EFFECT OF BIOCHAR ON THE GROWTH AND YEILD OF SOYBEAN (*Glycinemax*.L.Merill)

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Abstract
The experiments were conducted at the Teaching and Research Farm, Faculty of Agriculture, Nasarawa State University, Shabu-Lafia Campus during 2018 and 2019 cropping seasons to find the effect of biochar on the growth and yield of soybean in Lafia southern Guinea savanna of Nigeria. The experiments were laid in randomized complete block design (RCBD) and replicated three times. Biochar was incorporated into ridges before planting at the rates of 0, 4, 8 and 12 tons/ha. All data collected were subjected to analysis of variance (ANOVA) using GENSTAT statistical package while least significant difference was used to separate treatment means at 5% probability. The results obtained indicated that biochar at the rate of 8 tons/ha recorded consistently and significantly ($p<0.05$) produced tallest plant, highest number of branches, heaviest weight per 100 seeds and seed yield per plot and per hectare of soybean respectively in both cropping seasons. The highest rate of biochar (12 tons/ha) in this study did not necessarily influence all soybean parameters tested in both cropping seasons indicating that biochar at the rate of 8 tons/ha seemed to be the optimum rate for sustainable soybean production in the study area.

Key words: Biochar, growth, soybean, yield.

Introduction

Biochar is a heterogeneous and chemically complex material; made by heating biomass under the exclusion of air (Pyrolysis) (Wilson, 2014a, Wang *et al.*, 2016). It is a black charcoal-like substance and one of the oldest soil amendments in the history of agriculture (Schemidt and Wilson, 2014, Wilson, 2014b). Biochar incorporated into soil acts as a long-term soil fertility improvement and improves crop production (Wang *et al* 2016). It increases soil water holding capacity, improves soil aeration, releases plant nutrients and raises soil pH value (Schemidt and Wilson, 2014).Soybea(Glycine Max.L.Merill) is a species of legume, widely grown for its edible bean.It contains more than 36% protein; about 30% carbohydrates and 20% oil (Atli, 2019). It is an excellent source of dietary fiber, Vitamins and Minerals. Soybean is the only available crop that provides an inexpensive and high-quality source of protein comparable to meat, poultry and eggs (Atli, 2019). It improves soil fertility by adding nitrogen from the atmosphere which is a major benefit in African farming system where soils have become exhausted by the need to produce more food for increasing population and where fertilizers are hardly available (scarce) and expensive for farmers.Nigeria is the largest producer of soybean in sub-Sahara Africa with about 500,000 metric tons produced annually followed by South Africa.It is produced mostly in the middle belt of Nigeria with Benue State accounting

for about 45-70% of the total production in the country.Soybean requireswell drained and fertile loamy soils with high organic matter and pH range between 6.0 and 7.5 (Dugje *et al.,* 2009, IITA, 2018).

There is increasing economic importance and uses of soybean as it is being converted and made into various traditional food products such as soy-milk, soy-cake (Wara), soy-soup etc in Lafia by the local inhabitants/populations but the use of biochar have not received much attention hence, the need for this kind of study to encourage local farmers to increase the cultivation of the crop to meet the increasing demand for the crop by the inhabitants of the study area. Therefore, the aims of this study are to find the effect of biochar on the growth and yield of soybean and to determine optimum level of biochar for sustainable soybean production in Lafia, southern Guinea savanna of Nigeria.

Materials and Methods

The experiments were conducted at the Teaching and Research Farm, Faculty of Agriculture, Nasarawa State University, Shabu-Lafia Campus during 2018 and 2019 cropping seasons.The study area is located between latitude 08.33^0N and Longitude 08.33^0E which falls within the southern Guinea savannah zone of Nigeria (Jayeoba, 2013).The experiments were laid out in a randomized complete block design (RCBD) with three replications. Biochar was incorporated into ridges before planting at the rates of 0, 4, 8 and 12 tons/ha. Four (4) seeds of soybean were planted per hole at a spacing of 5cm between plants on four manually prepared ridges of 2m long. The seedlings were thinned to two (2) plants at two (2) weeks after planting (WAP).All data obtained from this study were subjected to analysis of variance (ANOVA) using GENSTAT Statistical Package while least significant difference (LSD) was used to separate treatment means at 5% probability.

Results and Discussion

Table 1 below is the results of the effect of different rates of biochar on Soybean plant height at 8 and 10 weeks after planting.The results shows that biochar at the rate of 8 tons/ha produced significantly($p<0.05$) tallest Soybean plant height followed by biochar at the rate of 4 tons/ha. However,there was no significant difference between biochar at the rates of 12 tons/ha and the control at 8 and 10 WAP in both 2018 and 2019 cropping years.Application of biochar to soil positively increased soybean plant height linearly up to 8 tons/ha but declined at 12 tons/ha in 2018 and 2019 cropping years respectively.This result is in line with the finding of Bayan (2013) who reported that biochar at 2% in pot experiment significantly enhanced Soybean plant growth by 35% over the control and 5% of biochar application.Similarly, Njoku *et al* (2015) reported that Maize plant height were significantly higher in plots amended with biochar than the control..

Table 1.Effect of Biochar on Plant Height of soybean during 2018 and 2019 Cropping Seasons

Treatment	2018		2019	
Biochar (tons/ ha)	8	10	8	10
0	38.9c	44.1c	39.9c	46.1c
4	40.0b	46.6b	42.1b	48.1b
8	40.4a	48.0a	42.7a	49.2a
12	38.8c	43.8d	40.0c	46.0c
LSD (0.05)	0.14	0.12	0.22	0.12

Values followed with the same letter (s) within a column are not significant at 5% probability.

Table 2 below is the result of the effect of different rates of biochar on the number of branches of Soybean.The result indicates that biochar at the rate of 8 tons/ha recorded significantly ($P<0.05$) highest number of branches followed by biochar at the rate of 4 tons/ha while biochar at the rate of 12 tons/ha and the control recorded similar number of branches per Soybean plant at 8 and 10WAP in both 2018 and 2019 cropping years. The result indicates that the increased in the rate of biochar per hectare up to 8 tons/ha resulted in significant increase in number of branches per Soybean plant in both cropping years respectively. The result confirms the finding of Mete *et al* (2015) who reported that total biomass production of Soybean increased on average by 67% as a result of the application of biochar compared to the control treatment.

Table 2 Effect of Biochar on Number of Branches of soybean during 2018 and 2019 Cropping Seasons

Treatment	2018		2019	
Biochar (tons/ ha)	8	10	8	10
0	3.0c	3.8c	3.1b	3.7b
4	3.4b	4.4b	3.7a	4.3a
8	4.5a	4.5a	3.6a	4.4a
12	2.9c	3.3d	3.0b	3.3b
LSD (0.05)	0.18	0.08	0.29	0.34

Values followed with the same letter (s) within a column are not significant at 5% probability.

Table 3 below is the results of the effect of different rates of biochar on 100 Seed weight (g) of Soybean. The result shows that biochar at the rate of 8 tons/ha recorded significantly ($p<0.05$) heaviest weight(g) per 100 seed of soybean followed by biochar at the rates of4 tons/ha and 12 tons per hectare while biochar at the rate of 0 ton/ha (control) recorded lowest weight(g) per 100 seeds of soybean in both 2018 and 2019 cropping seasons respectively.Rondo *et al*. (2007) reported that yields increased by 46% over the control as aresult of the application of 90 g/kg of biochar to soil.

Table 3 Effect of Biochar on 100 Seeds Weight (g) of soybean during 2018 and 2019 Cropping Seasons

Treatment Biochar (tons/ha)	2018	2019
0	12.6d	12 6d
4	15.4b	14.2b
8	16.9a	14.9a
12	14.0c	13.1c
LSD (0.05)	0.13	0.25

Values followed with the same letter (s) within a column are not significant at 5% probability.

Table 4 below is the result of effectof different rates of biocharon seed yield per plot of soybean. The result indicates that the plot treated withbiochar at the rate of 8 tons/ha recordedsignificantly ($p<0.05$) heaviest seed (grain) weight per plot followed by biochar at the rates of 4tons/ha and 12tons/ha while biochar at the rate of 0 ton/ha (control) recorded lowest seed weight per plot in both 2018 and 2019 cropping seasons respectively.Mete et al (2015) reported that seed yield of Soybean increased on average by 84% as a result of application of biochar to soil compared to the control.Rondo et al (2007) reported that Beans yields increased by 46% over the control as a result of the application of 90g/kg of biochar.Agboola and Moses also reported that combined application of biochar and Cow dung significantly increased yield of Soybean compared to the control.

Table 4 Effect of Biochar on Seed Yield per Plot of soybean during 2018 and 2019 Cropping Seasons

Treatment Biochar (tons/ha)	2018	2019
0	221.7d	223.5d
4	354.0b	356.0b
8	391.2a	395.2a
12	316.1c	319.8c
LSD (0.05)	0.16	0.25

Valuesfollowed with the same letter(s) within a column are not significant at 5% Probability.

Table 5 below is the result of the effect of different rates ofbiochar on the weight (kg) of seed of soybean per hectare. The result shows that biochar at the rate of 8 tons/ha recorded significantly ($p<0.05$) highest seed weight (grain) yield (kg) per hectare followed by biochar at the rates of 4 tons/ha and 12 tons/ha respectively while biochar at the rate of 0 ton/ha (control) recorded lowest seed (grain) yield (kg) per hectare in both cropping years respectively. This result confirms the report of Mete *et a*l (2015) who reported that seed yield of Soybean increased by84% as a result of application of biochar compared to the control. SimilarlyAgboola and Moses (2015) reported that combined application of biochar and Cow dung significantly increased growth and yield of Soybean.

The low response of soybean to higher rate of biochar may be that the dose was too high which affected the growth and yield of the crop indicating that 8 tons/ha is the optimum rate of biochar for sustainable soybean production in the study area.

Table 5 Effect of Biochar on Seed Yield of soybean per Hectare (kg/ha) during2018 and 2019 Seasons

Treatment Biochar (tons/ha)	2018	2019
0	739.0d	745.0d
4	1180.0b	1187.3b
8	1304.0a	1316.7a
12	1053.7c	1066.0c
LSD (0.05)	0.16	0.19

Values followed with the same letter(s) within a column are not significant at 5% probability

Conclusion

The results of this study show that the application of biochar to soil positively influenced growth and yield parameters of Soybeantested. The results also reveal that application of biochar at the rate of 8 tons/ha significantly ($p<0.05$) produced tallest plant height,highest number of branches, heaviest weight per 100 seed and grain yield of soybean per plot and hectare during 2018 and 2019 cropping seasons respectively. The highest rate ofbiochar (12 tons/ha) applied in this study did not necessarily influence all Soybean parameters tested in both cropping years. Thus, application of biochar at the rate of 8 tons/ha seemed to be the optimum rate for sustainable Soybean production at Lafia, Nasarawa State, Nigeria and is hereby recommended.

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