Research article

The Comparison of Liquid Bio-slurry and Rice Husk Biochar Application on the Production Yield of Dai Neang Chili Pepper (*Capsicum annum L*)

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Received 21 December 2015 Accepted 11 April 2016 (*Corresponding Author)

Abstract In Cambodia, Dai Neang chili pepper (*Capsicum annum* L) has mostly grown in areas around Tonle Sap Lake and some other provinces such as Prey Veng, Kandal, Kampong Cham, and Kampong Thom. However, farmers keep practicing conventional methods, which do not get high yield. Liquid bio-slurry and rice husk biochar which obtained from biodigester and rice production residues, could be applied to improve soil fertility for the chili production. The key objectives of this study were (1) to analyze the fertility compositions [nitrogen (N), phosphorous (P), and potassium (K)] contents in the liquid bio-slurry and rice husk biochar and (2) to investigate the effects of liquid bio-slurry and rice husk biochar on yield of Dai Neang chili pepper. In the research, different proportions of combination of liquid bio-slurry and rice husk biochar were applied on Dai Neang chili pepper in a total quantity of 1.4kg/m^2. Data of total yield, plant height, plants diameter, roots length, number of branches, leaves area, fruit length, and fruit weight per plant, good fruits and damaged fruits were collected as the primary data. As the results, the percentages of N-P-K compositions in the liquid bio-slurry and in the biochar were 0.52%, 1.22%, 0.30% and 0.78%, 0.73%, 3.00%, respectively. The treatment using liquid bio-slurry 25% and rice husk Biochar 75% obtained highest yield and more number of branches compared with other treatments and the control. In conclusion, liquid bio-slurry, a waste of biogas and rice husk biochar could improve the soil fertility and yield of Dai Neang chili pepper.

Keywords liquid bio-slurry, rice husk biochar, Dai Neang chili pepper, fertilizer

INTRODUCTION

Currently, 80% of Cambodia's population lives in rural areas and 60% depend on agriculture, which makes the government determined that the development of the agricultural sector is a key priority to reduce poverty and contribute to increase macroeconomics (MoP, 2014). The agricultural sectors have contributed 31.6% of Gross Demonstrate Products in 2013 (MAFF, 2013). In the Cambodia, vegetable crops are the most important after rice crop as foods for human consumption. Dai Neang chili pepper is one of a supplementary vegetables which favored by consumers countrywide. It contains high vitamin C. which helps to prevent oxidation and many other nutrients that are importance to human (LPI, 2011).

In general, fertilizer application is a common practice of farmers in crop cultivation in order to add nutrients into soil for growing crops. Most of agricultural production often uses chemical fertilizers and pesticides. As a result, substances of these chemicals remain in fruits and vegetables, which make most products to be tainted and to affect the human's health. Meanwhile, long term of chemical fertilizers application resulted in soil degradation, soil pH fluctuations and losing soil microbes which improve the soil fertility (Kim, 2003). Hence, Ministry of Agriculture, Forestry, and Fisheries in Cambodia has urged farmers to produce crops by applying natural fertilizer to improve soil fertility, obtain high yield and less effect on human's health as well as environments (MAFF, 2013).

Rich husk biochar is one of the natural fertilizers, a coal derived from burning rice husk (pyrolysis condition). Its function is to help improve soil quality by increasing the pH, phosphorus, and, porosity in the soil to let plant roots absorb minerals and water easier. In addition, to increase shift level between potassium and magnesium to have a strong valid for making photosynthesis. The core of rice husk biochar contains small holes that absorb liquids well. It helps to increase micro-organs in the soil, reduce the number of insects and other harmful diseases to crops. The rice husk biochar contains other minerals that plants can absorb into subsistence for rapid growth and healthy. Especially, it helps to neutralize the acid and alkaline substances stable in the soil, which contains chemicals that these features have made the convenience for farmers' cultivation (Oyetola, and Abdullashi, 2006).

Meanwhile, considering agricultural waste management, National Biodigester Programme, Cambodia has suggested a liquid bio-slurry, which is fertilizer that obtained from stocking cattle manures in anaerobic conditions of biodigester that animal wastes were kept under high temperatures in the biodigester for 40 days at least (NBP, 2013).

Considering the availability of liquid bio-slurry and rice husk biochar in rural areas of Cambodia, farmers should pay attention to apply these natural fertilizers to their crops instead of chemical fertilizers. However, the nutrients component and the suitable amount of liquid bio-slurry and rice husk biochar apply in agricultural crops are needed to be determined.

OBJECTIVE

The objectives of this study are: (1) to analyze the composition [nitrogen (N), phosphorous (P), and potassium (K)] in liquid bio-slurry and rice husk biochar and (2) to investigate the effects of liquid bio-slurry and rice husk biochar on yield of Dai Neang chili pepper.

METHODOLOGY

The Dai Neang chili pepper was grown at faculty of Agricultural Engineering in Royal University of Agriculture, Cambodia from May to September 2015. The experiment was designed in a randomized block design with applying liquid bio-slurry and rice husk biochar at different proportion following the standard of organic fertilizer application of 1.4 kg/m^2 or 14 t/ha. There were six treatments in this study. Each treatment was conducted in four replications. The size of one experimental plot was 2 m^2 and all plots of this experiment covered 80.75 m^2.

Treatment

- 1.T1: RHB (100%) 14 t/ha
- 2.T2: RHB (75%) with LBS (25%) 14 t/ha
- 3.T3: RHB (50%) with LBS (50%) 14 t/ha
- 4.T4: RHB (25%) with LBS (75%) 14 t/ha
- 5.T5: LBS (100%) 14 t/ha
- 6.T0: Control (No Fertilizer)

Note: RHB=Rice Husk Biochar, LBS=Liquid Bio-slurry.

Fig. 1 Liquid bio-slurry (left) and rice husk biochar (right)

Table 1 Total fertilizer allied for chili pepper

Treatments	RHB (kg)	LBS (kg)	Rep.	Surface (m^2)	Total RHB Quantities (kg)	Total LBS Quantities (kg)	Total (kg)
T0	0.00	0.00	4.00	2.00	0.00	0.00	0.00
T1	1.40	0.00	4.00	2.00	11.20	0.00	11.20
T2	1.05	0.35	4.00	2.00	8.40	2.80	11.20
T3	0.70	0.70	4.00	2.00	5.60	5.60	11.20
T4	0.35	1.05	4.00	2.00	2.80	8.40	11.20
T5	0.00	1.40	4.00	2.00	0.00	11.20	11.20
Total	3.50	3.50	24.00	12.00	28.00	28.00	56.00

(RHB=Rice Husk Biochar, LBS=Liquid bio-slurry, Rep= Replicates)

After 25 days of seeds sowing, chili pepper seedlings were transplanted with 0.5 m X 0.5 m between rows and plants.

The soil in experimental plots was sandy with silt, with pH 7.5, humus 0.8%, containing total nitrogen (0.035%), total phosphorous (0.0197%), total potassium (0.12%), total carbon (0.156 mil/100 g soil), a C/N = 5, with organic matter 0.26% (Bona, 2007).

In order to get rice husk biochar, rice husk has burned in pyrolysis apparatus for 6 hours. Liquid bio-slurry and rice husk biochar was determined for some compositions and nutrients such as pH, N-P-

K, and moisture content. nitrogen has determined by Kjeldahl method, phosphorus measured by spectrophotometer, and potassium determined by flame photometer (Latiff et al, 1996).

Chili fruits were harvested manually when they had reached maturity in 3 stages. Data collection was conducted on 50% flowering day, 100% flowering day, branch of plants, leaves area, fruit length, roots length, plant diameter, height, weight per plant, good fruits weight, bad fruits weight, and total fruit weight. Data subjected and to analyze of variance in Statistic 8. If interactions were significant, they used to explain all of data. If interactions were not significant, means have separated with Tukey test.

RESULTS AND DISCUSSION

The results showed that the N-P-K percentage of LBS and RHB were 0.52%, 1.22%, 0.30% and 0.78%, 0.73%, 3.00%, respectively (Fig. 2). Furthermore, total chili pepper yield was shown in Fig. 3. Moreover, plant growth parameters such as plant height, plants diameter, roots length, number of branches, leaves area, fruit length, fruit weight per plant, good fruits and damaged fruits weight were shown in Table 2.

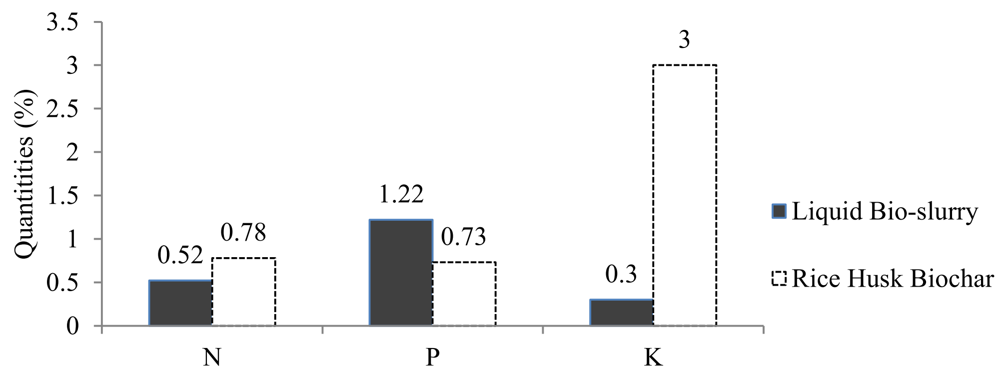

Fig. 2 Quantities of N-P-K substance in both fertilizers

Table 2 Means of plant growth parameters and yield of Dai Neang chili pepper

Treatment	T0	T1	T2	T3	T4	T5
50% flowering day	29.00	29.25	28.50	30.00	28.50	28.00
100% flowering day	35.75	36.75	36.00	36.50	35.50	35.00
Plant Height (cm)	58.05	62.90	69.45	64.20	65.50	74.55
Plant Diameter (mm)	6.28	6.89	8.23	7.23	7.56	8.23
Branch/Plant	6.66	8.35	9.35	8.34	8.72	7.28
Leaf Area (cm^2)	13.72	19.48	20.39	19.90	18.31	25.06
Fruit Length (cm)	5.18	5.83	5.39	6.32	5.77	5.44
Root Length (mm)	26.20	31.65	35.40	30.60	31.50	31.75
Fruit weight per plant (g)	95.45	106.35	129.85	107.75	117.20	113.00
Bad fruit weight (t/ha)	0.18	0.11	0.19	0.11	0.14	0.17
Good fruit weight (t/ha)	2.43	3.44	4.58	4.02	3.94	4.33
Total fruit weight (t/ha)	2.60	3.55	4.76	4.13	4.08	4.50

The result obtained from counting days of 50% flowering showed that the treatment that experienced first flowering was T5=28 days in Table 2, and T3 was the treatment in which 50% flowering appeared the latest because it used 50% of RHB and 50% of LBS. The difference in 50%

flowering days was highly significant (p-value < 0.01, CV = 1.70%). Days of 100% flowering were also counted, and the result indicated that the treatment which first reached full flowering was T5, which took 35 days, whereas T1 took the longest time until flowers fully appeared. This difference in 100% flowering days was significant (p-value = 0.05, CV = 2.03%). In addition, plant diameters measured in each treatment were significantly different (p-value < 0.01, CV = 6.21%), and the largest diameter was 8.23 mm both in T2 and in T5. Moreover, fruit length in each treatment was significantly different (p-value < 0.01, CV = 2.86%), and the treatment which had the longest fruit length (6.23 cm) was T3 and T0 had the shortest fruit length (5.18 cm). Fruit weight per plant in each treatment differed significantly (p-value < 0.01, CV = 4.71%), and the treatment that had the heaviest fruit weight (129.85 g/plant) was T2, while T0 had the lightest fruit weight (95.45 g/plant). Furthermore, the weight of damaged fruit in each treatment did not differ (CV = 34.03%), but the difference in weight of good fruit was significant (p-value < 0.01, CV = 2.16%), and the maximum weight of good fruit was 4.58 t/ha in T2 and 2.43 t/ha in T0.

As shown in Table 2, plant height, leaf area, branch of chili plant, and root length were also detected. As a result of the ANOVA test, plant height in each treatment differed significantly, and T5 had the greatest plant height (74.55 cm), followed by T2 with plant height of 69.45 cm, whereas T0 was the shortest in height (58.05 cm). Leaf areas in each treatment were significantly different, and the biggest leaf areas were 25.06 cm^2 in T5 and 20.39 cm^2 in T2, and the smallest leaf size (13.72 cm^2) was found in T0. Branches per plant in each treatment differed significantly. T2 had 9.35 branches per plant, but T0 had the fewest branches (6.66 branches). Furthermore, the lowest plant diameter was T0, and the difference in root length measured in each treatment was very significant. Among all of the treatments, T2 had the longest root length (35.40 mm). In addition, shortest roots length was T0=26.20 mm.

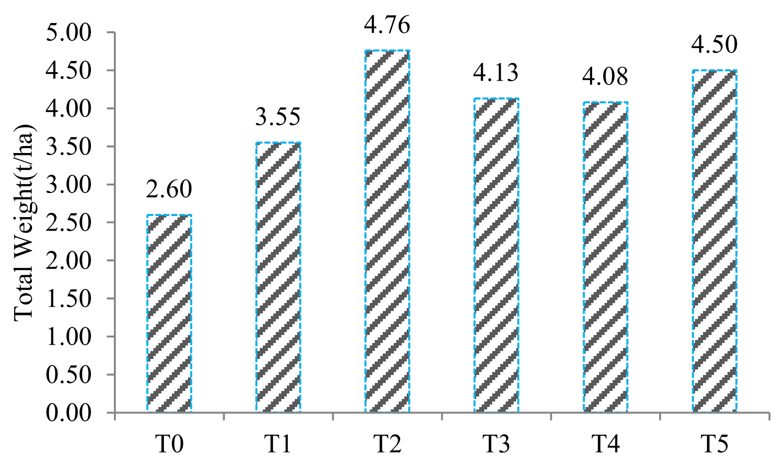

Fig. 3 Total yield from each treatment

Figure 3 showed that total weight of chili from each treatment. The highest yield was T2=4.76 t/ha followed by T5=4.50 t/ha and the lowest yield was T0=2.60 t/ha. However, yield of each treatment were different from previous research as Kbal Koh vegetable research station mentioned that non-fertilizer application on chili can gain the yield from 2.5 to 2.70 t/ha same as the experiments in Royal University of Agriculture (KKVRS, 2000).

Furthermore, considering other factors that might affect chili pepper growth that can be observed in this experiment include soil type in experimental plots, mulching for weed controlling or keeping moisture, ditching for crop's irrigation or fertilizer application (burying, spraying and etc.).

CONCLUSION

According the rice husk biochar (RHB) and liquid bio-slurry (LBS) application on Dai Neang chili pepper, it can be concluded that the fertilizers improved the chili pepper yield effectively. The results showed that the N-P-K percentage of LBS and RHB were 0.52%, 1.22%, 0.30% and 0.78%, 0.73%, 3.00%, respectively. And according to the results, where the criterion for fertilizer selection and its application rate is based on total chili pepper yield, then the following fertilizer application can be recommended: T2= rice husk biochar 75% add liquid bio-slurry 25% which obtained the highest yield of 4.76 t/ha in this experiment and next suitable was T5= liquid bio-slurry 100% that obtained yield of 4.50 t/ha.

ACKNOWLEDGEMENTS

I would like to thank my advisor, Mr. Lor Lytour, and my assistants for advising and guiding on my research. Also many thanks to the People in Need Organization (PIN) whose provided financial support for my bachelor thesis. Besides that, I also express my gratitude to National Biodigester Programme (NBP) for providing the research documents and for helping in consultation. My respective teacher, who has always been sincere and helpful in making me, understanding the different system of legal research and conceptual problems in my manuscript.

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