermicompost fertilizer dose combination treatment of 400 grams, 200 grams, 0 grams with the addition *Terralyt-plus* 60 ml, 40 ml and 0 ml is not significantly different from similar treatment. The highest value of the amount of chlorophyll (a) in the treatment of vermicompost fertilizer dose of

200 gr/plant (84.80 mg/L). While the greatest value on the amount of chlorophyll (b) in the treatment of vermicompost fertilizer dose of 400 grams (145.77 mg/L) and (230.07 mg/L) in total chlorophyll with similar treatment.

Table 6. The average in the number of chlorophyll due to seed the growth response of cocoa plants (*Theobroma cacao* L.) against the application of vermicompost and *Terralyt-plus*.

Treatment	The amount of chlorophyll (mg / L)		
	chlorophyll a	chlorophyll b	Klorofi Total
Dose Fertilizer Vermicompost			
0 grams	83,13a	142,25a	227,99a
200 grams	84,80a	142,75a	227,96a
400 grams	83,63a	145,77a	230,07a
<i>Terralyt-plus</i>			
0 ml	82,91a	142,94a	228,38a
40 ml	84,86a	144,07a	228,85a
60 ml	83,79a	143,76a	228,79a
HSD α 5%	1.94	3.25	2.18

Description: The figures are accompanied by the same letters in the same column indicate no significant at α HSD test 5%.

This confirmed by the statement Sutedjo (2002), that main role of N for plants is stimulated growth, especially the trunk, branches and leaves because nitrogen is a building block of chlorophyll, protein, fat, co-enzyme and nucleic acids. The best treatment of *Terralyt-plus* for the amount of chlorophyll (b) and the total chlorophyll is *Terralyt-plus* with the addition of 40 ml/plant with a value (144.07 mg/L) on chlorophyll (b) and (228.85 mg/L) for total chlorophyll. Therefore we can conclude the best treatment from both treatments is the addition of 400 grams of fertilizer vermicompost and *Terralyt-plus* 40 ml to the amount of chlorophyll in the leaves.

CONCLUSION

Based on the analysis of response plant growth of cocoa (*Theobroma cacao* L.) against vermicompost fertilizer application and *Terralyt-plus*, it was concluded as follows:

1. There is no interaction between the fertilizer vermicompost and *Terralyt-plus* on the parameters increase total leaf area and increase the number of leaves with vermicompost fertilizer treatment combined 400 gr/plant and *Terralyt-plus* 40 ml/plant.
2. Vermicompost fertilizer treatment 400 gr/plant influence on the increase of total leaf area and a number of leaves of the cocoa plant (*Theobroma cacao* L.).
3. Treatment *Terralyt-plus* 40 ml/plant influence on the increase of total leaf area and a number of leaves of the cocoa plant (*Theobroma cacao* L.).

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