Utilization of coconut water waste to increase cocoa growth seedling by different application methods and intervals

S Rosniawaty1*, M Ariyanti1, C Suherman1, R Sudirja2 and S Fitria3

1Department of Agronomy, Faculty of Agriculture, Padjadjaran University, Bandung, West Java Indonesia
2Department of Soil Sciences, Faculty of Agriculture, Padjadjaran University, Bandung, West Java Indonesia
3Graduate School of Agriculture, Faculty of Agriculture, Padjadjaran University Bandung, West Java Indonesia

Corresponding author: santi.rosniawaty@unpad.ac.id

Abstract. Giving coconut water might increase cocoa seedling growth because coconut water contains nutrients and hormone that is needed for plant growth. This experiment was conducted to study the growth response of cocoa seedlings towards the application of coconut water. The experiment was conducted from October 2019 until February 2020 in Ciparanje field station, Padjadjaran University, Jatinangor with the altitude of 760 meter above the sea level. Experimental design used was randomized block design (RBD) with nine treatments and each treatment was repeated three times. The treatments consisted of control application (urea 2 g every 12 days), coconut water application towards plant every 3, 7, 14, 21 days, and to the soil every 3, 7, 14, 21 days. The application of coconut water every 21 days to the plant and to the soil affected the seedling height at 12 WAA (week after application) and on the stem diameter in 8 WAA. Negligible differences were observed between application method and intervals with leaf number and chlorophyll index of seedlings.

1. Introduction
Cocoa is one of the sources of Indonesia’s income from the plantation sub-sector. However, Indonesia’s cocoa production has decreased when compared to other cocoa producing countries in the world. In the year 2017/2018, Indonesia is the 6th largest cocoa producer country after Ivory Coast, Ghana, Ecuador, Nigeria and Cameroon [1]. In 2016/2017 Indonesia ranks 4th as the world’s largest cocoa producer country [2]. The decline in Indonesian production could be caused by aging cocoa plants or the use of seeds that are not superior, making their production not in optimal condition.

Indonesian cocoa productivity cultivated by smallholders is only 346 kg/ha, private estates 641 kg/ha, and government estates 819 kg/ha [3]. Thus, increased productivity is required, such as the use of improved seed and maintenance for in nurseries. Also, to increase productivity, these methods should be implemented properly.

There have been many superior seeds produced by the Indonesian Coffee and Cocoa Research Center. One of them is the Sulawesi 1 Cultivar. This cultivar has a potential yield of 1.8 - 2.5 tons / ha, resistant to VSD, somewhat resistant to rot disease and susceptible to CPB pests [4]. Quality seeds that have been produced, must be properly maintained to match the growth potential.
One way to support the growth of superior seeds is fertilization. Fertilization is adding nutrients to plants. Nutrients can be obtained from inorganic fertilizers, organic fertilizers and other materials that contain nutrients, such as coconut water.

Besides containing nutrients, coconut water also contains growth hormones. The weakness of coconut water is especially the low Nitrogen (N) element, when compared to Urea which has 45% N element. The advantage of coconut water is that it contains nutrients other than N and growth hormone. Coconut water contains N (0.018%), P (13.85%), K (0.12%), Na (0.002%), Ca (0.006%), Mg (0.005%) and C organic (4.52%). The growth hormones contained in coconut water are IAA (Indole-3-acetic acid) (0.0039%), GA3 (Gibberellic acid) (0.0018%), Cytokinin (0.0017%), Kinetin (0.0053%) and Zeatin (0.0019%) [5].

The productivity of Indonesian coconut in the form of copra in 2017 was 794.8 kg / ha. If 1 kg of copra is produced from 3 coconuts, then, one hectare will produce 2,384 coconuts. If 250 ml of coconut water is produced from one coconut, it will produce about 59.6 liters of coconut water. Coconut water has a potential for this purpose and can be used as organic material to increase plant growth.

Methods to add nutrients to the plant can be done through an application to the growing medium or directly applied to the plants themselves. If it is given to growing medium, the organic matter process requires a longer soil absorption time. This is because the nutrients need to go through the roots for absorption. On the other hand, giving coconut water through the leaves is absorbed through the stomata, so it runs quickly and can be directly absorbed by the plants. Giving organic material in the right methods will positively affect the plant growth. Nutrient uptake is performed primarily by plant roots but nutrients can also be absorbed by leaves through foliar applications at adequate levels [6].

Interval fertilizer application should also be considered. More fertilizer given to the plant will not necessarily yield better growth of seedlings, because the more often it is given, the more nutrients are received by the seeds. This is in line with the theory of luxury consumption, the growth of seedlings is not always going to be better. Prevention of luxury consumption can be done by looking for alternative ingredients that contain natural nutrients, including using coconut water. The nutritional interval is needed to see the growth response according to the growth stage.

The purpose of this study was to determine whether coconut water could be used to fulfill the nutrition requirement of cocoa seedling through different application methods and intervals

2. Methods
The experiment was conducted at the Experimental Station Ciparanje, Faculty of Agriculture, Padjadjaran University, with an altitude of 760 meters above sea level and Inceptisol soil order. The experiment was conducted in October 2019 until February 2020.

The materials used in this experiment were copra, 4 WAP (Weeks After Planting) old coconut water from Jatinangor traditional market containing C organic 1.38% and pH 5.14 (Results of laboratory analysis showed elements contained in coconut water are listed in Table 1), sheep manure as a mixture of planting media and urea fertilizer for control treatment.

The tools used in this experiment were watering can, hoes, polybags size 20x30 cm, treatment labels, measuring cups, 70% paranet shade, spray bottles, brown envelopes, analytical scales, and ovens.

This experiment used a Randomized Block Design (RBD) method. The experiment was carried out using nine treatments and each treatment consisted of three plants. Each treatment is repeated three times so that the number of plants required was 81 seeds of Sulawesi 1 Cultivar cacao. The treatments were as follows: A = 2 grams of urea application through soil per 14 days; B = coconut water application through plants per 3 days; C = coconut water application through soil per 3 days; D = coconut water application through plants per 7 days; E = coconut water application through soil per 7 days; F = coconut water application through plants per 14 days; G = coconut water application through soil per 14 days; H = coconut water application through plants per 21 days; I = coconut water...
application through soil per 21 days. Coconut water application to the soil and plants is applied with a different volume. Application of coconut water to the soil volume is adjusted to the field capacity of the planting medium, which is 100 ml; and the application of coconut water to the plant volume is adjusted to the calibration results of 9-31 ml at the age of 0-12 week after application (WAA).

Data compiled in the table Analysis of Variance (ANOVA) were analyzed using ANOVA with F test at 95% confidence level. If there are differences among treatments, then we will do a further test using Duncan test at the level of 95% [7].

| Growth hormones | Quantity | Macronutrients | Quantity | Micronutrients | Quantity |
|-----------------|----------|----------------|----------|----------------|----------|
| IAA (%)         | 0.0012   | N (%)          | 0.05     | Fe (ppm)       | 27.89    |
| GA3 (%)         | 0.0008   | P (%)          | 0.013    | Mn (ppm)       | 3.10     |
| ABA (%)         | 0.0013   | K (%)          | 0.56     | Pb (ppm)       | 11.56    |
| Zeatin (%)      | 0.0011   | Na (%)         | 0.06     | B (ppm)        | 0.93     |
|                 |          | Ca (%)         | 0.13     | S (ppm)        | 4.87     |
|                 |          | Mg (%)         | 0.04     |                |          |

3. Results and discussion

3.1. Cacao seedlings height

Based on the result of the statistical analysis test, giving coconut water to the seedlings had given a significant effect on the height of the cocoa seedlings at 12 WAA (Figure 1). Treatment H (giving coconut water every 21 days to the plant) and treatment I (giving coconut water once every 21 days to the soil) gave a significantly different effect than treatment C (giving coconut water to the soil once every 3 days), treatment E (giving coconut water once every 7 days to the soil) and F treatment (giving coconut water once every 14 days to the plant), but not significantly different from other treatments.

New cocoa seedling responded to coconut water in many different ways and intervals at the age of 12 WAA. This response can be caused by the cocoa plant characteristic, which is a perennials plant; so, their growth is slow. Also, the nutrient and hormone content in coconut water is also low, so it takes a long time to sufficiently fulfill growth needs of cocoa seedling. It can be seen in Figure 1 that treatment H (giving coconut water once every 21 days to the plant) and treatment I (giving coconut water once every 21 days to the soil) resulted in a higher plant height compared to the control treatment (urea 2 g). This is because coconut water, apart from containing macronutrients, is also containing micronutrients and growth hormones. The content of coconut water used is listed in Table 1. The amount of K element from coconut water is as much as 0.56%. This helps to increase the plant height because the K element can increase cell size and plays an important role in cell physiology. Potassium is an essential macronutrient that fulfills important functions related to enzyme activation, osmotic adjustment, turgor formation, cell expansion, membrane electrical potential regulation, and pH homeostasis [8]. K elements also play many important roles in regulating formation in plants [9]. Coconut water also contains gibberellins. One of the functions of gibberellin is the extension and expansion of organs through cell growth [10].

For plant height variable, giving coconut water through plants or soil was just as effective. This is because the two methods of provision both have advantages. Provision of coconut water through the soil has a dual role, namely being able to improve soil fertility which will later affect the availability of nutrients in the soil so that it can increase production and quality of plant production [11]. Provision of coconut water through plants can also be done because coconut water that enters through the stomata in the leaves will be processed quickly in the photosynthetic process that occurs in the leaves. on foliar fertilizer application which can induce fast absorption, high nutrient availability and high economic benefits [6].
3.2. Diameter of cocoa seedlings
Based on the statistical analysis test, giving coconut water in several different ways and intervals had a significant effect on the stem diameter of cocoa seedlings at 8 WAA (Figure 2).

Figure 1. Plant height of cocoa seeds given coconut water in different ways and intervals

Figure 2. Diameter of cocoa seedlings given coconut water in different ways and intervals

Figure 2. shows that the provision of coconut water has an effect on the stem diameter of the cocoa seedlings at the age of 8 MSA. Treatment A (urea 2 g once every 2 weeks), treatment H (giving coconut water once every 21 days to the plant), and treatment I (giving coconut water once every 21 days to the soil) had a significantly different effect than treatment C (giving coconut water once every 3 days to the soil), E treatment (giving coconut water once every 7 days to the soil) and F treatment (giving coconut water once every 14 days to the plant), but not significantly different from other treatments.

The diameter of the cacao plant seedling stems at the age of 3-4 months is 7-10 mm [12]. The results of the experiment showed that the stem diameter was 6-7 mm. So, it was in accordance to how the diameter is supposed to be at that age. At 8 WAA, treatment A (2 g urea) have stem diameter of cocoa seedling which was not significantly different from treatment H (giving coconut water every 21 days to the plant) and treatment I (giving coconut water every 21 days to the soil). Application of urea fertilizer at a dose of 2 grams can increase nutrient availability in cocoa seedling. So, urea can be used...
for stem diameter growth. In line with [13] that nitrogen plays a most important role in various physiological processes promotes leaves, stem and other vegetative parts of growth and development; It encourages the uptake and utilization of other nutrients including potassium, phosphorous and controls overall growth of plant. However, the use of inorganic fertilizers in the long-term causes soil organic matter to decrease, so that the level of soil fertility will decrease over time [14].

Provision of coconut water as an organic material can replace the role of inorganic fertilizer (urea) in cocoa seeds. Treatment H (giving coconut water once every 21 days to the plant) and treatment I (giving coconut water once every 21 days to the soil) resulted in the same good growth in the diameter of the cacao seedlings. This is because coconut water, in addition to containing the element N (0.05%), also contains the P element (0.013%). The P element plays a role in the formation of Adenosine Triphosphate (ATP) which is a substance that acts as an energy for plants to carry out cell activities such as cell division, cell enlargement, and cell elongation [15]. Coconut water also contains K elements as much as 0.56% which plays a role in accelerating the growth of stem diameter and strengthening the stems so they do not fall easily.

3.3. Number of cocoa seed leaves
Based on the statistical analysis test, giving coconut water in different ways and intervals had no significant effect on the number of leaves of cocoa seedlings (Figure 3).

Figure 3 shows that coconut water has no significant effect on each treatment for the number of leaves variable. The increase in the number of leaves tends to rise on each observation, although not significantly different. This can be caused by leaf growth that is influenced by genetic factors. [16] suggests that two components of total leaf count are under genetic control.

Based on previous research [12], the standard number of cocoa leaves is 12 at the age of 12-16 MST, or an increase of about 3-4 pieces per month. The results of the experiment showed that all the leaves at the age of 12 WAA were above 12.

3.4. Chlorophyll content of cocoa seed leaves
Based on the statistical analysis test, the provision of coconut water had no significant effect on the chlorophyll index of the leaves of cocoa seedlings (Figure 4). Figure 4 shows that coconut water has no significant effect on each treatment for the leaf chlorophyll content variable. This indicates that the cocoa seeds are not deficient in N element, because the Chlorophyll Content Index (CCI) content in nitrogen fertilizer is the same as the CCI content in coconut water. The coconut water used, in addition to containing the element N, is also containing the element Mg as a constituent of chlorophyll [17].
The Chlorophyll Content Index (CCI) shows the relative chlorophyll content in each leaf. The results of CCI measurements are almost linear with the measurement of chlorophyll concentration in leaf area units [18]. At 12 WAA, the highest leaf chlorophyll content was 33.60 CCI and the lowest was 29.79 CCI.

Figure 4. Chlorophyll index of cocoa seed leaves given coconut water in different ways and intervals

4. Conclusion
The application of coconut water once every 21 days to the plant and to the soil has effects on the seedling height at 12 WAA (week after application) and on the stem diameter in 8 WAA. Mentioned treatment showed similar result as 2 grams of urea/12 days application. Negligible differences were observed between application method and intervals with leaf number and chlorophyll index of seedlings.

References
ICCO 2019 Production of cocoa beans ICCO Quarterly Bulletin of Cocoa Statistics, Vol XLV, No 4, Cocoa year 2018/19 https://www.icco.org/about-us/international-cocoa-agreements/search_result.html
[2] ICCO 2020 Production of cocoa beans ICCO Quarterly Bulletin of Cocoa Statistics, Vol XLVI, No2, Cocoa year 2019/20 https://www.icco.org/about-us/international-cocoa-agreements/search_result.html
[3] Badan Pusat Statistik 2019 Indonesian Cocoa Statistics 2018 (Indonesia: BPS-Statistics)
[4] Susilo A W 2014 Bahan Tanam Unggul Kakao Pusat Penelitian Kopi Kakao Indonesia http://www.cocoasafeindonesiaid/wp-content/uploads/2015/03/Bahan-Tanam-dan-Perbanyakan.pdf
[5] Rosniawaty S, Anjarsari I R D and Sudirja R 2018 Journal of Industrial and Beverage Crops 5 31-38
[6] Wang D, Xuhui D, Bei W, Na Z, Chengzhi Z, Zixuan J, Rong L and Qirong S 2019 PLoS ONE 14
[7] Gomez K A and Gomez A A 1995 Prosedur Statistik untuk Penelitian Pertanian Edisi ke-2 (Jakarta: Universitas Indonesia)
[8] Ragel P, Natalia R, Eduardo O L, Francisco J Q and Jose M P 2019 Front plant Sci 10
[9] Prajapati K and Modi H A 2012 Indian Journal of Plant Sciences 1 177-186
[10] Binenbaum J, Roy W and Ellon S 2018 Plant Science 23 410-421
[11] Sutanto R 2002 *Penerapan Pertanian Organik Pemasyarakatan dan Pengembangannya* (Jakarta: Kanisius)

[12] Badan Penelitian dan Pengembangan Pertanian 2008 *Buku Budidaya dan Pasca Panen Kakao* (Bogor: Departemen Pertanian)

[13] Leghari S J, Niaz A W, Ghulam M L, Abdul H L, Ghulam M B, Khalid H T, Tofique A B, Safdar A W and Ayaz A L 2016 *Environmental Biology* **10** 209-218

[14] Isnaini M 2006 *Pertanian Organik* (Yogyakarta: Kreasi Wacana) 247-248

[15] Gardner F P, Pearce R B and Mitchell 1991 *Fisiologi Tanaman Budidaya* (Penerjemah Herawati Susilo) (Jakarta: Universitas Indonesia Press)

[16] Li, Dan, Xufeng W, Xiangbo Z, Quyue C, Guanghui X, Dingyi X, Chneglong W, Yaneng L, Lishuan W, Cheng H, Jinge T, Yaoyao, Wang F T 2015 *New Phytol* 2016 **210** 256–268

[17] Taiz L and Zeiger E 2010 *Plant physiology and Development (5th ed)* (Massachusetts; Sinauer Associates, Inc, Publishers Sunderland)

[18] Sribawanti P, Lapanjang I M and Made U 2016 *E-Jurnal Agrotekbis* **4** 267-273