Application of liquid organic fertilizers from market waste on the growth and nitrogen uptake of oil palm seedlings

P B Hastuti*
Agrotechnology Study Program, Faculty of Agriculture, Stiper Agricultural Institute Yogyakarta, Indonesia

*Email: pauliz@instiperjogja.ac.id

Abstract. The purpose of this study was to determine the effect of various concentrations of liquid organic fertilizer from market waste on the growth and N uptake of oil palm leaves seedlings in pre-nursery. This experiment used a completely randomized design with ten replications. There were eight treatments namely 15%, 25%, 35%, 45%, 55%, 65%, chemical fertilizer (NPKMg and urea) as control and solid compost. The results showed that the application of liquid organic fertilizer at concentrations of 35% to 45% and solid compost gave the highest stem diameter and N uptake of oil palm leaves. The application of liquid organic fertilizer from a concentration of 25% to 45% and solid compost gives the highest dry weight and leaves of oil palm seedlings. Application of liquid organic fertilizer with a concentration of 45% to 65%, solid compost, or chemical fertilizer produces the highest amount of chlorophyll.

1. Introduction
Oil palm is one of the main plantation crops that affect Indonesia's economic growth. The use of palm oil in the world is increasingly diverse, especially for food, including cooking oil and margarine. Also palm oil is used as raw material for non-food products, such as biofuels, soap, detergents, surfactants, cosmetics, and medicines, various household and industrial products [1]. The total area of oil palm plantations in Indonesia in 2018 reached 12.761 million ha with crude palm oil production amounted to 36.594 million tons [3]. At present the need for oil palm seedlings is a major concern for the oil palm plantation industry because the production and productivity of oil palm plants is largely determined by the quality of the seedlings. The efforts to get quality of oil palm seedlings can be done by providing nutrition through fertilization. The cost for fertilizing oil palm plants is more than 60% of the cost of maintaining plants, so the cost of using inorganic fertilizers for the palm oil industry is higher and more expensive. An alternative that can be used is to use organic fertilizer.

One of the organic fertilizers that need to be developed is a fertilizer that comes from traditional markets namely vegetables and fruits waste. Organic waste of vegetables and fruits is often found in the market environment or residential areas. The compost obtained from vegetables remains shows no phytotoxicity and is suitable for use as organic fertilizer [14]. Househould kitchen waste or food stalls and food scraps have almost the same composition. Residential waste has an organic proportion of around 70% while the specialty market for vegetables and fruit can reach 95%. Organic waste vegetables, fruit, or food scraps generally have high water content (> 60%), so that if not treated immediately will experience decay. The accumulation of wet waste in containers often invites flies, cockroaches, or rats, followed by anaerobic overhaul by bacteria which often causes a foul odor [18].
These materials if not utilized will pollute the environment and harm, even though in it various kinds of nutrients can be utilized as organic fertilizer. At present most of the vegetable and fruit waste from traditional markets are still sent to landfills. Day by day the piles of garbage are mounting. Leachate results that come out of the landfill environment have been mixed with pollutants such as heavy metals or toxic organic compounds, making it difficult to use. For that reason, composting of vegetables and fruits waste can be used as a simple and inexpensive environmentally friendly technology using biocompost reactors. Vegetable waste extract fertilizer using the local microorganisms has a pH of 8, 561 mg.l⁻¹ C, 3.868 mg.l⁻¹ N, 175 mg.l⁻¹ P, 363 mg.l⁻¹ K, 106 mg.l⁻¹ Ca, 166 mg.l⁻¹ Mg, 101 mg.l⁻¹ S, 0.6 mg.l⁻¹ Fe, 0.1 mg.l⁻¹ Mn and 0.1 mg.l⁻¹ Zn [15]. Organic matter can improve soil properties chemical, physical, and biological. Its effects on the chemical properties of the soil include providing nutrients and increasing cation exchange capacity, neutralizing toxic substances, preventing an increase in soil acidity or alkalinity. As for the physical properties of the soil, among others, can improve soil structure so that soil aeration and drainage become good, increase the capacity to hold soil water, help absorb more heat so that it kills pathogenic microorganisms, makes the soil crumb and easily penetrated by roots. Its influence on the biological nature of soils is that it can be a good medium for the growth of soil microorganisms [4].

The results of Maulana's research [10] on the manufacture of liquid fertilizer from vegetable and fruit waste showed that the best results in optimum conditions were at 8 days fermentation, using types of vegetable and fruit waste such as mustard greens, cabbage, sprouts from green beans, apples, and pear as much as 500 grams, and the addition of an activator volume of 30 ml with 30.78% C, 3.868 mg.l⁻¹ C, 2.8% N, 2.3% P, 363 mg.l⁻¹ K, 166 mg.l⁻¹ Mg, 101 mg.l⁻¹ S, 0.6 mg.l⁻¹ Fe, 0.1 mg.l⁻¹ Mn and 0.1 mg.l⁻¹ Zn [15]. Organic fertilizer in liquid form is more easily absorbed by plants because the elements in it have been decomposed so that plant growth can be optimized.

While the results of research that have been carried out by Magfirah [8] using liquid organic fertilizer at a dose of 50 ml and 80 ml liter of water gives the best results on the production of red chili plants. Previous research showed that the administration of cabbage waste compost in the nursery media was able to increase the growth of cocoa seedlings [5].

2. Experimental Methods

Pot experiments were conducted in the garden of education and research, Stiper Agricultural Institute Yogyakarta in 2020. This experiment used a completely randomized design with ten replications. There were eight treatments concentration of liquid organic fertilizer namely 15%, 25%, 35%, 45%, 55%, 65%, chemical fertilizer (NPKMg and urea) as control and solid compost. The research site was cleared of weeds and the ground level was leveled, and then made a bamboo fence. The planting medium is regosols, which were previously filtered with a 2 mm sieve, then put into a polybag (15 x 23 cm) to 1 cm from the lip of the polybag. Making compost from vegetable and fruit waste is done by using an anaerobic bio compost reactor by referring to the Yuwono method [18]. The components of bio compost reactor are 1. Drum / barrel 2. Faucet (under the side for harvesting liquid organic fertilizer/leachate) 3. Two holes with a diameter of 2 cm (besides the lower lid for air surface and the path of black flies lay eggs) 4. Close tightly with a handle (rainwater does not enter, holding vapors/ odors upward, safe from rat interference) 5. Filter in the middle to separate solids and liquids. 6. Space where the organic waste (vegetables, fruit, kitchen scraps) was laid. The composting process takes 1.5 months and the liquid organic fertilizer or leachate that comes out was collected and put in a plastic bottle. The oil palm seed used was the Yangambi variety from IOPRI (Indonesian Oil Palm Research Institute) Medan, after the seed was 1 month old, the liquid organic fertilizer and chemical fertilizer as a control to be applied. Urea fertilizer was applied on weeks (5, 7, 9, and 11) with a concentration of 0.2% (2 g urea liter of water⁻¹) with a volume of 50 ml seedling⁻¹. Whereas NPKMg fertilizer was given on weeks (6, 8, 10, and 12) with the same concentration and amount of giving. Liquid organic fertilizer with a volume of 50 ml seedling⁻¹ was given every week. While the application of solid compost fertilizer was evenly mixed with regosols in a ratio of 1: 1. Oil palm seedlings in pre-nursery were harvested at the age of 3 months. The observed N content of leaves with the Kjeldahl method.
The data were analyzed by ANOVA (Analysis of Variance) using the SPSS program. The differences among treatments means were determined by Duncan's Multiple Range Test (DMRT) at P < 0.05.

3. Results and Discussion

3.1. Effect of liquid organic fertilizers on the growth of oil palm seedlings in pre-nursery

The results of the analysis of the composition of liquid organic fertilizers from the market waste had a pH level was 8.13, 0.99% C-organic, 1.707% organic material composition, and 0.03% N-total.

Table 1. Growth of oil palm seedlings in pre-nursery at various concentrations of liquid organic fertilizer from market waste.

| Parameter                  | Concentrations liquid organic fertilizer (%) | Chemical compost fertilizers |
|----------------------------|---------------------------------------------|------------------------------|
| Plant height (cm)          | 15  25  35  45  55  65                     |                              |
|                            | 22.77 a  23.47 a  24.50 a  25.54 a  23.49 a  23.28 a  25.17 a  4.88 a |
| Stem diameter (mm)         | 7.37 c  7.50 bc  8.72 a  8.43 ab  7.18 c  6.64 c  6.40 c  8.54 ab |
| The number of leaves       | 3.70 a  3.70 a  3.40 a  3.80 a  3.60 a  3.80 a  3.80 a  3.60 a |
| Chlorophyll (spad)         | 47.33 bcd  46.06 cd  45.46 d  50.87 abc  51.37 ab  49.28 abcd  53.11 a  53.59 a |
| Fresh weight of plant (g)  | 3.49 c  4.81 ab  4.45 abc  5.29 a  3.83 bc  3.83 bc  3.46 c  5.25 a |
| Dry weight of plant (g)    | 0.69 d  0.96 abc  0.89 bcd  1.05 ab  0.76 cd  0.76 cd  0.76 cd  1.14 a |
| Fresh weight of leaves (g) | 2.00 c  2.83 ab  2.68 ab  3.16 a  2.39 bc  2.30 bc  2.21 bc  3.07 a |
| Dry weight of leaves (g)   | 0.45 d  0.63 abc  0.59 abcd  0.71 ab  0.52 cd  0.51 cd  0.57 bcd  0.74 a |
| Dry weight of root (g)     | 0.18 a  0.24 a  0.24 a  0.27 a  0.19 a  0.23 a  0.21 a  0.28 a |

Remarks: Means followed by the same letters in the same line were not significantly different based on DMRT at a 5% level.

Table 1 showed that the treatment of various levels concentration of liquid organic fertilizer from market waste gave the same results on plant height, the number of leaves, and dry weight of root of oil palm seedlings in pre-nursery. Planting media that were given liquid organic fertilizer at various concentrations from 15% to 65% produced plant height, number of leaves, and dry weight of root similar to seedlings that were given solid compost and chemical fertilizers (NPKMg and Urea) as controls.
This means that the application of chemical fertilizers can be replaced by liquid organic fertilizers or solid organic fertilizer (compost) from market waste. Liquid organic fertilizers from market wastes contain complete nutrients both macro and micro, so that the source of nutrients for plants increases, and can increase plant growth [15]. Besides plant height is also influenced by genetic traits of plants where the same plant varieties will show growth that tends to be the same height [12]. The results of the study [9] show that the plant height, number of leaves, and stem diameter of oil palm seeds a significant high heritability value has traits that are easily inherited. Genetic factors play a dominant role compared to environmental factors.

Results also showed that the highest chlorophyll content in the application of solid compost fertilizer which was not significantly different from chemical fertilizers and liquid organic fertilizer concentrations between 45% to 65%. It is suspected that at low liquid organic fertilizer concentrations, the nitrogen content as a constituent of chlorophyll is also low. Chlorophyll is very important for photosynthesis and the leaves of plants with high chlorophyll content will get energy and produce food more efficiently. Nitrogen is an important nutrient for chlorophyll production [17]. The chlorophyll content of leaves is related to the amount of nitrogen, which is a structural component of chlorophyll. Chlorophyll is the main pigment in plants and greener leaves showed more pigment and hence more nitrogen. According to Lesing and Aungoolprasert [7] organic fertilizer is a source of nitrogen, and also provides higher chlorophyll content in kale leaves. The analysis showed that the concentration of liquid organic fertilizer significantly affected the stem diameter of oil palm seedlings in pre-nursery. The good growth of plants illustrates the presence of good nutrient uptake in these plants. Potassium in the soil that increases due to the addition of compost is a nutrient that plays a role in the growth of meristematic tissue, especially the stem, strengthening the plant so it does not easily fall [2].

The concentration of liquid organic fertilizer 35% and 45% produced the highest stem diameter and was not significantly different from the administration of solid compost. An increase in the concentration of liquid organic fertilizer is followed by an increase in stem diameter, but in the application of chemical fertilizers and liquid organic fertilizer to a concentration of 55%, 65% in stem diameter has begun to decline. This showed that the higher the concentration of liquid organic fertilizer, the solution becomes concentrated and can damage the roots because the roots undergo plasmolysis [6].

The value of organic fertilizers is generally low and highly variable, for example, the elements nitrogen, phosphorus, and potassium, but also contains other essential microelements. Nitrogen and other nutrients contained in organic fertilizer will be released slowly. Continuous use will help a lot in building soil fertility [16].

Giving liquid organic fertilizer at 45% concentration produced the highest fresh weight and dry weight of the plant, the highest fresh weight and dry weight of leaves and were not significantly different from solid compost fertilizer and liquid organic fertilizer at concentrations of 25% and 35%, while low yields on chemical fertilizers and liquid organic fertilizer concentrations higher (55% and 65%). This showed that the application of liquid organic fertilizer from a concentration of 25% to 45% can produce a biomass or leaf weight that was statistically better than the recommended chemical fertilizer treatment. It was suspected that the application of liquid organic fertilizer from market waste can increase the metabolism of oil palm seedlings and the seedlings will be effective in absorbing nutrients. The higher the dry weight of the seedlings indicates that the seedlings can absorb nutrients better.

Whereas the lower liquid organic fertilizer concentrations of 15% and the high liquid organic fertilizer concentrations of 55% and 65% gave a lower dry weight of plant and leaves. This is because the more dilute the solution, the faster the absorption of nutrients but the levels of nutrients absorbed by plants per unit of timeless, while the more concentrated the solution will inhibit the process of absorption of nutrients by plant roots [13].

3.2. Effect of liquid organic fertilizers on N content and N uptake of leaves
Table 2 showed that the application of liquid organic fertilizer at various concentrations produces N content of leaves was the same as chemical fertilizer and solid compost fertilizer, while the highest N
uptake of leaves in liquid organic fertilizer with 45% concentration was not significantly different from solid compost fertilizer, liquid organic fertilizer 35% concentration and chemical fertilizer. The 15% liquid organic fertilizer concentration treatment produced the lowest N uptake of leaves. The results of the analysis showed that the high plant dry weight followed by the high N uptake of leaves. This was consistent with the opinion of Mengel and Kirkby [11] that an increase in plant dry weight is one of the characteristics of an increase in nitrogen uptake in plants.

| Concentrations of liquid organic fertilizer (%) | N content of leaves (%) | N uptake of leaves (g seedling⁻¹) |
|-----------------------------------------------|------------------------|---------------------------------|
| 15                                           | 1.58 a                 | 0.006 c                         |
| 25                                           | 1.49 a                 | 0.009 bc                        |
| 35                                           | 2.02 a                 | 0.012 ab                        |
| 45                                           | 1.94 a                 | 0.015 a                         |
| 55                                           | 1.86 a                 | 0.009 bc                        |
| 65                                           | 1.94 a                 | 0.009 bc                        |
| Chemical fertilizer                           | 1.95 a                 | 0.011 abc                       |
| Solid compost                                 | 2.12 a                 | 0.015 a                         |

Remarks: Means followed by the same letter in the same column were not significantly different based on the DMRT test at 5% level

4. Conclusion
Application of liquid organic fertilizer of market waste concentration of 35% to 45% and solid compost gave the highest stem diameter and N uptake of leaves of oil palm seedlings. Provision of liquid organic fertilizer from a concentration of 25% to 45% and solid compost provide the highest dry weight of plant and leaves of oil palm seedlings. Provision of 45% to 65% liquid organic fertilizer, solid compost fertilizer, and chemical fertilizer produces the highest amount of chlorophyll.

Acknowledgments
The authors thank to the Stiper Agricultural Institute for supporting this research, and Yan Martin Sitopu for providing the plant materials.

References
[1] Ardana I K and Kariyasa K 2016 *J. Littri* 22 (3) 125–134
[2] Ariyanti M, Dewi I R, Maxissely Y and Chandra Y A 2018 *J. of Oil Palm Res.* 26(1) 11–22
[3] BPS-Statistics Indonesia 2018 *Indonesian Oil Palm Statistics* 2018 Retrieved from www.bps.go.id
[4] Esmaeilzadeh J and Ahangar A G 2014 *Int. J. of Plant, Animal and Environmental Sci.* 4(4)
[5] Hastuti P B, Maria Astuti Y Th and Kurniadi A 2007 *Bulletin Ilmiah Instiper* 14(2) 6–13
[6] Jumiati E 2009 The effect of various EM4 concentrations on the fermentation of inorganic fertilizers on hydroponic growth and yield of Amaranthus tricolor L. (in Indonesian) Thesis (Faculty of Agriculture: Sebelas Maret University)
[7] Lesing S and Aungoolprasert O 2016 *J. Sci. Technol.* 24(2) 320–332
[8] Magfirah 2018 *J. Galung Tropika* 7(1) 1–10
[9] Maulana A I, Putri L A P and Hanafiah D S 2019 *Agroekoteknologi J.* Agriculture Fac. Univ.of North Sumatra 7(1): 66–71
[10] Maulana Y 2014 Utilization of waste vegetables and fruits into liquid fertilizer through the fermentation process (in Indonesian) Dipl. Thesis (Sunan Gunung Djati State Islamic Univ. of Bandung)
[11] Mengel K and Kirkby E A 2001 *Principles of plant nutrition* 5th ed (London: Kluwer Academic) 849 p

[12] Pahan I 2013 *Complete palm oil guide. agribusiness management from upstream to downstream* (Jakarta: Penebar Swadaya)

[13] Rohmiyati S M, Surya M and Hastuti P B 2006 *Buletin Ilmiah Instiper* 13 (1) 1–11

[14] Samaniego J, Pérez-Murcia M D, Bustamante M A, Paredes C, Pérez-Espinosa A, Gavilanes Teran I, López M, Marhuenda-Egea F C, Brito H and Moral R 2017 *PLoS ONE* 12(7) e0181621

[15] Sastro Y, Lestari I P, Indrasti R and Bakrie B 2007 *Study on the utilization of vegetable and fruit waste as organic fertilizer and animal feed ingredients* Research report Assessment Institutes for Agricultural Technology Jakarta

[16] Sutanto R 2002 *Application of organic agriculture* (Yogyakarta: Kanisius) 219 p

[17] Tancho A 2013 *Natural agriculture applied concepts in Thailand in 2013* (National Sci. and Technol. Development Agency Bangkok)

[18] Yuwono N W 2016 Utilization of hi bio compost reactors to produce liquid organic fertilizer with vegetable and fruit waste materials *Proc. of national Conf. Academics Contribution to Achieving Sustainable Development* (Brawijaya Univ)