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Effect of Biochar on Growth and Yield of Sunflower (*Helianthus annus* L.) in Non-saline Tidal Area of Bangladesh

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Abstract: Biochar is an organic amendment used for crop production. A piece of research work was conducted in the field laboratory of Patuakhali Science and Technology University, Dumki, Patuakhali to observe the effect of biochar on the growth and yield of sunflowers. There were four treatments as Control, 5 tons ha^{-1} biochar, 10 tons ha^{-1} biochar, and 20 tons ha^{-1} biochar. A significant difference was found in the plant height, number of leaves, length of leaves, number of seed $head^{-1}$, head diameter, seed weight $head^{-1}$, 1000 seed weight, yield, and stover yields when different biochar doses were applied. The highest plant height (181.37 cm), number of leaves (20.82), leaf length (45.84 cm), number of seed $head^{-1}$ (677.13), head diameter (20.63 cm), total seed weight $head^{-1}$ (68.19 g), 1000 seed weight (65.49 g), grain yield (3.42 tons ha^{-1}) and stover yield (5.79 tons ha^{-1}) was recorded from 20 tons ha^{-1} treatment. Biochar of 20 tons ha-1 could be recommended for higher growth and yield of sunflower.

Keywords: Biochar; Growth; Sunflower; Yield.

INTRODUCTION

Sunflower (*Helianthus annus L.*) is a major source of oil and it is the fourth largest vegetable oilseed crop in the world (Rodriguez et al. 2002). In Bangladesh, the scarcity of edible oil has been a severe problem for many years (Khatun et al. 2016). To fulfill the demand every year Bangladesh Government has to spend a huge amount of money. As rice is the staple food crop in Bangladesh, the farmer in the southern tidal region follows the rice (transplant *aman*)-fallow- fallow cropping pattern. However, the area of oilseed crop cultivation can be increased by utilizing the fallow land. Cultivation of mustard is limited in this region due to some unavoidable environmental factors. Farmers are not encouraged to grow soybean in their fields as the processing of soybean is very difficult. So sunflower might be the only oilseed crop that can be cultivated in this region for oil production to fulfill the oil demand.

A proper management system and adequate nutrients in the soil is prerequisite for optimum crop yield. Biochar is an organic amendment used in soil to grow more crops. It is used in soil to improve soil's physical and chemical properties (Lehmann et al. 2006). Attention should be paid to biochar-based soil management strategies to reduce greenhouse gas emissions, preserve soil organic matter, conserve soil fertility, maintain soil moisture, and finally maintain a favorable environmental conditions for crop production (Atkinson et al. 2010; Schulz and Glaser, 2012). The addition of biochar to the soil could mitigate the climate change effect (Glaser et al. 2002; Sohi et al. 2010). Biochar can modify soil properties by its carbon sequestration characteristic and can change soil characteristics positively in aeration and water and nutrient retention capacity in soil (Atkinson et al. 2010; Chan et al. 2007; Glaser et al. 2002) and can also modify biological activity (Lehmann et al. 2011). The effect of biochar on growth and production depends on the application rate and types of biochar, soil properties, environmental condition, etc. (Chan and Xu, 2009; Jeffery et al., 2011; Schulz and Glaser, 2012). For the above circumstances, a study was conducted to observe the effect of biochar on the growth and yield of sunflowers.

MATERIALS AND METHODS

Description of the experimental site and period

The study was carried out in the field laboratory of Patuakhali Science and Technology University, Dumki, Patuakhali which was situated in AEZ13 and at 22°20'90″N latitude and 90°20'29″ E longitude (Figure 1). The experiment was conducted from November 2016 to April 2017.

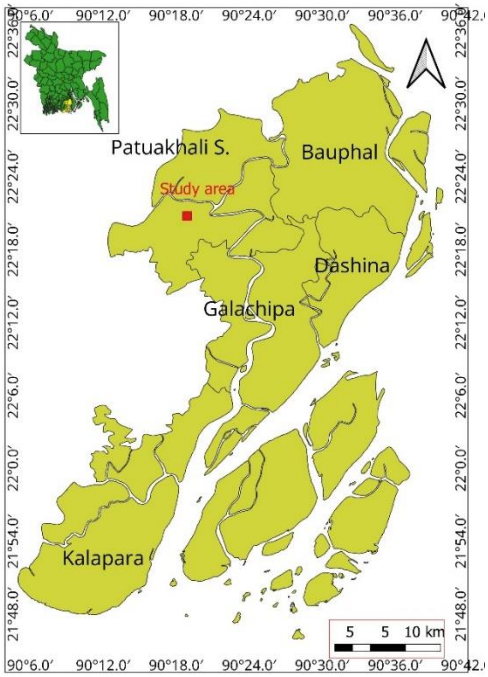

Figure 1. Location of the study area in the map

Treatments and experimental design

In our experiment, we used four treatments of rice husk biochar. They were (i) Control, (ii) 5 tons ha-1 biochar, (iii) 10 tons ha-1 biochar, and (iv) 20 tons ha-1 biochar. The experiment was laid out in a randomized completely block design with three replications.

Land preparation and application of manures and fertilizers

The plots of the experiment were first plowed on 20 November 2016 with a country plow and were exposed to the sun for about one week. To obtain a good tilth, plots were plowed followed by laddering three times. The weeds were removed and finally, the plots were prepared on 27th November 2018. The same amount of fertilizers were applied according to the BARI fertilizer recommended guide in each plot along with treatment.

Seed sowing in the plot

The seeds of sunflower var. Kiron was sown on 15 December 2018, row to row distance was 40cm and the plant-to-plant distance was 35cm. The seeds were placed manually. Two or three seeds were placed on every hill.

Intercultural operations

All the intercultural operations like thinning, gap filling, irrigation, weeding, insect and pest management, etc. were done according to BARI, Bangladesh.

Sampling, harvesting, and processing

From each plot, five plants were randomly selected and marked. After ninety days of seed sowing the plant height, number of leaves, and length of leaves were recorded from the selected plants. Harvesting was done depending on the full maturity of the head. The harvested sunflower was properly tagged and dried in the sun. The straw was also sun-dried properly.

Data collection

The following data were recorded: The plant height (cm), number of leaves plant^{-1}, length of leaves (cm), number of seed head^{-1}, head diameter (cm), seed weight head^{-1} (g), 1000 seed weight (g), seed yield (ton ha^{-1})and stover yield (ton ha^{-1}).

Statistical analyses

The statistical analyses were done using the statistical package SPSS 16.0. The mean difference was compared by Duncan's Multiple Range Test and the analysis of variance was calculated.

RESULTS

The effect of biochar on sunflower growth

The plant height was measured at 90 days after sowing and a significant variation was found (Table 1). The highest plant height (181.37cm) was observed in 20 tons ha-1 treated plots but the lowest plant height (172.11cm) was found in control plots. A significant difference was also found in the number of leaves per plant (Table 1). The height number of leaves (20.84) was found in 20 tons ha-1 treated plots whereas the lowest number of leaves (14.88) was found in control plots. The length of the leaf showed a significant difference due to different treatments of biochar (Table 1). The highest length of leaves (45.84cm) was recorded from the plots treated 20 ton ha-1 biochar and the lowest length of leaves (36.07cm) was found from control plots.

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Table 1. Effect of biochar on the plant height, number of leaves, and length of leaves of sunflower

Treatments	Plant height (cm)	Number of leaves	Length of leaves (cm)
Control	172.11±0.75b	14.88±0.79d	36.07±0.72c
5 ton/ha	173.17±0.35b	16.61±0.87c	40.82±0.23b
10 ton/ha	174.60±0.41b	19.02±0.21b	42.58±0.52b
20 ton/ha	181.37±2.26a	20.82±0.28a	45.84±1.35a
Level of significance	**	**	**

** = significance at 0.01% level

Effect of biochar on seed yield and yield attributing characters

Effect of biochar on the number of seed head-1 of sunflower

A significant variation was found in the number of seed head^{-1} (Table 2). The highest number of seed head^{-1} (677.13) was counted from 20 tons ha^{-1} biochar-treated plots and the lowest number of seed head^{-1} (425.30) was counted from control plots (Table 2).

Table 2. Effect of biochar on the number of seeds head-1, head diameter, weight of seed head-1, and 1000 seed weight of sunflower

Treatments	No of seed head^{-1}	Head Diameter (cm)	Weight of seed per head (g)	1000 seed weight (g)
Control	425.3±10.10d	15.1±0.7b	42.46±1.16d	45.56±3.25d
5 ton/ha	587.1±14.58c	16.63±0.51b	47.86±0.68c	54.6±0.6c
10 ton/ha	658.43±16.06b	19.37±1.01a	55.17±2.32b	60.14±1.4b
20 ton/ha	677.13±6.81a	20.63±0.49a	68.19±3.42a	65.49±2.93a
Level of significance	**	**	**	**

** = significance at 0.01% level

Effect of biochar on the head diameter of sunflower (cm)

A significant difference was found in the case of the head diameter (Table 2). The highest head diameter (20.63cm) was found in 20 tons ha-1 treated plots but the lowest head diameter (15.10cm) was found in control plots.

Effect of biochar on seed weight head^{-1} (g)

In respect of total seed weight head^{-1} significant difference was found (Table 2). The highest seed weight head^{-1} (68.16g) was observed from 20 tons ha^{-1} treated plots and the lowest seed weight head^{-1} (42.45g) was observed from control plots.

Effect of biochar on 1000 seed weight (g)

A significant difference was found among the treatment in respect of 1000 seed weight (Table 2). The highest 1000 seed weight (65.49g) was recorded from 20 tons ha^{-1} treated plots but the lowest 100 seed weight was recorded from control plots.

Effect of biochar on grain yield (ton ha^{-1})

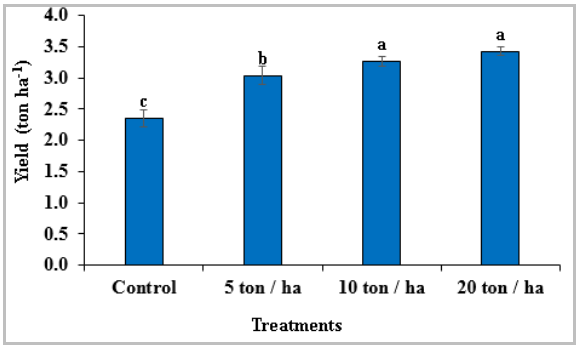

Figure 2. Effect of biochar on yield of sunflower

A significant difference was found among the treatment in the case of grain yield (Figure 2). The highest seed yield (3.42 tons ha-1) was recorded from the 20 tons ha^{-1} treated plots though there was no statistical difference with the yield of 10 tons ha^{-1} biochar treated plots. The lowest seed yield (2.35 tons ha^{-1}) was recorded from control plots.

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Effect of biochar on stover yield (ton ha^{-1})

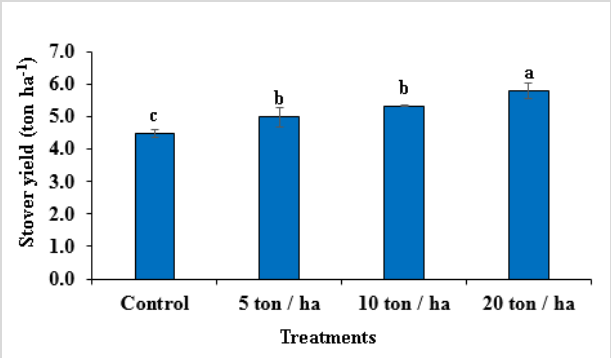

Figure 3. Effect of biochar on stover yield of sunflower

DISCUSSION

The 20 tons ha^{-1} biochar plots showed the highest number of leaves because of higher plant height due to the application of biochar. Pfister and Saha (2016) reported that plant height was increased in biochar treated field compare to control treatments. Biochar application could increase water retention, and microbial activities and reduce nutrient leaching which attributes to increased plant height and yield (Hunt et al. 2010). Steinbeiss et al., (2009) reported that, as a soil amendment, the quail litter biochar increased the soil fertility and had beneficial and positive influences on growth and yield, including increased nutrient availability, Particularly N and this improves crop productivity. This higher yield was contributed primarily by the plant height, number of seed head-1, head diameter, seed weight head-1, and 1000 seed weight. All the parameters measured were highest in 20 tons ha^{-1} biochar application. A similar result was found by Liu et al. (2016) who reported that biochar adsorbs more nutrients which release slowly as a result grain yield was increased. For several properties like adsorption, large surface area, porous in nature, medium of micro-organisms, etc. of biochar improve soil properties which are favorable for crop production (Nigussie et al. 2012). Biochar can absorb more plant nutrients directly to its surface both cations and anions for its greater porosity and surface area (Atkinson et al. 2010; Liang et al. 2006) leading to higher plant growth and yield.

CONCLUSION

The plant height, number of leaves, length of leaves, number of seed head-1, head diameter, seed weight head-1, 1000 seed weight, seed yield, and stover yield were significantly different with different treatments. The highest plant height (181.37cm) number of leaves (20.82), length of leaves (45.84cm), head diameter (20.63cm) seed weight head-1(68.19g) 1000 seed weight (65.49g) seed yield (3.42 tons ha-1) and stover yield (5.79 tons ha-1) was recorded from 20 tons ha^{-1} biochar treatment. Biochar of 20 tons ha-1 could be recommended for higher growth and yield of sunflower.

Conflict of Interest

There is no conflict of interest declared by the authors.

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