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Advances in Ecological and Environmental Research, 25-31 | Science Signpost Publishing

Application of Biogas Digestate as Biofertiliser for Paddy Rice Cultivation in Southern Vietnam

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Received: October 16, 2017 / Accepted: November 17, 2017 / Published: February 25, 2018

Abstract: Chemical fertilizer has been replaced by liquid waste of biogas plant for rice cultivation in the pilots scale at Hau My Bac B ward, Cai Be, Tien Giang, Viet Nam with four different proportions of Nitrogen source designed: 100% chemical fertilizer (mode 1 - control); 100% bio fertilizer (mode 2), 50% chemical fertilizer plus 50% bio fertilizer (mode 3) and 75% chemical fertilizer plus 25% bio fertilizer (mode 4). The result show that the leaf's color in the range of 3.75 (baseline N dose) to 4 (high N dose) and the rice's height of mode 1, 2, 3, 4 with respective value 78.5±2.06, 75.0±3.00, 73.5±4.09, 72.5±3.04 cm were not significant different. On the other hand, the length of node is difference between mode 1, 2, 3, 4 were respective value 4.75±0.43, 2.88±0.53, 4.75±1.77, 3.48±0.82 cm. The farmer's experience leading to the result of nutrient composition of soil has much variation compared to the initial parameters. Although the nutrient content of the experimental formulations was not significantly different. However, the microbial density of the formula using 100% bio fertilizer showed that lower than other formulas. Based on initial analysis results, the liquid waste from the Biogas plant can be used as a biofertilizer source to replace chemical fertilizer in rice cultivation.

Key words: Biogas, liquid waste from Biogas plant, Bio-fertilizer

1. Introduction

There are different ways in agriculture one is related to the fertilizer supply of crops and another to recycle of organic residues. For sustainable cultivation of crops the amount of mineral fertilizer should be reduced and partly replaced with bio-fertilizer. A sustainable way is the use of biogas digestate as bio-fertilizer for paddy rice cultivation. Using the digestate as a bio fertilizer leding to benefits both farmers and the environment [6]. It helps restore the natural recycling process of valuable nutrients, contributes to the avoidance of detrimental greenhouse gas emissions [1], and replacing mineral fertilizer with local bio fertilizer the farmers will get

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financial advances [3]. Rice production in Vietnam contributes more than 50% of the GHG emission from agriculture [9]. A large quantity of agriculture waste discharges in the Mekong Delta of Vietnam, if this biomass source is used for electricity generation, in theory for the period of 2005 - 2020 it can potentially make 94.2 million MWh/year from rice straw, 18.5 million MWh/year from rice husk, 3.66 million MWh/year from bagasse, and 3.02 million MWh/year from corn straw [7].

Therefore an experiment was designed in the Mekong delta with mineral and organic fertiliser treatments. This research focused on using liquid waste from biogas plant as bio-fertilizer to replace mineral fertilizer for rice cultivation. The results of the study will show the ability and benefits of the use of biological fertilizers from straw anaerobic fermentation on the basis of the analysis of the indicators of rice growth, quantity of microorganism and quality of field land.

2. Materials and Methods

Digestate was obtained from the biogas plant in Hau My Bac B ward, Cai Be, Tien Giang, Viet Nam and was applied for rice cultivation on two models: experimental field and experimental pilots in four modes (mode 1: 100% chemical fertilizer, mode 2: 100% biofertilizer, mode 3: 50% chem – 50% bio, mode 4: 75% chem -25% bio) [2]. The area experimental field was repeated three times for each mode. The fields were sown in January, 2017 and harvest of rice in May, 2017. Digestate was used in replace the amount of 5l per g Nitrogen. Digestate was also tested for the content of macroelements. Soil samples were examined for the content of macroelements as well. The parameters collected include:

The rice’s height and the length of node by tape measure;

Leaf’s Color Chart (LCC) method;

Total Aerobic bacteria: ISO 4833–1:2013;

Total Yeast and Fungi: ISO 21527–2:2008;

Total Anaerobic bacteria: ISO 15213–2003;

Total nitrogen: ISO 11261:1995;

Total potassium: TCVN: 8660:2011;

Total phosphorus: TCVN 8563:2010.

3. Results

3.1. Soil quality parameters and nutrient supply during cultivation

The farmer's experience leading to the result of nutrient composition of soil has much variation compared to the initial parameters [8]. Although the nutrient content of the experimental formulations was not different significantly (table 3.1). Based on the results of the analysis showed that the nutrients needed to grow of rice plant by farmers through fertilizer. The results also show that the nutrient content in the soil in the surveyed area has degenerated. (Table 3.1, Fig 3.1). Sites of research had location in the dyke system. Accroding to previous studies show that the dyke system is one of the main causes leading to erosion, plant diseases, soil fertility decline and natural degradation in the protected flooding areas of the Mekong Delta [5].

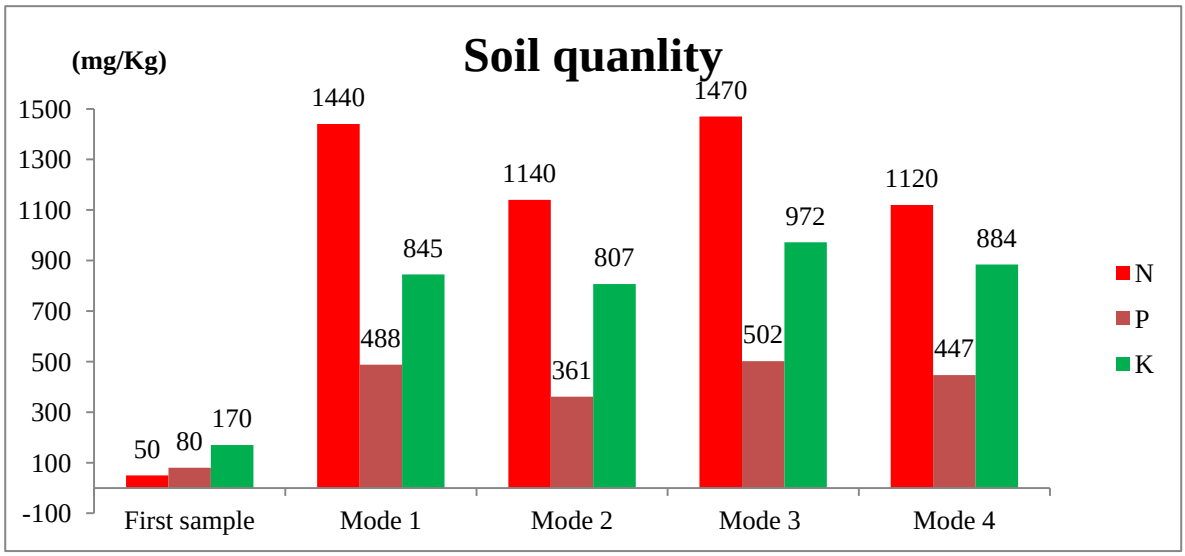

Fig 3.1: The parameter of soil quality

Table 3.1. The parameter of soil quality and the indicators of rice growth

Test content	Fields sample	Mode 1	Mode 2	Mode 3	Mode 4
N (mg/Kg)	50	1440	1140	1470	1120
P (mg/Kg)	80	488	361	502	447
K (mg/Kg)	170	845	807	972	884
Leaf's Color Chart (LCC)		4.25 ± 0.43	3.50 ± 0.71	4.00 ± 0.71	4.50 ± 0.43
Rice's Height (cm)		80.25 ± 2.28	78.50 ± 5.12	79.25 ± 2.17	82.75 ± 2.05
Lenght Of Node (cm)		3.35 ± 0.63	3.80 ± 0.58	4.20 ± 1.30	3.00 ± 0.63
Aerobic bacteria (*10^7)	N/A	2	0.68	3.9	4.1
Anarobic bacteria (*10^4)	N/A	4.6	1.5	11	4.6
Yeast (*10^3)	N/A	2.4	0.34	4.7	2.1
Fungi(*10^4)	N/A	1.6	1.9	1.2	1.5
Organic (mg/Kg)	850	N/A	N/A	N/A	N/A
Moisture (%)	28.2	N/A	N/A	N/A	N/A
pH	7.07	N/A	N/A	N/A	N/A

N/A. Not apply

3.2. Microorganism in soil

The results of soil microbial analysis of control treatments showed similarity with the study by Nguyen Thanh Hoi [4].

The results showed that the density of anaerobic bacteria produce H_2S of treatments using 100% bio-fertilizers is lower than the other treatments. This can be explained by the absence of competition between methane and Sulfate Reduce Bacteria (SRB) in the anaerobic digestion tank.

The results also showed that the fungal density in mode 2 was higher than that of other treatments. This is a group of microorganisms involved in mineralization that converts nitrogen from organic to inorganic (Fig 3.2, Table 3.1)

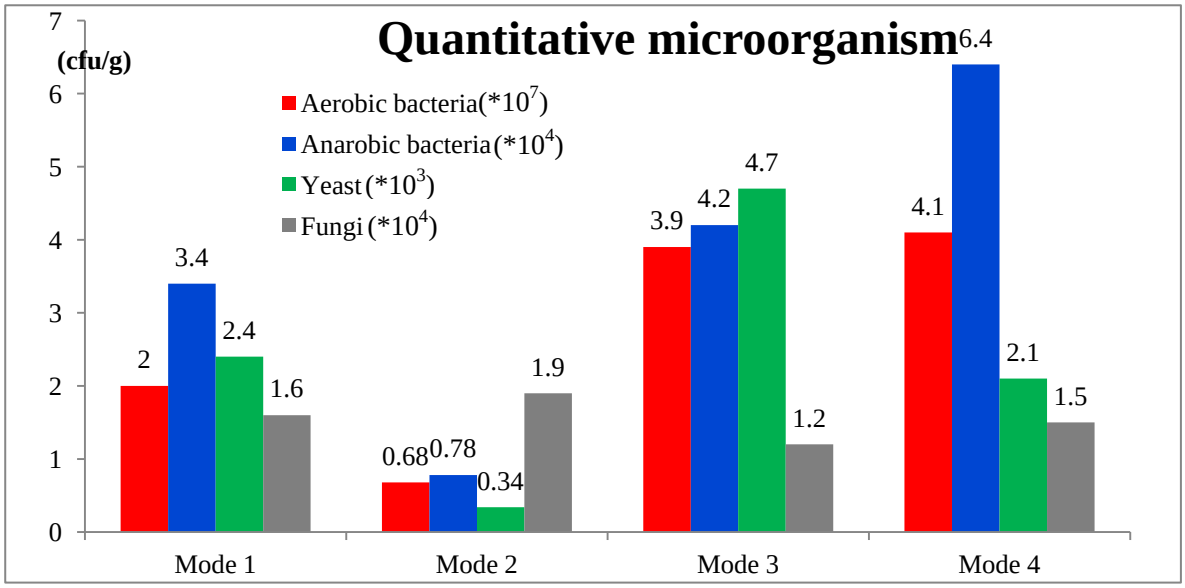

Fig 3.2: The quantitative microorganism of soil

3.3. The indicators of rice growth

Results of the survey parameters on rice plant development including leaf color, height and height of node shows that the replacement of chemical fertilizers by biological fertilizer does not affect the growth of the rice plant. Leaf color indicates that no nitrogen deficiency in the experimental treatments (Figure 3.3). Besides, the height of the rice plant also shows that rice has been provided with sufficient nutrients to grow (Figure 3.4).

When height of node was survey, the results show that, while experimental treatments replaced 50% of chemical fertilizers, the results were comparable to that of control treatments. However, the results the height of node showed differences in treatments using 100% and 25% bio fertilizer compared to the other treatments (Fig 3.5).

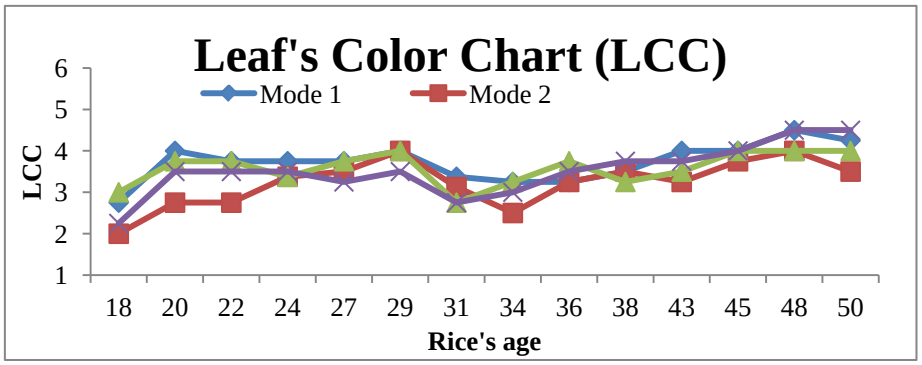

Fig 3.3. The leaf's color

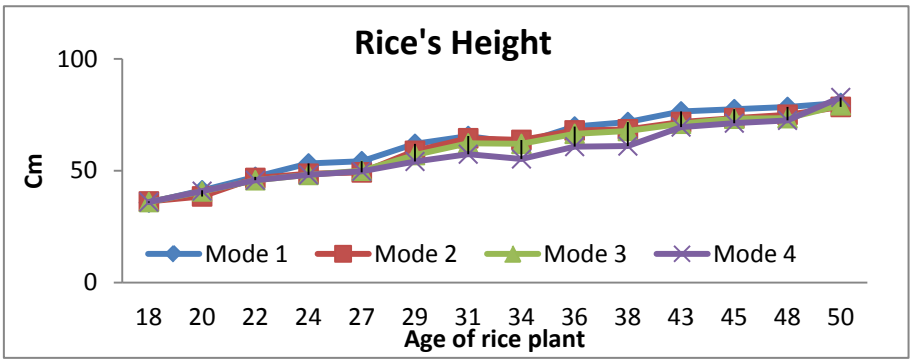

Fig 3.4. The indicators of rice growth

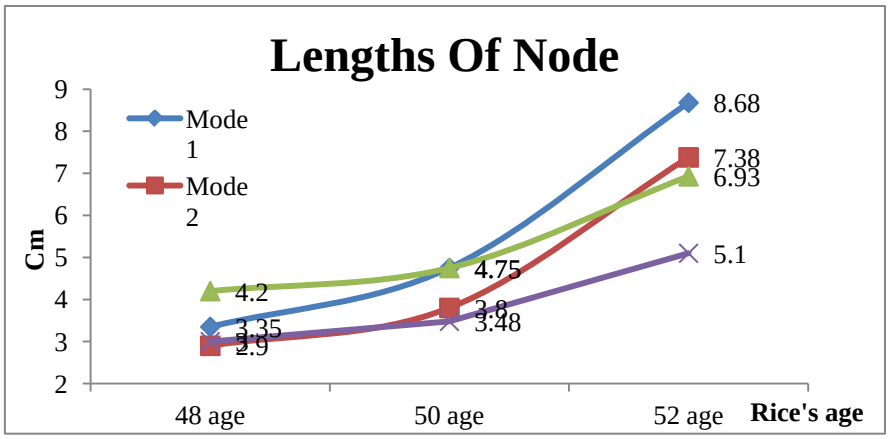

Fig 3.5. The indicators of the rice plant node

4. Conclusion

The leaf's color in the range of 3.75 (baseline N dose) to 4 (high N dose) and the rice's height of mode 1 , 2, 3 and 4 with respective value 78.5 ± 2.06, 75.0 ± 3.00, 73.5 ± 4.09, 72.5 ± 3.04 cm had no change . Whereas the length of node is difference between mode 1, 2, 3, 4 were respective value 4.75 ± 0.43; 3.80 ± 0.53; 4.75 ± 1 .77; 3.48 ± 0.82 cm. Based on initial analysis results, the liquid waste from the Biogas plant can be used as a bio-fertilizer source to replace chemical fertilizer in rice cultivation. Further studies are necessary to confirm that digestate has an effect on plants' yielding.

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