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RESEARCH ARTICLE

BRIQUETTES COMPOST AND LIQUID FERTILIZER APPLICATION FOR YELLOW LOCAL RICE GROWING ON BAMBOO RAFTS AS FLOATING SYSTEM

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ABSTRACT

Growing rice had been done previously by applying crumble compost on the floating raft but part of compost was lost through runoff, so briquettes compost needs to be buried in soil. The aims of this research were to find out the effects of briquettes compost and liquid fertilizer on rice and soil and plant nutrients content. Briquettes compost and liquid fertilizer were made of water mimosa (*Neptunia prostrate Lam.)*. Briquettes were applied at rates of (0, 10, 20 and 30) ton ha^{-1} and liquid used at (0 and 20) ml clump^{-1}. This experiment used Factorial Randomized Block Design. Briquette compost was made by mixing compost with starch and the application was by inserted into the soil. Liquid fertilizer was made from extracted compost and the application was sprayed on plant leaves. Results showed that the application of Briquette compost (10 ton ha-1) increased (0.34%) P and (1.88%) K plant contents significantly, compared to the control treatment were only (0.09%) for P and (1.38%) for K plant contents. Combination of briquettes compost (20 ton ha^{-1}) and liquid fertilizer (20 ml clump^{-1}) increased dried weight rice significantly to (4.55 ton ha^{-1}) from (1.58 ton ha^{-1}) for control treatment. Briquettes compost inserted into the soil had increased nutrients P and K absorbed due to more contact between roots and nutrients and produced more rice yield.

Keywords: briquette, compost, fertilizer, floating, liquid.

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INTRODUCTION

Water mimosa (*Neptunia prostrate* Lam.*)* is one of the weeds growing in swampland paddy field during flooding, this legume plant was composted and contained high nitrogen (4%) and also other nutrients such as P (1675 mg kg^{-1}), K (5.6%), Ca (0.32%), Mg (0.32%) (Bernas, Wijaya, Sagala, Nurul, & Fitri, 2015). Compost used to be applied in form of granular or crumb and put on top of the soil and this compost exposed to the air could cause

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nutrients lost by leaching, erosion, and evaporation (Bajracharya, Lal, & Kimble, 2000; Kettler, Lyon, Doran, Powers, & Stroup, 2000; Kristensen, McCarty, & Meisinger, 2000). The application of compost incorporated into the soil could overcome this problem, for example, if the compost was in the form of briquette and inserted into the soil before paddy was planting, it reduced nutrients lost. Previous results showed that some of the applied composts on topsoil on the rafts were removed by water (Bernas, Pohan, Fitri, & Kurniawan, 2012). Even though the result had shown growing brown gelatinous rice on the rafts with the application of 10 ton ha^{-1} of crumble compost, had produced more than 90% filled spikelet (Bernas, Chandra, & Sulistiyani, 2012). That why the application of briquette compost was inserted into the soil. Curtis & Claassen (2005) found out that organic matter incorporated into the soil could increase the ability of the plant to absorb water through root proliferation. Compost was able to stimulate plant growth, root development and thus nutrient uptake (Walker & Bernal, 2008) Application of briquette compost by inserting into the soil about roots could make contacting of roots and composts more intensively, then absorption of water and nutrients were increased.

Liquid fertilizer (extracted compost) was used in this research because of high N content and high pH (Bernas et al., 2013). Gharib, Moussa, & Massoud (2008) reported that oil percentage and yield per plant was almost two-fold higher on a fresh weight basis as a result of applied aqueous extracts of compost. This was due to nutrients content in the liquid fertilizers ready available for the plant when it sprayed on the plant leaf.

Planting paddy and several vegetables on beds made of hyacinth plants and bamboos as a floating system, had been practicing in Myanmar (Than, 2007) and in Bangladesh (Assaduzzaman, 2004) and those beds floated depending on water level and organic agricultural system. Previous results (Bernas, Pohan, Fitri, & Kurniawan, 2012) showed that 20 ton ha^{-1} compost had increased black gelatinous rice significantly when this rice grew on bamboo rafts as a floating system. Growing this rice on the rafts was chosen in this research because this rice was rather expensive and the price of making rafts could be compensated by the rice yield. Another result has shown planting brown gelatinous rice on the rafts with the application of 10 ton ha^{-1} crumble compost had produced more than 90% filled spikelet (Bernas, Chandra, Sulistiyani, 2012).

The purposes of this research were to find out the best combination dose of briquettes compost and liquid organic fertilizer on soil and plant nutrients content, productive tiller and yield of yellow rice were growing on the rafts as floating agriculture.

MATERIAL AND METHODS

A raft was made of a big bamboo with about 10 cm its diameter, the length of the raft was 6 meters and wide was 1.2 meters. There were all 10 rafts and each raft was divided into 3 parts for replication, there were 30 treatments, each part was filled with 270 kg of topsoil. This research was carried out on swampland water and water pH (H_2O) was 4.43.

Compost was made of water mimosa (*Neptunia prostrate* Lam.) see Figure 1, which was a kind of weed in a paddy field, chopped water mimosa plant was decomposed for 10

Table 1. Characteristics of briquette compost and liquid fertilizer made of water mimosa (*Neptunia prostrata* Lam.) (Bernas et al., 2015).

No	Chemical Properties	Unit	Briquette Compost	Liquid Fertilizer
1.	P-available	(mg kg^{-1})	1675	-
2.	N	%	4.0	6.15
3.	K	%	5.6	-
4.	Ca	%	0.32	-
5.	Mg	%	0.32	-
6.	pH (H_2O)	Unit	6.8	8.73
7.	C.E.C.	$Cmol^{+}kg^{-1}$	262	-
8.	C/N	8.32		

Note: (-) very low.

weeks. Briquette compost (BC) was made by mixing compost with boiled cassava flour and pressed into plastic pipe, which the weight of 28 g; 56 g; 74 g; and 112 g where the sizes of briquettes were according to dose of application for one plant equal to rates of (0, 10, 20 and 30) ton compost ha^{-1}.

Paddy used in this experiment was yellow local rice from a farmer in the swampland of Keramasan District, Palembang. The application of briquette compost was inserted into the soil and paddy was planted above of briquette compost placed. The application of one briquette for one plant was based on above dosages. Liquid fertilizer (LF) application was (0 and 20) ml per plant and spraying on the leaves twice when the plant was 4 and 8 weeks old following planting. This experiment used Factorial Randomized Block Design, which briquettes compost as first factor and liquid fertilizer as second factor, if there were any significant differences between treatments then LSD was used for further statistical calculation. Data collected were N, P and K soil and plant contents at an early stage of anthesis. Nitrogen was analyzed using Kjeldahl Method, K was using (NH_4OAc at pH 7.0) and P (Bray-1). The component yield of yellow rice analyzed was the amount of productive tiller, filled grain and rice yield.

RESULTS AND DISCUSSION

Effect of Briquette Compost and Liquid Fertilizer on the Soil Fertility

Results showed that briquette composts (BC) and liquid fertilizer (LF) gave effects varied to soil and plant nutrients content and the two treatments did not affect soil pH, N, P, K contents significantly at early anthesis stage (Table 2). However briquettes compost tended to increase pH, N, P, and K content in the soil compared to control.

Soil reaction (pH) was not significantly affected by application briquette compost (BC) and liquid fertilizer, where soil pH was from very acid to acid (Table 1). However, the addition of BC increased pH from very acid (4.2) to acid (>4.5), a combination between liquid fertilizer (20 ml per clump) and BC (20 ton ha^{-1}) gave the highest soil pH (4.81) which was still acid. Even though BC could act as pH buffer and liquid fertilizer has high pH (8.7), these could not affect soil pH in a very acid swampland water, where the research was carried out during the dry season and water pH was (4.43) very acid, due to this swampland contained acid sulfate layer. So it is better to do an experiment in rain season or flooding time and where the water is more dilute and neutral.

Soil Nitrogen contents (Table 2) were not influenced significantly by the addition of briquette compost and liquid fertilizer, even though the two fertilizers contained high N (Table 1). The highest N soil content was 0.17% (for 10, 15 and 20 ton ha^{-1} BC treatments) and the lowest was 0.12% (for control). Actually BC applied in this experiment was with low CN ratio (8.32), indicating that nutrients were in the form of available to the plant, however soil N remained low. This might due to mineralization (ammonification) of organic nitrogen produced volatile NH_3 and resulted in available nitrogen as ammonium (NH^+_4) (Foth, 1978), this form was easy to be leached in wet soil, especially in the rafts where water content was high and the soil was sandy soil. Decreasing soil N content on the high application of compost also could be caused by N absorbed by the plant for production, since productive tillers and rice yield were increased significantly by compost application (Table 3). Even though nutrients contained in the liquid fertilizer was readily available for plant (Gharib et al., 2008) and N content was very high (4%) (Table 1) but could not affect soil N content, this might be caused by method of application with spraying on the leaves and only 2 times application, N could also volatilize and leached from the leaves. It may be suggested to apply more frequently with a lower dose and spray more than 2 times. In general soil N content was the rarely high even application of high N fertilizer (225 kg ha^{-1} N) and inserted into 10 cm soil deep and 5 cm from the rice roots, where N soil was about 0,20% (Liu et al., 2016), this caused by N lost through ammonia volatilization. The lost of N in the raft could be more than in rice field, due to the raft was floating on the water and fertilizer could be leached from the bamboo base. It needs further investigation on how to decrease leaching by using other material instead of using jute sack on the base of the rafts.

Soil P was also not influenced by addition BC and liquid fertilizer. According to Nuryani, Haji, & Widya (2010) soil chemical properties such as N, P and K contents were not easy to be affected significantly by the addition of organic matter. However, more dosages of BC tended to decrease soil P content. The highest soil P content (20.88 mg kg-1) was reached by application of 10 ton ha-1 with or without liquid fertilizer and the lowest was 11.79 mg kg-1 P at control with 20 ml liquid fertilizer. Low soil P at 20 ton ha-1 application of briquette could be caused by maximum plant absorption at this stage as showed by increasing P plant content (Table 2) and producing more productive tillers, rice yields, and filled grain (Table 3). Application of briquettes compost by inserting into the soil about roots could make contacting between roots and composts more intensively then increasing nutrients absorbed. Compost was able to stimulate plant growth, root development and thus nutrient (Walker & Bernal, 2008)

Effect of Briquette Compost and Liquid Fertilizer on the Plant Nutrient Content

Plant N content (Table 2) was not influenced significantly by the addition of briquette compost and liquid fertilizers, even though the two fertilizers contained high N (Table 1). The lowest plant N was 1.07% with the application of 10 ton ha-1 compost and the highest was 1.67% reached by application of 20 ton ha-1 compost. These values were higher compared to research done by (Nurrahma & Melati, 2013), where the application of 5 ton compost combined with 15 ton chicken manure produced 0.95% plant N content, also by (Liu et al., 2016) where rice straw contained 0,95% N after application of N an organic fertilizer inserted into the soil about 20 cm depth. It showed that BC inserted into the soil might decrease the lost of N through leaching or volatile. Thus inserted BC was more effective in increasing plant N content than inorganic fertilizer.

Plant P and K contents were not affected significantly by the addition of briquette compost and liquid fertilizer, but the combination of these two fertilizers gave significant effect on plant P and K contents. The best plant P content (0,34%) was reached by a combination of 10 tons ha BC and 0 liquid fertilizer and the lowest (0,09%) P was obtained by control (without BC and LF). More dosages of BC application produced higher plant P contents (Table 2). The application of BC inserted into the soil just around the roots increased P absorption, caused by BC available about the roots and created more contact between root hairs to nutrients in compost (Curtis & Claassen, 2005) (Walker & Bernal, 2008). BC as the organic matter could also act as pH buffer, since swampland water pH was 4,43, that why P absorption was rather high. Liquid fertilizer did not influence plant P content because LF contained very low P (Table 3), but it was expected to increased P plant because of high pH liquid fertilizer (8,7), this might be caused by an application on the leaves, thus could not affect soil pH.

The best K plant content (1,88%) was gained by combination application of 20 ton ha^{-1} BC and 0 LF and the lowest (1,38%) was achieved by control (without BC and LF). Similar to P plant content in LF, K content was also very low in LF treatment (Table 2).

Table 2. The effects of liquid fertilizer and briquette Compost on pH, N, P, K of soil and plant.

Liquid Fertilizer (ml per clumps)	Dosage of briquette Compost (ton ha^{-1})	Soil pH (H_2O)	Nutrient Plant Content (%)			Nutrient Soil Content		
			N	P	K	N (%)	P (mgkg^{-1})	K (CmolKg^{-1})
0	0	4.42	1.26	0.09 a	1.38 a	0.12	13.28	0.17
	5	4.56	1.18	0.20 ab	1.63 ab	0.15	13.44	0.26
	10	4.63	1.07	0.34 b	1.71 ab	0.17	19.48	0.24
	15	4.68	1.31	0.25 ab	1.71 ab	0.16	20.88	0.34
	20	4.58	1.69	0.20 ab	1.88 b	0.17	14.36	0.31
20	0	4.42	1.11	0.14 a	1.71 ab	0.12	11.79	0.24
	5	4.41	1.36	0.22 ab	1.54 a	0.15	20.01	0.20
	10	4.65	1.48	0.25 ab	1.67 ab	0.15	20.88	0.31
	15	4.58	1.09	0.22 ab	1.83 b	0.17	17.79	0.41
	20	4.81	1.40	0.25 ab	1.83 b	0.17	14.89	0.48
LSD $_{(0.05)}$		ns	ns	0.24	0.44	ns	ns	ns

Note: Different letters in similar column indicates statistically significant different values among treatment in LSD (p<0.05).

Table 3. The effect of briquette compost and liquid fertilizer on tillers and rice yields.

Liquid Fertilizer (ml per clump)	Dosage of briquette compost (ton/ha)	Productive tiller per clump	Filled grain (g/clump) or (%)	Dried weight rice (g/clump) or (ton/ha)
0	0	3.67a	7.88 a (89.65)	8.79 a (1.58)
	5	5.33ab	12.65 ab (91.87)	13.77 ab (2,48)
	10	6.00ab	14.89 ab (91.91)	16.20 ab (2.92)
	15	6.00ab	19.40 bc (93.49)	20.75 ab (3.73)
	20	7.67ab	17.68 abc (91.51)	19.32 ab (3.48)
20	0	5.67ab	12.79 a (94.11)	13.59 ab (2.45)
	5	6.33ab	14.85 ab (94.11)	15.78 ab (2.84)
	10	8.33b	18.07 bc (94.61)	19.10 ab (3.44)
	15	8.33b	18.07 bc (94.61)	19.10 ab (344)
	20	9.33b	24.26 c (96.04)	25.26 b (4.55)
LSD $_{(0.05)}$		**4.42**	**9.13**	**14.21**

Note: Different letters in a similar column indicates statistically significant different values among treatment in LSD (p<0.05).

Effect of Brequette Compost and Liquid Fertilizer on Productivity of Yellow Local Rice

Briquettes compost affected productive tillers and rice yields significantly, but liquid fertilizer did not give significant effects on a component of rice yields. However the combination of briquettes compost and liquid fertilizer affected maximum, productive tillers and rice yields significantly (Table 3).

The amount of yellow rice productive tillers were (8.33) per clump (Table 3), it was similar to a previous study (Bernas, Pohan, et al., 2012), where the amount of productive tiller of glutinous rice growing on the rafts were 8 per clump. This production was low compared to the research done by Pratiwi & Arisoesilaningsih (2014) which produced 15 productive tillers on paddy field and normally were 18 to 26 tillers according to DEPTAN (2008). However, this finding was similar to the research done by Suhardjadinata, Sunarya, & Tedjaningsih (2015) where humic substance could not increase rice tiller. According to Gharib et al. (2008) compost was better in increasing plant shoots and branches, and the application of mixed compost from varied plants could increase (0.21% P) plant content compared to application of NPK fertilizers only (0.16% P) content. Low productive tillers might also cause by low productivity of local rice and late planting on the rafts, due to making rafts needed longer time than expected, thus the plants were too old (8 weeks) for more tiller production (Figure 1). Even though average tillers were low, dried rice was rather high in combination treatments.

Combination of briquettes compost (20 ton ha-1) and liquid fertilizer (20 ml) increased productive tillers significantly from 3.67 (control treatment) to 8.33; filled grain weight increased from 7.88 (control) to 24.26 g clump-1; and dried weight rice from 8.79 g clump-1 (1.58 ton ha-1) (control) to 25.26 (4.55 ton ha-1). This results were higher compared to researches done in swampland by Koesrini, Saleh, & Nurzakiah (2017) which applied high fertilizers: 550 kg phonska and 50 kg urea for Ciherang paddy and produced only 3.37 ton ha-1. Another experiment was done by Hairmansis, Aswidinnoor, & Suwarno (2013) showed that IR 42 produced 2.43 ton ha-1 in a potential acid sulphate soil of swampland and (Shazana, Shamshuddin, Fauziah, Panhwar, & Naher, 2014) carried out the research on acid sulfate soil with application of ground basalt produced 4.41 ton ha-1 rice, author had considered result was good for infertile soil. So dry rice yield (4.55 ton ha-1) in this research was considered very good for without addition of synthetic fertilizer, thus BC made of water mimosa was promised for organic rice production.

This yellow local rice productivity was usually about 2-3 ton ha^{-1}, thus this finding was better than rice yield from farmer paddy field. The high content of filled grain also caused by compost contained micronutrients such as B, Cu, Zn, Mo and Si which were important in rice grain development and especially for micronutrients shortage soil (Hameeda, Harini, Rupela, & Reddy, 2007). The advantages of compost because it contained complete micro and macronutrients (Zulkifli, Ichsan, & Syafruddin, 2012).

Figure 1. Water mimosa (*Neptunia prostrata* Lam.)

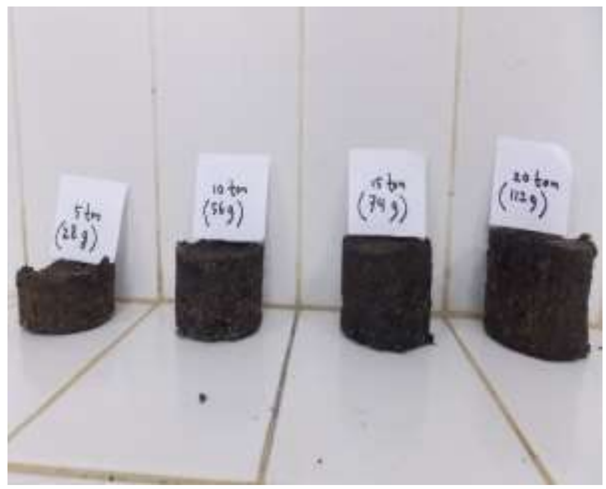

Figure 2. Briquettes compost made of water mimosa (doses in ton ha and in g per clump).

Figure 3. A raft full of soil for growing rice

Figure 4. Growing local yellow paddy on a raft

According to Shamshuddin (2006) in Shazana, Shamshuddin, Fauziah, Panhwar, & Naher (2014), acid sulfate soil contained Al or Fe and very low pH, but in submerged condition, Fe^3 could change to soluble Fe^2, which was harmful to plant growth (Herviyanti, Prasetyo, Ahmad, & Darmawan, 2010). This briquettes compost could release P which fixed by Fe, Al and Ca and in turn P would be more available and could be absorbed by the plant (Nuryani et al., 2010), besides BC contained high P. High filled grain was similar to result on research done for brown gelatinous rice on the rafts with the application of 10 ton ha^{-1} crumble compost had produced more than 90% filled grain (Bernas et al., 2012). BC was made of water mimosa, this was a weed growing vigorously in swampland rice field (Bernas et al., 2015) and thus farmers could collect and use it for compost to increased rice yield.

CONCLUSIONS AND RECOMMENDATIONS

Briquette composts increased P and K plant contents significantly from (0.09% to 0.34%) P for 0 and 10 ton ha^{-1} compost treatments and from (1.38% to 1.88%) K for application of 0 and 20 ton ha^{-1} compost respectively. Liquid fertilizer did not affect soil and plant nutrients content and plant productivity, the application of this liquid was needed to be evaluated such as applying more frequently with a low dosage. Combination of briquettes compost (20 ton ha^{-1}) and liquid fertilizer (20 ml) increased productive tillers significantly from 3.67 (control) to 8.33, filled grain weight increased from 7.88 (control) to 24.26 g $clump^{-1}$, and dried weight rice from 8.79 g $clump^{-1}$ (1.58 ton ha^{-1}) (control) to 25.26 (4.55 ton ha^{-1}). Growing rice on the raft as floating agriculture has a potential prospect in the future, especially on swampland and for the organic system. It is needed further investigation on using clay soil instead of sandy soil on the rafts for rice and growing other vegetables on the floating system, also carrying researches on applying briquette composts on a paddy field at swampland.

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