Effects of Liquid and Solid Organic Fertilizer from Urine and Feces of Cow on Rice Production

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Abstract. This study aims to determine the effect of Liquid and Solid Organic fertilizers from Urine and feces of Cows on Rice Production. It was conducted on March-July, 2019 in Siti Mulyo village, Piyungan sub-district, and Bawuran village, Pleret sub-district, Bantul regency, Indonesia. Furthermore, about 74 farmers were included and were divided into three differing patterns (A, B, and C) of 16, 30 28 respectively. Farmers in A and B conducted solid and liquid organic fertilizer application methods for 4 ton/ ha and 3.2 liter/ha. The rice planting system of A was similar Tajarwo 4:1 while B appeared as squares (25 cm x 25 cm). Pattern C farmers used fertilizer and rice planting systems according to their habits. The variables observed were plant height at harvest, number of productive tillers, panicle length, amount of grain/panicle, amount of green grain/panicle, and dry gain production. Data were analysed using analysis of variance and Duncan Multiple Range Test for significant differences. The results of the study showed that the growth of rice cropping patterns A, B, and C were not different. However, rice production was significantly different, where pattern A, B, and C was 8.36 ± 1.48 t ha⁻¹, 7.84 ± 1.24 t ha⁻¹ and 7.48 ± 0.54 t ha⁻¹ respectively.

Keywords: Liquid and Solid Organic Fertilizer, Rice Production

1. Introduction

Cow-rice integration is an effort to improve efficiency, both in rice farming and cattle rearing. Principally, the concept of integration is to improve business efficiency by utilizing production inputs [1]. Farmers that depend solely on rice are expected to receive additional income from raising cows [2]. Therefore, the efficiency and income of narrow paddy fields can be increased through integrated rice farming. The low income of farmers is that technological innovations in rice cultivation and cattle farming as well as the use of by-products have not been optimally implemented. Technological innovation in bio-industry to integrate cow-rice production increases productivity, livestock population, income, and welfare of farmers [3].

The most important characteristic of the bio-industry based on the integration is the occurrence of synergism or a mutually beneficial relationship between rice cultivation and cattle farming [4]. In the bioindustry, local resources such as manure and rice straw are utilized as fertilizer and animal feed respectively [5; 6]. The main characteristic of this model is the integration between planting and cattle rearing to improve farming efficiency by reducing the use of inorganic fertilizers and increasing rice production [7]. This method is advantageous since it provides fertilizer from cow manure and feeds from straw and rice brand [8].

One of the challenges in the development of bio-industry integrated cow-rice is the lack of technological innovation in fertilizing and processing rice plants' waste as animal feed [9]. To enable high production, balanced organic and inorganic fertilizers are required, and their application is effective...
when used in the same ratio. The application of organic fertilizer increases biological activity, the level of mineralization, and nutrients in the soil. However, fertilizers from cow manure have not been optimally utilized as organic fertilizer to increase soil fertility.

The application of solid and liquid organic fertilizer from cow manure is one option to meet the nutritional needs of rice plants. The implementation for producing solid organic fertilizer from cow faeces is simple and feasible [10]. Furthermore, the technology for making liquid organic fertilizer from cow urine is also cheap, easy, and provides benefits for farmers [11]. The benefits of using liquid organic fertilizer include saving costs, fertilizing the soil, increasing crop productivity and income. Previous results indicate that grain production can be increased through the use of liquid fertilizer [12]. It has also been reported that the application of liquid organic fertilizer on leaves increases production by around 10%. Therefore, this study aims to determine the effect of the use of solid and liquid organic fertilizer from cow urine and faeces on rice production.

2. Material and Method

2.1. Pattern and Farmers Involved

This study was conducted on March - July 2019 in Siti Mulyo village, Piyungan sub-district, Bantul regency (7°52'14'', 110°25'16'',11''136''), and Bawuran village, Pleret sub-district, Bantul regency (7°50'31'', 110°26'23'',00m,181°), Indonesia. The numbers of farmers involved were 74, divided into three patterns of A, B, and C. The sampling method was purposive random sampling [13; 14] with pattern A consisting of 16 farmers on an area of 1.14 ha. Furthermore, patterns B and C consisted of 30 and 28 farmers in areas of 4.79 ha and 4.99 ha with a total of 10.92 ha using Ciherang variety. The method adopted the farming business system from [15], and the explanation of the pattern A, B, and C are stated in Table 1.

| Pattern | Description | A | B | C |
|---------|-------------|---|---|---|
| Pattern explanation | Farmers implemented the rice planting system with technological innovation. | Farmers implemented the rice planting system with technological innovation. | Farmers did not implement the rice planting system with no technological innovation. |
| Technology use | Solid organic fertilizer 4 ton/ha, liquid organic fertilizer 3.2 liter/ha with rice planting system as Tajarwo 4:1. | solid organic fertilizer 4 ton/ha, liquid organic fertilizer 3.2 liter/ha with rice planting system as a square (25 cm x 25 cm) | Using fertilizer and rice planting systems according to habits |

Note: Tajarwo: technology innovation of planting system by use 4:1 [16].

2.2. Variables Observed and Analysis

Variables observed were plant height at harvest, number of productive tillers, panicle length, and amount of grain/panicle, amount of green grain/panicle, dry grain, and straw production. In addition, data were analysed using analysis of variance [17] and Duncan Multiple Range Test (DMRT) for significant difference [18].

3. Result and Discussion

3.1. Plant Height at Harvest

The highest plant height at harvest was within pattern B, followed by A, then C. The plant height (110 days after planting) of patterns B and A was 5-10 cm higher compared to plants of C. This is due to the application of solid and liquid organic fertilizer 4 ton/ha and 3.2 liter/ha to increase the availability of soil nutrients. The result is consistent with the study by [19], where it was reported that the application of liquid organic fertilizer increases the total N-soil due to the contribution of nitrogen sourced from
organic compounds and produce acids. Furthermore, it was also reported that nutrient N is given to influence the vegetative growth of plants. This is consistent with the opinion of [20] which states that the nitrogen element can stimulate the vegetative growth of plants. Conversely [21] states that the deficiency will cause symptoms of slow growth, yellowish and narrow leaves, short and upright, old leaves quickly turn yellow and die. The plant height at rice harvest of patterns A, B, and C are shown in Figure 1.

3.2. Number of Productive Tillers

The number of productive tillers in patterns A and B is lower than C but statistically shows no significant difference. The difference in the number of productive tillers between patterns is 0.3-0.5/family. The average number of productive tillers range from 17.2-17.8 per plant. The application of solid and liquid organic fertilizer affects panicle length. The highest length was obtained from pattern B, followed by C, and then A. Panicle length ranges from 25.2-25.8 cm. According to [23], the element N influences panicle length, number of grains/panicle, and number of pithed grains/panicle. It is obtained from organic fertilizer given to plants [24] and has been suggested that the nutrients that plants need, when available in sufficient quantities, allow them to grow and produce to the maximum.

3.3. Panicle Length

The number of grain/panicle of pattern A produced is more than B or C, and the application of solid and liquid organic fertilizer affects the number of grain/panicles. The difference between A and C is 10 grains / panicles y=5.25x+152.99 (R² =0.84). Providing high nutrient content can meet nutritional requirements in the process of photosynthesis compliance [25].

3.4. Amount of Green Grain /Panicle

The number of increased green grains/panicles will be followed by the percentage of empty grains (Figures 2). Green grain/panicle amount will have an impact on the yield of both dry and milled grain as well as its rice yield. According to [26] rice production is influenced by the number of panicles, grains/panicles and rice grains. The percentage of filled grain in patterns A and B is higher than C (Figure 3), and will affect increasing the production of rice per hectare. Furthermore, the higher percentage of green grain affects the reduction of rice production, yield, and quality per hectare.
3.5. Dry Grain Production

The highest production of dry grain is from pattern A (8.36 ± 1.48 ton/ha), followed by B (7.84 ± 1.24 ton/ha) and then C (7.48 ± 0.54 ton/ha), as presented in Table 2.

| Pattern | Technology Use                                                                 | Production       |
|---------|--------------------------------------------------------------------------------|------------------|
| A       | Solid and liquid organic fertilizer 4 ton/ha and 3.2 liter/ha with rice planting system as Tajarwo 4:1. | 8.36± ± 1.48     | 20.25 ± 3.56 |
| B       | Solid and liquid organic fertilizer 4 ton/ha and 3.2 liter/ha with rice planting system as a square (25 cm x 25 cm)| 7.84± ± 1.24     | 18.52 ± 1.39 |
| C       | Using fertilizer and rice planting systems according to habits                   | 7.48± ± 0.54     | 18.34 ± 1.40 |

The results [27] showed that when a square rice planting (25 cm x 25 cm) is changed to a 4:1 Tajarwo system, grain production will be increased by about 10-15%. The difference of production between pattern C compared to B and A is 0.36 – 0.88 tons/ha. According to [28], when the nutrients within the fertilizer are not utilized by the plants, its efficiency becomes reduced and vice versa. The long-term
yield of rice straw recommends that it should be returned better than burned [29]. This is widely considered as an effective method for increasing soil organic carbon (SOC) and reducing chemical fertilizer application [30; 31; 32] reported that the SOC of rice paddy fields increased by 34–56% when straw return is compared with only fertilizer application. The results on rice and straw yields are in Table 2.

Rice straw production was not significantly different, where patterns A, B, and C had 20.25 ± 3.56 ton/ha, 18.52 ± 1.39 ton/ha, and 18.34 ± 1.40 ton/ha respectively. Pattern A produces higher rice straw and grain/panicle due to the 4:1 Jarwo planting system. Furthermore, the result of rice straw production was higher than [33], where it was reported as 5 ton/ha per harvest. [34] reported that the higher productivity, profitability, and the ratio of output value, as well as cost of cultivation, were achieved in the integrated method as compared to conventional rice farming.

4. Conclusion

It is reasonable to conclude that the use of solid and liquid organic fertilizer technology from faeces and urine of cows as well as the 4:1 Tajarwo rice planting system can increase grain yield. This can be produced from solid and liquid organic fertilizer of 4 ton/ha and 3.2 liter/ha respectively.

References

[1] Gunawan and Talib C 2014 Potential development of bio-industry in the integration system of oil-palm Wartazoa 24 (2) 67-74
[2] Soeharsono, Rustijarno S and Triwidyawastuti K 2017 Breeding for beef cattle in the crop integration system in the southern coast region of Bantul district Anim. Sci. 6 (1) 49-55
[3] Haryanto B 2009 Animal feed technology innovation in the crop-livestock integration system free of by-products to supports efforts to increase meat production J. of Agric. Innova. Dev. 2 (3) 153-176
[4] Gunawan and Sulastiyah A 2010 Development of cattle breeding business through the integration of livestock plants and the development of livestock areas. J. Agric. Sci. 6 (2) 157-168.
[5] Basuni R, Muladno, Kusmana C and Suryahadi 2010 System of integration of beef cattle in paddy fields Food Crops Bull. 5 (1) 31-48
[6] Winarti E and Widyastuti A 2016 The effect of calf starter ration for pre-weaning ongoke calves on body weight gain J. of the Indonesian Trop. Anim. Agric. 41 (4) 209-215
[7] Bamualim A and Tiesnamurti B 2009 Conception of the system of integration between rice, oil palm and cocoa with cattle in Indonesia Crop Livestock Integration System: Rice-Palm-Cocoa ed A M Fagi, Subandriyo and I Wayan Rusastra (Jakarta: LIPI Press) pp 1-14
[8] Winarti E, Gunawan, Djaffar T F, Widyastuti A, Supriadi, Widyastuti K T, Harsanto, Basuki H, Cahyaningrum N 2016 Development model of bio-industry agriculture based on integration of cow-rice in the Special Region of Yogyakarta. (Yogyakarta: Assessment Institute for Agricultural Technology) p 36
[9] Gunawan, Sutardi and Winarti E 2018 Rice cultivation technology and management of biomass in integrated bio-industry agriculture Agriculture bio-industry future agricultural solutions ed L Hutahean et al (Jakarta: IAARD Press)
[10] Gunawan 2015 Manufacture and use of organic fertilizers (solid and liquid) (Yogyakarta: Yogyakarta Assessment Institute for Agricultural Technology)
[11] Gunawan 2013 Processing liquid organic fertilizer from cow manure 100 Specific Location of Agricultural Technology Innovations in the Special Region of Yogyakarta ed Sudarmaji et al (Jakarta: IAARD Press)
[12] Purwono and Purnamawati H 2007 Cultivation of 8 Superior Food Crops (Jakarta: Penebar Swadaya)
[13] Taherdoost H 2016 Sampling methods in research methodology: how to choose a sampling technique for research IJARM 5 (2) 18-27
[14] Triyono 2019 Sampling Technique Upgrading of Research Data Analysis for Lecturers of Private (Kalimantan: Universities XI) p 4
[15] FAO 1990 Farming system development-Guidelines for the Conduct of a Training Course in Farming System Development (Rome: FAO)
[16] Sirnawati E and Sumedi 2019 Factors determining the adoption of Jajar Legowo Super technique in the Centers of rice production Agric. Res. of Food Crop 3 (3) 143-152
[17] Gomez K A and Gomez A A 2007 Statistical Procedure for Agricultural Research 2nd Ed E Sijamsuiddin and J S Baharsjah (Jakarta: UI Press)
[18] Cohort 2008 CoSTAT Version 6.400 Copyright 1998-2008 Cohort Software (USA: 798 Lighthouse Ave, Montere)
[19] Isrun 2009 Changes in the status of N P K soils and yields of sweet corn (Zea mays saccharatusturt) due to the provision of organic liquid fertilizer on entisols. Agroland. J. 16 (4) 281-285
[20] Haryadi M S 2005 Introduction to Agronomy (Jakarta: PT Gramedia)
[21] Suryamto 2010 The role of Nutrient N, P, K in Rice Plant Metabolism Process. (Bogor: Center for Agricultural Research and Development)
[22] Lakitan B 2010 Fundamentals of Plant Physiology (Jakarta: Rajawali Press)
[23] Syakhhril, Riyanto and Arsyad H 2014 Effect of nitrogen fertilizer on the appearance and productivity of Sidenuk inpari rice AGRIFOR J. XIII (1)
[24] Effendi 1997 Fertilizers and Fertilizing Methods (Bogor: Food Crop Research Institute)
[25] Habibullah H, Idwar and Murmiati 2015 The effect of fertilizer N P K and organic liquid fertilizer on the growth and efficiency of upland rice production (Oryza sativa L) in ultisol medium. JOM Faperta 2 https://media.neliti.com/media/publications/202489-none.pdf
[26] Fageria NK, Moreira A and Coelho A M 2011 Yield and yield components of upland rice as influenced by nitrogen sources J. of Plant Nutrition 34 361-370
[27] Winarti E, Sudarmaji, Gunawan, Djaffar T F, Pertwiwinrum A, Widyastuti A, Widyastuti K T, Basuki H, Cahyaningrum N, Harsanto and Sutarno 2015 The development model of bio-industry agriculture based on integration of cow-rice in the Special Region of Yogyakarta (Yogyakarta: Yogyakarta Assessment Institute for Agricultural Technology) p 40
[28] Suryanto W A 1994 Fertilizing Technology Breakthroughs in the Era of Organic Agriculture: Cultivation of Food Crops, Horticulture and Plantation (Yogyakarta: PT Kanisius)
[29] Huang Wan, Wu Jian-fu, Pan Xiao-hua, Tan Xue-ming, Zeng Yong-jun, Shi Qing-hua, Liu Tao-ju and Zeng Yan-hua 2021 Effects of long-term straw return on soil organic carbon fractions and enzyme activities in a double-cropped rice paddy in South China. J. of Integrative Agric. 20 (1) 236–247
[30] Lehtinen T, Schlatter N, Baumgarten A, Bechini L, Krüger J, Grignani C, Zavattaro L, Costamagna C and Spiegel H 2014 Effect of crop residue incorporation on soil organic carbon and greasehouse gas emissions in European agricultural soils Soil Use and Manag. 30 524–538.
[31] Liu C, Lu M, Cui J, Li B and Fang C 2014 Effects of straw carbon input on carbon dynamics in agricultural soils: a meta analysis Global Change Biol. 20 1366–81
[32] Zhang M, Cheng G, Feng H, Sun B, Zhao Y, Chen H, Chen J, Dyck M, Wang X and Zhang J 2017 Effects of straw and biochar amendments on aggregate stability, soil organic carbon and enzyme activities in the Loess Plateau, China. Environ. Sci. and Pollution Res. 24 10108–120.
[33] Ardiansyah R F 2012 Efficient Use of Fertilizer N, P and K on Rice (Oryza sativa L.) PB-42 Varieties in the Riau Makmur Food Operations Program (OPRM) in Ranah Village, Kampar Regency (Pekanbaru: Faculty Agriculture of Riau University)
[34] Nayaka P K, Nayaka A K, Pandaa B, Lalb B, Gautamc P, Poornama A, Shahida M, Tripathia R, Kumara U, Mohapatraa S D and Jambhulkara N 2018 Ecological mechanism and diversity in rice based integrated farming system. Ecol. Indic. 91 359–375 https://doi.org/10.1016/j.ecolind.2018.04.025