Rainfer: fertilizer production using rainwater as raw material

by Badrus Zaman

Submission date: 08-Feb-2022 11:50AM (UTC+0700)
Submission ID: 1757489434
File name: Rainfer_fertilizer_production.pdf (473.72K)
Word count: 2968
Character count: 14600

Rainfer: fertilizer production using rainwater as raw material

B Zaman[1], D S Handayani[1], Purwono[2]

[1]Department of Environmental Engineering, Faculty of Engineering Diponegoro University, Jl. Prof. Soedarto, SH, Tembalang, Semarang Indonesia, 50275 Phone (+6224) 76480678
[2]Center Science and Technology, IAIN Surakarta, Jl. Pandawa, Pucangan, Kartasura, Indonesia 57168 Phone (+6271) 781516

Corresponding author: purwono.ga@gmail.com

Abstract Shortly after the rain falls to the surface of the soil, the water flows into the water body or seeps into the ground without being optimally utilized. The low chemical and physical components are the main drawbacks of rainwater utilization. The raw material for fertilizer in this research is rainwater, so we call it rain fertilizer (rainfer). The main components of the additive are *Bryophyta, sp,* monosodium glutamate, hydrated lime, sodium chloride. They are added to enrich the physical and chemical components. The rainfer reactor is cylindrical with a maximum capacity of 70 liters. As much as 35 litres of rainwater plus additive is put into the reactor and stirred using a pump for 15 minutes until homogeneous. Let the mixture sit for 7 x 24 hours. The results showed that the addition of additives succeeded in increasing the parameters of TDS and conductivity respectively by 98.68% and 99.03%. The concentration of nitrate as nitrogen increased by 96.54%, from 1.13 mg/L to 32.67 mg/L. The final pH was 7.78, total P was 78.47 mg/L, total K was 0.03 mg/L, and heavy metal Cu was 0.06 mg/L. The level of toxicity based on the germination index value was 70.16% compared to the control, which is equivalent to mature and stable compost. The addition of additives can improve the quality of rainwater based on physical, chemical, and non-toxic parameters.

1. Introduction

According to the Meteorology, Climatology and Geophysics Agency (BMKG), in 2019, the rainfall in January 2019 showed that as much as 89% of Indonesia's territory experienced rainfall of more than 200 mm/month [1]. It shows that rainfall in Indonesia is relatively high. Most of the rainwater is used for agriculture, fisheries, and tourism. Some of them use rainwater as a source of clean water (rain harvesting).

Rainwater contains a lot of nitrogen (N) [2], whereas nitrogen is the main component for the formation of living things on earth and an element that has a fast influence on plant growth. According to Wang & Han [3], rainwater can carry metals and metalloids with high concentrations of cations and anions such as ammonium, nitrite, nitrate, sulfate, and chloride. Zhao et al. [4] state that rainwater has an average pH of 4.03 and parameters SO_2^- and NH_4^+ are the most abundant ions, followed by Ca^{2+}, H^+, NO_3^-, Cl^-, K^+, Na^+, F^- and Mg^{2+}. Sources of these compounds include SO_2 and NO_x emissions from the combustion of vehicle fuel, then undergo photochemical reactions (with the help of sunlight) and are dissolved by rainwater when it rains. NH_3 comes from emissions from agriculture, livestock, fertilizers, soil emissions, and biomass burning. NH_3 will go to equilibrium with NH_4^+ when dissolved in rainwater. The source of Ca^{2+} mainly comes from dust flying in the wind. Other ions (such as Cl^-, Na^+, Mg^{2+} and

K^+) mainly come from natural sources such as soil, forest fires, and sea salt. But rainwater contains low chemical and physical components.

Pradana [5] states that rainwater can be used as raw material for making fertilizers that are easily absorbed by plants using the fermentation process for some materials. The additives used shallots *(Allium cepa L. var. aggregatum),* hydrated lime, monosodium glutamate (MSG), sodium chloride, coconut water, and honey. This fertilizer can accelerate the growth and development of plants; the yield of guava fruit also increases in quantity (28%) and quality. The weakness that they do not conduct further tests on the composition of the fertilizer, both physically, chemically, and biologically due to constraints on knowledge and costs. In line with Wilaela, Rivai, Lamahid, & Zulfahmi [6], Haji ENg in Bangka Belitung uses rainwater as an alternative of organic fertilizer to boost agriculture. The additives used are the result of trial and error and through a series of experiments. The organic fertilizer produced by the experiment can accelerate plant genetic growth and is claimed to be able to be used for various types of plants. The lack of experiment did not test the characteristics of the fertilizer.

The purpose of this research is to create an additive to produce rain fertilizer. The optimal additives are able to create fertilizers that are easily absorbed by plants. Besides, the toxicity and physical and chemical characteristics of fertilizers need to be identified in depth.

2. Methods

The Research was conducted at the Environment Laboratory, Department of Environmental Engineering, Faculty of Engineering, Diponegoro University in 2020. The rainfer reactor is cylindrical, made of polyethylene with a maximum capacity of 70 liters (rainfer production unit) and 20 litters (fermenter unit). The maximum working volume of the rainfer production unit is set at 50 L to provide ample free space for mixing the liquid using a pump. The rainfer reactor is placed outside the room to get direct sunlight. The water in the rainfer reactor will be stirred due to the push of water coming out of the pump. The rainfer reactor is equipped with an outlet to dispense mature and stable liquid fertilizer. Fig. 1. show a schematic of rainfer reactor.

The primary raw material in this research is rainwater collected from the roof of the Joint College Building, Faculty of Engineering, UNDIP Semarang, Central Java. Rainwater collected is 50 liters, with details of 30 liters for production and 20 liters for the fermenter unit.

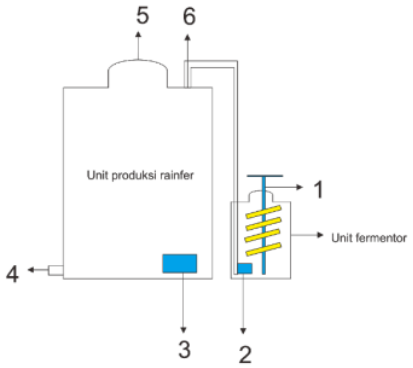

Figure 1. The rainfer reactor scheme consists of a fermenter unit and a rainfer production unit. (1) stirrer, (2) pump from the fermenter unit, (3) production unit pump for stirring the mixture, (4) rainfer liquid fertilizer outlet, (5) cover the production unit with transparent material as well as rainwater inlet, (6) liquid inlet

The materials used in the fermentation stage were Bryophyta, sp as much as 3 kg, 100 g of shallots *(Allium cepa L. var. Aggregatum),* 100 g of hydrated lime (technical grade), 100 g of monosodium glutamate (p.a grade), 100 g of sodium chloride (p.a grade), coconut water as much as 2 liters, and honey

as much as 100 g. Solid raw materials such as *Bryophyta, sp* as much as 3 kg, 100 g of shallots (Allium cepa L. var. Aggregatum), 100 g of hydrated lime, 100 g of monosodium glutamate are mixed and dried using an oven (Memmert UN 50, Germany) for 24 hours. The mixture that has been dried mashed using a blender with a size of 200 mesh. The solid is put into a fermenter unit equipped with a stirrer, then 15 liters of groundwater and 100 g of sodium chloride are added. The mixture was incubated for 2 x 24 hours at 36 °C.

As much as 35 liters of rainwater is put into the production unit. Furthermore, the inoculum from the fermenter unit is inserted into the production unit and agitated using a pump for 15 minutes until it is homogeneous. The mixture is allowed to stand for 7 x 24 hours outside in the sun. On the 8th day, the rainfer product is ready to use.

Laboratory tests are used to ensure that the rainfer product is mature and stable (safe to use). Rainfer liquid fertilizer quality standards refer to SNI 19-7030-2004 and Permentan No. 70 / Permentan/SR.140/10/2011 regarding organic fertilizers, biological fertilizers, and soil repairers with parameters C/N, P, K, heavy metals, germination index (GI). Germination index is used to test the toxicity level of rainfer fertilizers on plants C-Organic test using the spectrophotometry (Spectrophotometer UV-Vis 150, Thermosciencetific, USA) [7]. Rainfer product maturity level is seen from the C/N ratio, according to SNI 19-7030-2004 mature compost with a C/N ratio is between 10-20.

Data obtained from testing in the laboratory are then analyzed using Microsoft Office Word and Microsoft Office Excel to obtain data in the form of tables and figures. Based on these parameters, conclusions will be drawn about a ready-to-use formula and the creation of 'Rainfer' appropriate technology that can be utilized by the wider community.

3. Result and discussion

3.1 Rainwater

Table 1. Physical and chemical characteristics of rainwater samples, additives, and rainfers

No.	Parameter	Unit	Sample			
			Rainwater	Additive	1st day Rainfer	7th day Rainfer
1	pH	-	7.26	9.00	9.35	7.78
2	Temperature	° C	26.9	27	27	27
3	TDS	mg/L	12.2	2,050	889	925
4	Turbidity	NTU	1.64	-	-	-
5	Conductivity	µS	18.2	1,743	4.160	1,867
6	Nitrate	mg/L	1.13	52.48	72.23	32.67
7	Nitrite	mg/L	0.11	7.74	4.63	0.05
8	C / N ratio	-	-	30.35	14.88	2.04
9	P Total	mg/L	-	58.47	40.05	78.47
10	K Total	mg/L	-	4.35	4.54	0.03
11	Cu	mg/L	-	0.17	0.71	0.06

The purpose of measuring the quality of rainwater is to determine the physical and chemical characteristics of rainwater used as raw material for rainfer production. The results of measuring the quality of rainwater shown in Table 1. Based on table 1 shows that the pH value is 7.26, the temperature is 26.9 ° C, TDS is 12.2 mg/L, turbidity is 1.64 NTU, and conductivity is 18. 2 µS. The pH value does not differ significantly from research conducted by Yanti [8] said that the pH value of rainwater in 2016

ranged from 5.6-7.5. Other parameters are nitrate as nitrogen of 1.13 mg/L and nitrite 0.11 mg/L. it is indicated that the nitrogen content is relatively low.

3.2 Additive characteristic

Additives are used to improve the quality of rainwater, primarily physical and chemical parameters. The main additives consist of Bryophyta, sp, shallots *(Allium cepa L. var. Aggregatum),* hydrated lime, monosodium glutamate, Sodium Chloride, coconut water, and honey. The additive characteristics are shown in Table 1. The additive pH value is 9.00, including base [9]. The characteristics of solids in additives are known from the total dissolved solids (TDS) parameter. The TDS concentration in the additive is 2,050 mg/L, which means that the additive contains 2,050 mg/L inorganic salts, organic matter, and other dissolved materials in water [10]. The conductivity value was 1.743 µS, and the nitrogen concentration in the form of nitrate was 52.48 mg/L, and nitrite was 7.74 mg/L. The ratios of C / N, P Total, and K Total were 30.35; 58.47 mg/L, and 4.35 mg/L. The additive contains 0.17 mg/L Cu heavy metal.

The addition of *Bryophytes* as a source of carbohydrates, protein, fatty acids, and fat. The chemical composition of *Bryophytes*, from macro-compounds (carbohydrates, proteins, and lipids) [11] to specific substance groups such as fatty acids (FAs), terpenoids, flavonoids, and polyphenols. *Bryophytes* have a low lignin content, so easily decomposed compared to other cellulose biomass. Additionally, bryophyte does not affect food supply to humans - as opposed to sugar or starch-based biomasses. Besides, *Bryophytes* have a high growth rate so that they can be produced quickly. The monosodium glutamate manufacturer used as an alternative organic fertilizer, which is MSGshow a positive effect on plant growth when used as fertilizer with a composition of 1%, 5% and 10% w/v [12]. MSG reported showing a positive effect on plant growth when it was used as a fertilizer due to its high content of nitrogen. MSG is colourless, crystalline, soluble in water, inexpensive, and available in all stores. The use of MSG as organic fertilizer economically and biologically increased by 50% compared to control [13].

3.3 Rainfer quality

The characteristics of solids in additives are known from the total dissolved solids (TDS) parameter. According to APHA [14], TDS is the portion of total solids in a water sample that passes through a filter with a nominal pore size of 2.0 µm (or smaller) under specified conditions. Rainfer's TDS concentration is 925 mg/L, which means that the additive contains 925 mg/L inorganic salts, organic matter and other dissolved materials in water [10]. The addition of the additive succeeded in increasing the TDS parameter by 98.68%, from 12.2 mg/L to 925 mg/L. The conductivity value is 1,867 µS, where conductivity is the measure of a solution's ability to conduct electric current, which is much dependent on the availability of ionic species[10,14]. The concentration of nitrogen in the form of nitrate is 32.67 mg/L, and nitrite is 0.05 mg/L. The ratios for C/N, P Total, and K Total were 2.04 each; 78.47 mg/L, and 0.03 mg/L. The additive contains 0.06 mg/L Cu heavy metal.

Fig. 2 shows the increase in the percentage of the chemical and physical composition of rainwater due to the addition of additives. The addition of the additive succeeded in increasing the conductivity parameters of each by 99.03%. The concentration of nitrate as nitrogen has increased by 96.54% from 1.13 mg/L to 32.67 mg/L. The application of organic fertilizer is also more flexible and can be applied in a larger amount [11].

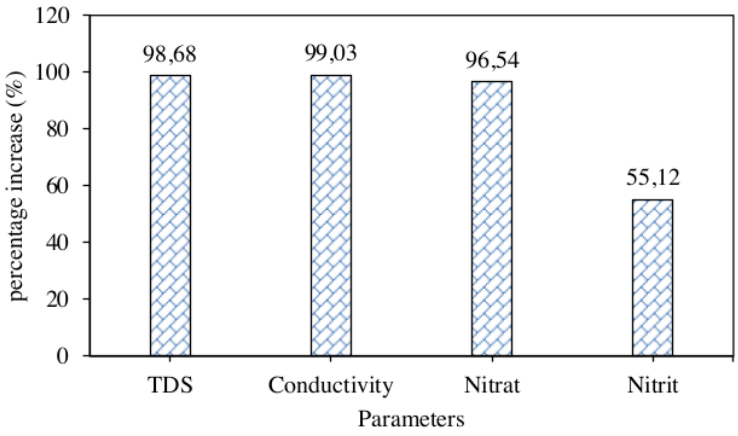

Figure 2. Percentage of increase in the chemical and physical composition of rainwater due to the addition of additives

3.4 Germination index (GI)

Rainfer's toxicity level was determined using the Germination Index (GI), where the compost is considered mature if the GI value is higher than 60%, compared with control [15]. GI testing used mung bean seeds which were incubated for 72 hours in a dark room. The results showed that the germination index value was 70.16% compared to the control, which means it was equivalent to mature and stable compost. This suggests that the phytotoxicity of rainfer has been lost.

4. Conclusion

This study aims to create a fermenter to produce rain fertilizer (rainfer) as a raw material. The results showed that the addition of Fermenter succeeded in increasing the TDS parameter and conductivity by 98.68% and 99.03%, respectively. The concentration of nitrate as nitrogen increased by 96.54%, from 1.13 mg/L to 32.67 mg/L. The final pH value was 7.78, total P was 78.47 mg/L, total K was 0.03 mg/L, and heavy metal Cu was 0.06 mg/L. The level of toxicity based on the germination index value was 70.16% compared to control, which means it is equivalent to mature and stable compost. The addition of a fermenter can improve the quality of rainwater based on physical, chemical, and non-toxic parameters. The optimal Fermenter is able to create fertilizers that are easily absorbed by plants.

Acknowledgments

Thank you to the Department of Environmental Engineering, Faculty of Engineering, Diponegoro University for funding this research through strategies grant for the financing year 2020

References

[1] BMKG 2019 *Analisis Hujan Januari 2019 dan Prakiraan Hujan Maret, April, dan Mei 2019* vol 2 (Jakarta)
[2] Moore J W 1990 *Inorganic Contaminants of Surface Water* (New York: Springer-Verlag)
[3] Wang H and Zhang L 2017 *Ecol. Eng.* **107** 33–40
[4] Zhao Q, Zhong H, Wang K, Wei L, Liu J and Liu Y 2013 *J. Environ. Sci.* **25** 59–68
[5] Pradana W E 2019 Bermula dari Alquran, Air Hujan Disulap Jadi Pupuk dan Pestisida Alami *https://kumparan.com/*
[6] Wilaela W, Rivai A A, Lamahid Q and Zulfahmi Z 2015 *Haji Eng Inspiring Person dari bangka Dari Pemahaman Keislaman ke Perbaikan Mutu Tanaman Menuju Pemberdayaan Ekonomi*

masyarakat (Riau: LPPM UIN SUSKA RIAU)
[7] Goering H K and van Soest P J 1970 *Forgae fibre analysis* (USDA Agricultural Handbook)
[8] Yanti A F D 2016 *Pengaruh pH Air Hujan Dan Beban Terhadap Karakteristik Korosi Pada Baja Galvalum* (Institut Teknologi Sepuluh Nopember)
[9] Moore J W 1991 *Inorganic Contaminants of Surface Water* (Canada: Springer-Verlag)
[10] Aniyikaiye T E, Oluseyi T, Odiyo J O and Edokpayi J N 2019 *Int. J. Environ. Res. Public Health* **16**
[11] Xiao L, Sun Q, Yuan H and Lian B 2017 *Acta Geochim.* **36** 198–204
[12] Kamarulzaman A F S and Asyraf Mohamad M 2019 *J. Sci. Technol.* **2** 1–7
[13] Lin X-J, Wang F, Cai H-S, Lin R-B, He C-M, Li Q-H and Li Y 2009 *Chinese J. Eco-Agriculture* **17** 235–8
[14] APHA 2017 *Standard Methods for the Examination of Water and Wastewater* (Washington)
[15] Oktiawan W, Zaman B and Purwono 2018 *E3S Web Conf.* **31** 2017–9

Rainfer: fertilizer production using rainwater as raw material

ORIGINALITY REPORT

2%	2%	1%	0%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Sulfianti Sulfianti, Eko Priyantono, Risman Risman. "CONTENT OF NPK HARA INGREDIENTS IN LIQUID ORGANIC FERTILIZER FROM VARIOUS TYPES OF RICE WASHING", AGROLAND The Agricultural Sciences Journal (e-Journal), 2022 Publication	<1%
2	www.scribd.com Internet Source	<1%
3	www.lrwu.com Internet Source	<1%
4	academic.oup.com Internet Source	<1%
5	iwaponline.com Internet Source	<1%
6	"Acid Rain - Deposition to Recovery", Springer Science and Business Media LLC, 2007 Publication	<1%

Exclude quotes	On	Exclude matches	Off
Exclude bibliography	On		