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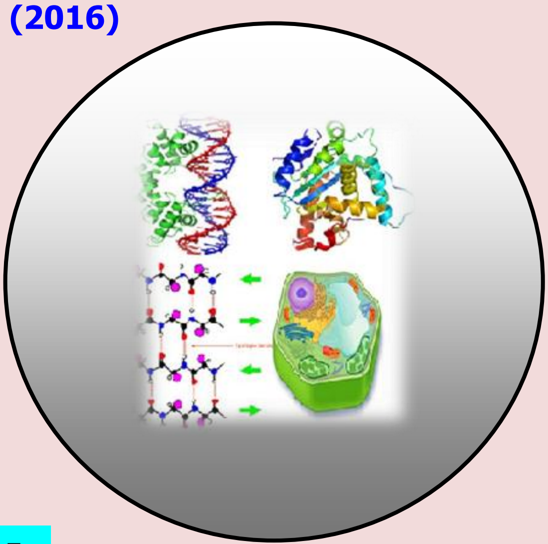

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RESEARCH PAPER

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The Effect of Biochar Bamboo on Growth and Results of Kangkung (*Ipomoea Reptans* P.)

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ABSTRACT

The aim of this research is to get the proper dosage of bamboo biochar in increasing the growth and yield of the kangkung. This study used a complete randomized design (RCD) of one factor with 4 replications. The tested treatment was bamboo biochar with 4 dose levels (0, 3, 6, 9, and 12 t ha-1). The results showed that bamboo biochar showed the significant effect on plant length variables and fresh weight of economic yield, but bamboo biochar had no significant effect on leaf number and oven dry weight. At the treatment dose of biochar 6 t ha-1 obtained the fresh weight of the highest economic result of 57.23 g, increased by 24.04% when compared with fresh weight value of the lowest economic result on without biochar equal to 46.14 g. From the regression analysis, the optimum dosage of biochar was 7.55 t ha-1, with the fresh weight of maximum economic yield of 56.02 g.
Keywords: Dosage, Biochar Bamboo, Charcoal and Ipomoea Reptans.

INTRODUCTION

Kangkung (*Ipomoea reptans* Poir) is a type of vegetable that can be planted in fields, garden, yard, or in pots. Many people who grow vegetables because it is very easy to plant and in a short time can be harvested. Vegetable kangkung start favored by the community because the nutritional content of Kangkung is quite high especially vitamin A, vitamin C, iron, calcium, potassium, and phosphorus (Sofiari, 2009).

The current condition, horticultural crop farming, especially vegetables in moorlands, is faced with the problem of low soil fertility and land management that is not in accordance with its potential and suitability. Recovery of soil fertility can be done by utilizing a soil enhancer such as biochar. Soil enhancers are materials added to the soil to improve soil fertility, physical, chemical, and biological properties of the soil. Biochar, known as charcoal, is a soil enhancer of a weatherproof material made from incomplete combustion (pyrolysis). Giving biochar to the soil has the potential to increase soil carbon content, improve soil fertility and restore degraded soil quality (Atkinson *et al*., 2010; Glaser *et al*., 2002). As a soil enhancer, biochar has the ability to store water and nutrients in the soil that will encourage the improvement of soil physical properties. The use of difficult decomposing materials such as bamboo biochar can provide new hope in the effort to improve degraded agricultural land and increase the productivity of agricultural production.

Some research results of biochar dose on food crops and horticulture obtained various results, depending on the type of biochar, soil type, plant type, placement method, and dose used. Nurida and Rahman (2011) reported that the introduction of biochar soil enhancer formula at doses of 5.0-7.5 t ha^{-1} was able to improve the physical, chemical, and biological properties of the soil, by increasing the percentage of available pore water, P-available, K-total, CEC, and respiration of soil microorganisms. The results of Situmeang and Sudewa (2013), Situmeang, *et al*. (2015), Situmeang *et al*. (2016). and Situmeang (2017a, b) show that utilization of bamboo waste biochar dose of 5-15 t ha^{-1} can increase the growth and yield of maize. Artawan, *et al*. (2015) reported that biochar feeding of 15 t ha^{-1} could increase the fresh weight of 100 seeds per maize plant from 18.67 g (control) to 26.78 g or an increase of 43.44%. Furthermore, Situmeang *et al*. (2017) reported that 5-15 t ha^{-1} bamboo biochar had not responded significantly to the yield of the pakchoy plants.

Giving biochar 4-8 t ha^{-1} can increase the productivity of plants by 20-220%, highly dependent on the cultivated commodities (Gani, 2009). The wide range of biochar properties in accordance with their basic materials, and the diverse interactions between biochar and soil type and the type of commodities used, it is necessary to research efforts among others by conducting research on the utilization of bamboo biochar on the vegetable of kangkung. The purpose of this study is to determine the appropriate dosage of bamboo biochar in increasing the growth and yield of kangkung plant.

MATERIAL AND METHODS

The materials used in this study are kangkung, biochar from bamboo waste, and soil media weighing 2.8 kg per each pot. This experiment was conducted at Rumah Kaca, Experimental Garden of Agriculture Faculty of Warmadewa University, Denpasar. This study has been conducted from June to September 2016.

The experiment used a complete randomized design (CRD) of one factor. The treatments were tested for biochar with 4 dose levels, with the treatment arrangement as follows: B0 = 0 t ha^{-1} (without biochar), B1 = 3 t ha^{-1} (4.2 g pot^{-1}), B2 = 6 t ha^{-1} (8.4 g pot^{-1}), B3 = 9 t ha^{-1} (12.6 g pot^{-1}), B4 = 12 t ha^{-1} (16.8 g pot^{-1}). Thus there were 5 treatments, each treatment was repeated 4 times so that there were 20 pot experiments.

The variables observed included plant length, number of leaves, fresh weight of economic yield, and oven dry weight of economic yield. Observational data were analyzed statistically with F (ANOVA) test using Microsoft Excel program. If the F test shows a significant effect on the 5% test level, then proceed with a 5% Duncan test.

RESULTS AND DISCUSSION

Research result

Based on the results obtained in this study and after the statistical analysis, the significance of the effect of biochar dosage treatment on the observed variables is presented in Table 1. From Table 1 it can be seen that biochar treatment showed the significant effect ($P<0.05$) on plant length and fresh weight of economic yield, but not significant ($P\geq0.05$) to leaf number and oven dry weight of economic result.

Table 1. The significance of the effect of bamboo biochar dose on all observed variables.

Variable	The dosage of Bamboo Biochar
1. Plant length (cm)	*
2. Number of leaves (strands)	ns
3. Fresh weight of economic results (g)	*
4. The dry weight of economic results (g)	ns

ns = not significant ($P\geq0.05$), * = real effect ($P<0.05$)

Plant Llength

The result of statistical analysis on plant length was found that biochar treatment (B) showed a significant effect ($P<0.05$) (Table 1). The average length of the plant on biochar treatment is presented in Table 2.

Based on Table 2 it can be seen that the average maximum plant length obtained at biochar 6 t ha^{-1} (B2) of 167.25 cm or markedly increased by 35.98% when compared to the lowest plant length value at without biochar (B0) equal to 123.00 cm. In this study, biochar treatments 3, 6, 9, and 12 t ha^{-1} showed no significant difference to plant length, so that the lowest dose of biochar 3 t ha^{-1} was able to improve the growth of plant length.

Table 2. The average length of the plant on bamboo biochar dosing treatment.

Treatment of Biochar Dosage	Variable Growth	
	Plant Length (cm)	Number of leaves (cm)
0 t ha^{-1} (B0)	123.00 b	29.50 a
3 t ha^{-1} (B1)	145.25 ab	32.75 a
6 t ha^{-1} (B2)	167.25 a	37.25 a
9 t ha^{-1} (B3)	164.50 a	35.25 a
12 t ha^{-1} (B4)	157.00 a	34.75 a
The coefficient of Diversity (%)	11.15	12.28

The same letters behind the mean values, showing no significant difference at the Duncan test level of 5%.

Number of Leaves

The result of the statistical analysis showed that bamboo biochar treatment (B) had no significant effect ($P \geq 0.05$) on the number of leaves (Table 1).The average number of plant leaves on biochar treatment is presented in Table 2. Provision of various doses of biochar showed no significant difference to the number of leaves (Table 2) so that biochar application has not responded to the number of plant leaves. However, there is a tendency for the average value of maximum leaf number obtained in biochar 6 t ha^{-1} (B2) of 37.25 strands, while the average value of the lowest number of leaves without biochar (B0) is 29.50 strands.

Fresh Weight of Economic Results

The result of the statistical analysis showed that biochar treatment (B) had a significant effect ($P<0.05$) on fresh weight of economic result (Table 1). The average fresh weight of economic yields on biochar treatment is presented in Table 3.

Table 3. The average fresh weight of economic yield and oven dry weight of economic yields on bamboo biochar dosage treatment.

Treatment of Biochar Dosage	Results Variable	
	Fresh weight of economic results (g)	The dry weight of economic results (g)
0 t ha^{-1} (B0)	46.14 b	4.21 a
3 t ha^{-1} (B1)	51.83 ab	4.40 a
6 t ha^{-1} (B2)	57.23 a	4.65 a
9 t ha^{-1} (B3)	54.32 a	4.52 a
12 t ha^{-1} (B4)	52.94 a	4.45 a
The coefficient of Diversity (%)	8.35	4.37

The same letters behind the mean values, showing no significant difference at the Duncan test level of 5%.

From Table 3 it can be seen that the provision of biochar showed a significant effect on the fresh weight of economic yield. The highest fresh weight of the highest economic yield was obtained on biochar 6 t ha^{-1} (B2) of 57.23 g, and conversely, the fresh weight average value of the lowest economic yield was obtained without biochar (B0) of 46.14 g.

Treatment of biochar 3, 6, 9, and 12 t ha^{-1} showed no significant difference to the fresh weight of economic yield, so with the lowest dose of biochar 3 t ha^{-1} was able to improve the fresh weight of economic yield (Table 3).

Oven Dry Weight of Economic Results

The result of statistic analysis showed that biochar treatment (B) had no significant effect ($P \geq 0.05$) on oven dry weight of economic result (Table 1). The average oven dry weight of economic yields on biochar treatment is presented in Table 3.

Provision of various doses of biochar showed no significant difference to oven dry weight of economic yield (Table 3), in other words, biochar treatment has not responded to oven dry weight of economic results. Nevertheless, the average value of oven dry weight of the highest economic yield was obtained at biochar 6 t ha^{-1} (B2) of 4.65 g, while the average value of oven dry weight of the lowest economic yield on without biochar (B0) was 4.21 g.

DISCUSSION

The results of this study indicate that the fresh weight average value of the highest economic yield is obtained on biochar 6 t ha^{-1} (B2) of 57.23 g or an increase of 24.04% when compared to the freshest weight value of the lowest economic yield on biochar (B0) of 46.14 g (Table 3). The high yield of fresh weight of crop yields is supported by plant length variables (r = 0.97**), the number of leaves (r = 0.99**), and oven dry weight of economic yield (r = 1.00**) (Table 4). This is presumably because biochar with its pore substance has caused biochar to improve soil physical properties such as structure, porosity, bulk density, and binding capacity of water and nutrients, which can encourage increased microbial activity in soil and soil fertility improvements. With the improved physical properties of the soil, the roots will grow and develop well in absorbing nutrients and water in the soil that will encourage the increased vegetative growth of the plant. This improved vegetative growth leads to increased interception of sunlight by the leaves to produce photosynthesis and in subsequent developments, this photosynthesis will be transferred to plant organs actively performing metabolic processes so that the growth of roots, stems, and leaves of the plant becomes better and will subsequently affect the weight yield fresh economic plant.

Table 4. The value of correlation coefficient between variables (r) due to the effect of dosing of biochar bamboo.

Variables	Plant length	Number of leaves	Fresh weight of economic results
Number of leaves	0.98**		
Fresh weight of economic results	0.97**	0.99**	
Oven dry weight of economic results	0.96**	0.99**	1.00**

r (0.05; 18; 1) = 0.444 r (0.01; 18; 1) = 0.561

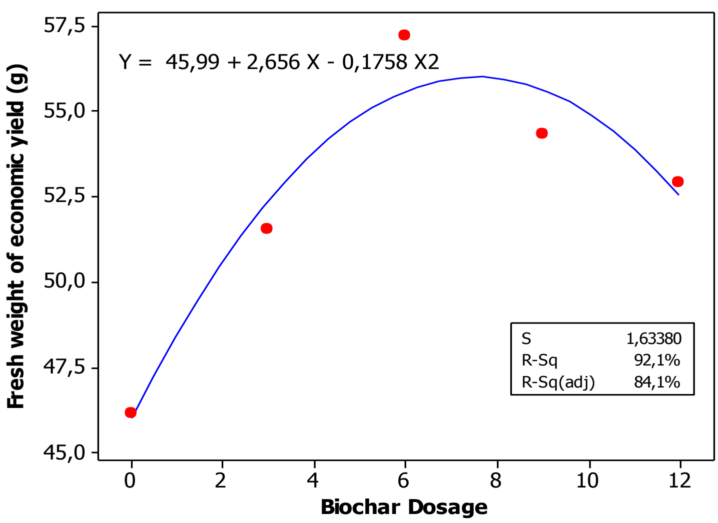

Figure 1. Relationship of bamboo biochar dosage with fresh weight is economic yield.

Biochar serves as one of the soil aggregates, which has the role of adhesive agent between soil particles to form soil aggregates, so biochar is essential in the formation of soil structures. In soils, porous biochar grains, in addition to retention of nutrients and water in the soil, can also provide habitat for soil microorganisms.

Nutritional and water retention has an effect on the addition of nutrients to plants, causing increased porosity of the soil, water holding capacity, C-organic, and microbial activity in the soil (Gani, 2010). Application of bamboo biochar to the soil can improve soil fertility both physical properties, chemical, and biological soil. In this case, the soil properties are improved by biochar such as aggregation and soil water holding capacity, pH and CEC as well as increased population and biological activity in the soil (Chan *et al*., 2007, Rondon *et al*., 2007).

The result of regression analysis of biochar dose with the fresh weight of economic result showed quadratic correlation with regression line equation: $\hat{Y} = 45.99 + 2.656 X – 0.1758 X^2$ with the determination coefficient (R^2) 92.10% (Figure 1). From the regression analysis, the optimum dosage of biochar was 7.55 t ha^{-1}, with the fresh weight of maximum economic yield of 56.02 g. Based on the results of regression analysis shows that fresh weight of economic results is higher with increasing doses of biochar to optimum, then decreased when exceeding the optimum dose.

CONCLUSIONS

Giving bamboo biochar showed the significant effect on plant length and fresh weight of economic yield, but bamboo biochar had no significant effect on the number of leaves and oven oven dry weight of economic yield. At the dose of biochar 6 t ha^{-1} obtained the fresh weight of the highest economic results of 57.23 g or an increase of 24.04% when compared with the value of the fresh weight of the lowest economic results on without biochar of 46.14 g. From the regression analysis, the optimum dosage of biochar was 7.55 t ha^{-1}, with the fresh weight of maximum economic yield of 56.02 g.

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REFERENCES

Artawan, I.K., Situmeang, Y.P. and Wahyuni, M.D. (2015). The Effect of How the Bamboo Biochar Placement and Dose Towards The Growth and Production of Sweet Corn. *Wicaksana*, *24*(1), 18-28.

Atkinson, C.J., Fitzgerald, J.D. and Hipps, N.A. (2010). Potential mechanisms for achieving agricultural benefits from Biochar application to temperate soils: a review. *Plant and Soil*, 337: 1-18.

Chan, K. Y., Van Zwieten, B. L., Meszaros, I., Downie, D. and Joseph, S. (2007). Using poultry litter Biochars as soil amendments. *Australian Journal of Soil Research* 46: 437- 444.

Gani, A. (2009). Potensi Arang Hayati Biochar Sebagai Komponen Teknologi Perbaikan Produktivitas Lahan Pertanian. *Iptek Tanaman Pangan* Vol. 4 No.1: 33-48

Gani, A. (2010). Multiguna Arang-Hayati (Biochar). *Sinar Tani*.

Glaser, B., Lehmann, J. and Zech, W. (2002). Ameliorating physical and chemical properties of highly weathered soils in the tropics with charcoal a review. *Biol Fertil Soils* 35:219–230.

Nurida, N.L., & Rachman, A. (2011). Alternatif pemulihan lahan kering masam terdegradasi dengan formula pembenah tanah biochar di typic kanhapludults Lampung. *Badan Litbang Pertanian*, Balai Penelitian Tanah.

Rondon, M.A., Lehmann, J., Ramirez, J. and Hurtado, M. (2007). Biological nitrogen fixation by common beans (*Phaseolus vulgaris* L.) increases with Biochar additions. *Biology and Fertility of Soils* 43: 699-708.

Situmeang, Y.P. and Sudewa, K.A. (2013). Respon Pertumbuhan Vegetatif Tanaman jagung pada Aplikasi Biochar Limbah Bambu. *Prosiding Seminar Nasional.* Fakultas Pertanian Universitas Warmadewa. Denpasar.

Situmeang, Y. P., Adnyana, I. M., Subadiyasa, I. N. N. and Merit, I. N. (2015). Effect of Dosage Biochar Bamboo, Compost, and Phonska on Growth of Maize (*Zea mays* L.) in Dryland. *International Journal on Advanced Science, Engineering and Information Technology*, *5*(6), 433-439.

Situmeang, Y.P., Sudewa, K.A. Suarta, M., & Risa, A.A.S. (2016). Biochar and Compost Effect on the Growth and Yield of Sweet Corn. *Jurnal Pertanian Gema Agro,* XVI (6): 16-19. Fakultas Pertanian Universitas Warmadewa. Denpasar.

Situmeang, Y. P. (2017a). Utilization of Biochar, Compost, and Phonska in Improving Corn Results on Dry Land. *International Research Journal of Engineering IT and Scientific Research*, *3(3)*: 38-48.

Situmeang, Y.P. (2017b). Agronomic Effectiveness of Bamboo Biochar on Corn Cultivation in Dryland. *Journal of Biological and Chemical Research*, 34(2): 704-712.

Situmeang, Y. P., Sudewa, K. A. and Holo, P. P. (2017). Utilization Biochar of Bamboo and Compost in Improving Yield of Pakchoy Plant. *Journal of Biological and Chemical Research (JBCR)*, *34*(2), 713-722.

Sofiari, E. (2009). Karakterisasi Kangkung varietas sutera berdasarkan panduan pengujian individual. *Buletin Plasma Nutfah*, 15(2): 49-50

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