



Effect of Different Rates of Rice Husk Biochar on the Initial Growth of *Moringa oleifera* under Greenhouse Conditions in the Savannah Ecological Zone of Ghana

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ARTICLE INFO	ABSTRACT
<p>Research Article</p> <p>Received : 13/03/2019 Accepted : 28/11/2019</p> <p>Keywords: Rice husk biochar <i>Moringa oleifera</i> Multipurpose Growth Nutrient content</p>	<p>This investigation was conducted to evaluate the outcome of rice husk biochar on growth performance of moringa. The study was carried-out in a greenhouse for 52 days. Different rates of rice husk biochar (150 to 350 g) was mixed with 500 g of soil. A Randomized Complete Block Design (RCBD) with 3 treatments (each of which was replicated 3 times) was used, giving a total of 12 experimental units. Plant height, stem diameter and number of leaves were assessed for each treatment. Results indicate that rice husk biochar (150 g, 250 g and 350 g) significantly increased the stem diameter of moringa as compared to that of the control 52 days after in the greenhouse. An increase in the number of leaves were observed at 150 g rice husk biochar after 40 days compared to the control. There were significant differences between treatments effects on all the parameters. Different rates of biochar certainly could constitute vital use of fertilizer to improve growth moringa in the nursery.</p>

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Introduction

Moringa oleifera is a multipurpose shrub a native from India, Pakistan, Bangladesh and Afghanistan that are now cultivated worldwide (Fahey, 2005). The tree is established in farmlands and around homestead in tropical Africa. It is use in food, medicine and water treatment (Jemal et al., 2006). Mentioned as a vital plant in the world which are palatable and are highly nutritious.

Studies have shown that different parts of this plant is considered a source of protein, vitamin and carotene, all essentials amino acids and phenolic components (Randriamboavonjy et al., 2016). Some of the plant parts could also be dried, turned into powder and used for several food diets.

According to Azeez et al. (2013), moringa has more vitamin A than carrots, more vitamin C than oranges, more calcium than milk and more iron than spinach and therefore, is a complete food in itself.

Moringa tree contains also antioxidants, anti-inflammatory, phytochemical elements, lipids such as omega-3 and omega-6 (Amaglo et al., 2010). It was

reported that it has the ability to reduce children nutritional deficiency in India or use to feeding people having HIV (Fahey, 2005). It has taken high socio-economic interest in the tropic. It's important to valorize its production in this area where hunger is occurring constantly.

Biochar is becoming a significant constituent of environmentally sound sustainable agriculture. Residual nature of organic sources makes them more value based for the whole system compared to individual crops (Haouvang et al., 2017). In recent times, the use of organic materials as fertilizers for crop production has received attention for sustainable crop productivity (Imran et al., 2015).

M. oleifera essentially require less amount of fertilizers however a normal quantity might improve its growth, mostly organic fertilizers for long term basis fertilization. It has been proven that the addition of organic matter improved soil properties such as aggregation, water-holding capacity, hydraulic conductivity, bulk density, the degree of compaction, fertility and resistance to water and wind erosion (Franzluebbers, 2002).

Generally, fertile soils have a relatively high structure stability index and percentage. Improvement in soil aggregation by organic matter may positively affect seed germination, roots, shoots plant growth and development (Van Noordwijk et al., 2015). The effect of long-term organic and inorganic fertilizer on soil physical properties such as aggregation, porosity and water-holding capacity has been reported (Celik et al., 2010).

Organic sources like biochar, farm yard manure, poultry manure, green manure and compost do not only supply the organic matters but also increase the fertility status of soil (Mohammadi et al., 2011). They provide organic acids that help dissolve soil nutrients and make them available to the plants (Husson, 2013). Recently, attention has been directed towards biochar because of the rising cost of inorganic fertilizers coupled with their inability to give the soil the desired sound health (Oyedeggi et al., 2014). In literature, effects of biochar applied on growth parameters were studied on various species such as maize, moringa and wheat (Abukari, 2014; Fagbenro et al., 2015; Shaon et al., 2018; Zheng et al., 2013), but the application of different amounts has not yet been investigated. The use of organic manure to fertilize moringa in the field is increasing, but very few studies have been carried out to evaluate the effect of this fertilizer in the nursery. This inadequacy makes it difficult to make any recommendation to farmers on the quantity and type of organic manure to apply.

The main objective of this experiment was to test the efficiency of various amounts of rice husk biochar on the initial growth of moringa in a greenhouse. The responses to plant growth parameters are discussed.

Materials and Methods

Study Area

The study was carried-out in greenhouse at the Faculty of Natural Resources and Environment (FRNE) station at University for Development Studies in Ghana. Experiments were studied for 52 days.

Biological Materials

Materials for this experiment were collected from local variety of moringa, while soil and the rice husk were collected in Nyankpala, Tamale in the Northern region of Ghana. Rice husk biochar was obtained after the pyrolysis at a temperature of 500 °C (Liu et al., 2013). Black polythene bags of 600 mL with a diameter of 7 cm were used to contain the applied treatments.

Experimental Design and Treatment

The investigation was done in a randomized complete block design (RCRD) with 4 treatments, each of which was replicated 3 times, giving a total of 12 experimental units. At 28, 32 and 52 days after sowing, 2 plants were randomly chosen and damaged per treatments to measure development. Table 1 shows the chemical composition of rice husk biochar used, Table 2 defines details on rice husk biochar of treatments, where Table 3 shows the chemical and physical contents of different rate of rice husk biochar after the experiment.

Soil Analysis

Soil pH was measured in soil to water ratio of 1:1 (McLean, 1982). The Walkey and Black procedure was used to determine soil organic content (Walkey and Black, 1934). The nitrogen content was determined using Kjeldahl digestion and distillation procedure. The cation exchange capacity was determined by NH₄OAc method. Calcium and Magnesium (Mg) were determined by atomic absorption spectrophotometry while potassium (k) and sodium (Na) were determined by flame photometry.

Treatments and Sowing

12 poly bags were used in this experiment and each polythene bag had uniform amount of soil (500 g) and the different biochar's varied from 150 g, 250 g and 350 g in accordance to a given treatment. Seeds were soaked for 24 hours in tap water before sowing.

Table 1. Chemical composition of rice husk biochar used in the experiment

pH (1:1H ₂ O)	Ca	Mg	K	Na	Al	OC	N	Bray P
	Cmol _c kg ⁻¹					%		ppm
9.8	2.67	18.2	14.23	3.2	3.89	28.34	0.73	323.54

Table 2. Account of treatments

Treatments	Quantity of soil used (g)	Biochar quantity (g)
C500	500	0
RHB150	500	150
RHB250	500	250
RHB350	500	350

Table 3. Physical and chemical properties of different rates of rice husk before and after experiment

Treatments	pH (1:1H ₂ O)	Ca	Mg	K	Na	CEC	OC	N	Bray P	Moisture content
		Cmol _c kg ⁻¹					%		ppm	%
C500	6.20	1.85	0.75	0.16	0.22	2.89	0.62	0.06	4.92	2.56
RHB150	6.23	2.23	0.81	0.26	0.26	3.20	2.30	0.09	5.45	3.34
RHB250	6.23	2.45	0.96	0.47	0.29	3.56	2.45	0.10	6.56	3.78
RHB350	6.23	2.87	1.23	0.68	0.56	3.87	2.75	0.19	7.34	4.56

Two (2) seeds at 2 cm depth were sowed, and germination ensued at 2 Weeks after Planting (WAP). After germination, one robust plant was permitted to grow in each polythene bag. Water was applied to plants at 300 mL/poly bag every 3 days.

Data Collection

The following parameters were assessed at germination from 2 WAP, 4 WAP, 6 WAP and 8 WAP. Plant height was measured from the base of stem to the last leaf using a graduated ruler; stem diameter was measured at the soil level using a slide calliper; leave number was determined by counting the leaves on plant; leave length was estimated on the basal leave at 4 WAP after germination and on leave located in the middle of plant (as from 8 WAP after germination).

Data Analysis

The data collected were analyzed using GenStat. The Analysis of Variance (ANOVA) was used to compare different treatments and Turkey test for multiple comparison range of means.

Results

Effect of Treatments on Plant Height

The influence of the treatments on moringa plant height is illustrated in Table 4. It illustrates that there was a significant difference between the treatments ($P < 0.01$). At 2 WAP, treatments RHB150, RHB250 and RHB350 recorded heights of respectively 7.45, 10.36 and 13.65. At 4 to 6 WAP, plant height recorded similar trends in height. The lowest plant height was observed in C500 treatment. At 8 WAP the plant height was improved by 34.43% when

treatment RHB350 was applied as compared to the control treatment.

Effect of Treatments on Plant Diameter (mm)

Data recorded in Table 5 indicate that the diameter of plants varied from one treatment to another ($P < 0.05$). At 4 WAP, the highest diameters were obtained from plants treated with RHB350, RHB250 and RHB150 as compared to the control. The effects of RHB (150, 250 and 350 g) were more noticeable at 8 WAP.

Effects of Treatments on Improvement of Leaves Number

Table. 6 shows that the different rate of rice husk biochar significantly increased the number of leaves compared to the control treatment. The number of leaves was increased by 37.67 % following application of 350 g of rice husk biochar at 8 WAP compared to the control C500.

Discussion

Soil fertility decline in the tropic is the main cause of low agricultural productivity (Dania et al., 2014). Integrated nutrient management approach contributed to important growth and yield of moringa in the greenhouse, indicating the effectiveness of organic amendment in this study. Its application on maize (Ridine et al., 2014) was recounted to significantly increase the yield of two maize varieties. The aim was to assess the effect of rice husk biochar on the initial growth of moringa in a potted experiment at the greenhouse. The results of the vegetative parameters of moringa were influenced significantly by various treatments which collaborate with the result of Abukari (2014) and Shaon et al. (2018).

Table 4. Effect of different rate of rice husk biochar on plant height

Treatments (g)	2WAP	4WAP	6WAP	8WAP
	Weeks after planting (cm)			
C500	3.22 ^a	8.47 ^d	10.54 ^c	13.79 ^b
RHB150	7.45 ^b	13.64 ^c	16.36 ^a	18.45 ^d
RHB250	10.36 ^c	19.82 ^b	22.21 ^d	24.60 ^a
RHB350	13.65 ^d	23.63 ^a	25.86 ^b	29.85 ^c

Source: Field experiment, 2018, Means with same letter in a column are not significantly different level ($P < 0.01$) of probability Turkey test for multiple comparison range of means.

Table 5. Effect of different rate of rice husk biochar on plant diameter (mm)

Treatments (g)	2WAP	4WAP	6WAP	8WAP
	Weeks after planting			
C500	0.21 ^d	0.92 ^a	1.12 ^c	1.16 ^b
RHB150	0.39 ^c	1.02 ^b	1.24 ^d	1.42 ^a
RHB250	0.44 ^b	1.25 ^c	1.32 ^a	1.54 ^d
RHB350	0.58 ^a	1.45 ^d	1.63 ^b	1.78 ^c

Source: Field experiment, 2018, Means with same letter in a column are not significantly different level ($P < 0.05$) of probability Turkey test for multiple comparison range of means.

Table 6. Effect of different rate of rice husk biochar on leaves count

Treatments (g)	2WAP	4WAP	6WAP	8WAP
	Weeks after planting			
C500	4 ^d	32 ^a	48 ^c	57 ^d
RHB150	7 ^a	42 ^b	56 ^d	76 ^c
RHB250	9 ^b	54 ^c	75 ^a	87 ^b
RHB350	12 ^c	67 ^d	91 ^b	133 ^a

Source: Field experiment, 2018, Means with same letter in a column are not significantly different at ($P < 0.05$) of probability Turkey test for multiple comparison range of means.

The application of different rates of rice husk biochar (150 g, 250 g and 350 g) significantly improved the size of plant and the number of leaves compared to the control (500 g soil). These results are in agreement to those obtained by Agegnehu et al. (2016).

It is clear that there were visible differences ($P < 0.01$) in plant height with the application of rice husk biochar. RHB350 recorded the highest (13.65 cm) plant height than the other treatment. However, both RHB150 and RHB250 showed good performance than the control (C500) (Table 4). This could also be explained by the high content of organic carbon of rice husk biochar in the soil, increased water holding capacity (Abukari, 2014). Plant height was improved by 34.43% with treatment RHB350 as compared to the control treatment suggesting that the application of rice husk biochar at the rate of 350 g is more efficient than the other treatments. Similar results were obtained in plant diameter when higher rates of rice husk biochar were applied compared to the control treatments (Table 5). Comparable results established by Varela et al. (2013) suggest that stem size of water spinach increases due to application of both wood biochar and rice husk biochar. These results are in agreement with those obtained by Dania et al. (2014), who pointed out that organic amendments improve the vegetative development of moringa. Adebayo et al. (2011) observed that organic amendments improved soil nutrient status. Rice husk biochar when applied has the capacity to provide a continuous supply of essential minerals. Compared with other raw organic materials, rice husk biochar provides a stabilized form of organic carbon and has the potential to enhance nutrient release in the soil. In most of the result obtained, higher rates of rice husk biochar were the best of all the treatments. This efficiency comes from its physical and chemical composition. Regarding the number of leaves both RHB350 and RHB250 treatments showed good performance than the control (C500) but RHB150 was significantly lower than both RHB350 and RHB250 treatments. This could be the reason that higher rates of biochar stored more water which aided in the development of the leaves than the lower rate.

The results showed that the addition of soil to small amount of rice husk biochar (150 g) improves the growth parameters. Recent research have suggested that the addition of rice husk biochar in soils can improve soil moisture. Increasing the rate of rice husk biochar improves water holding capacity of soils and as well improves the growth parameters of moringa (Abukari, 2014; Shaon et al., 2018). The number of leaves was increased by 37.67% with the application of RHB350 suggesting that RHB350 was more efficient than the treatments.

Conclusion

The research was carried out to evaluate the growth parameters of moringa using different rates of rice husk biochar proved to increase the number of leaf, plant diameter, and plant height when different rates of rice husk biochar were applied to soil. Plant height was improved by 34.43% with treatment RHB350 as compared to the control treatment suggesting that the application of rice husk biochar at the rate of 350 g is more efficient than the other treatments. Plant diameter was significantly improved with an

increasing rate of rice husk biochar application. The number of leaves was increased by 37.67% with the application of RHB350 suggesting that RHB350 was more efficient than the treatments. Therefore, it is suitable to grow moringa using preferably 250 g and 350 g of rice husk biochar with a mixture of soil in either a container or a pot.

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