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16th – 18th April, 2022

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Proceedings Citation Format
Sanni, K. O, Ewulo, B.S, Ojeniyi, S.O, Dada, B.F. & Bello, A. A. (2022) Effect Of Rice Husk Biochar On The Soil Physiochemical Properties And Performance Of Cowpea (Vigna ungiuculata) In Ikorodu And Ikenne Agro-Ecological Zones. Proceedings of the LASUSTECH 30th iSTEAMS Multidisciplinary Innovations Conference. Lagos State University of Science & Technology, Ikorodu, Lagos State, Nigeria May 2022. Pp 173- 184. www.isteams.net/lasustech2022
DOI: https://doi.org/10.22624/AIMS/iSTEAMS/LASUSTECH2022V30P15

Effect Of Rice Husk Biochar On The Soil Physiochemical Properties And Performance Of Cowpea (Vigna ungiuculata) In Ikorodu And Ikenne Agro-Ecological Zones

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ABSTRACT

Agricultural activities in South Western Nigeria generate large quantities of crop residues such as rice husk, which are left unused. As the amount of nutrients for plant growth decline in soil, growth of crop is inhibited and yield reduced. This necessitates the need to find ways to amend poor soils and help maintain high yields, food stability and good soil health. The objective of this study was to evaluate the effects of rice husk biochar on soil physiochemical properties and performance of Cowpea. The experiment was carried out on a 35 m x 11 m (385 m²) area of land at the Teaching and Research Farms of Lagos State Polytechnic, Ikorodu and IAR&T sub-station Ikenne. Three levels of biochar application rate were used in this study viz, 0 t/ha, 1.25 t/ha, and 2.5 t/ha which was applied and incorporated into the soil two weeks before planting. The experiment was laid out in Randomized Complete Block Design (RCBD). Seeds were sown at a spacing of 70 cm x 20 cm with two seeds per hole. 6 plants were tagged per treatment, while the entire plot was used for yield estimation. The data collected were: plant height, number of leaves, number of branches, and stem girth at 3, 5 and 7 weeks after planting as growth parameters, as well as number of pods, grain yield per hectare as yield parameters and soil pH, soil organic matter, total nitrogen, available phosphorus, exchangeable potassium, Soil exchangeable acidity, and Cation exchangeable capacity as soil physiochemical parameters. Data collected were subjected to Analysis of Variance (ANOVA), and significant means of treatments were compared using Duncan Multiple Range Test (DMRT) at 5% level of probability using SAS statistical software version 9.4 of 2012. Rice husk biochar had significant effects on performance of cowpea

Keywords: Rice husk biochar, soil physiochemical properties, performance, cowpea, Ikorodu and Ikenne agroecological zone.

1. INTRODUCTION

Cowpea provides an inexpensive source of protein and minerals for the urban and rural people of the region and is an important crop in the cereal-legume cropping systems (Sheahan, 2012). It requires very few inputs, as the plant's root nodules are able to fix atmospheric nitrogen, making it a valuable crop for resource-poor farmers and well-suited to intercropping with others like sorghum, millet, maize, cassava, or cotton crops (SADFF, 2011). The whole plant is used as forage for animals, which is use as cattle feed. Cowpea like other legumes, are cooked to make them edible, usually by boiling (Hamid *et al.,* 2016) and can also be processed into paste or flour (Gonçalves *et al.,* 2016). Biochar is charcoal formed from the thermal decomposition of biomass in a low or zero oxygen environment at moderate temperature (<700 ^{0}C) (Lehmann and Joseph, 2009).

Biochar application to soils is presently attracting universal attention due to its potential to improve water holding capacity, soil nutrient retention capacity, and sustainable carbon store, thus reducing greenhouse gas emissions (Downie *et al.,* 2009). Biochar application provides greater nutrient retention and availability than other nutrient sources, therefore, less conventional fertilizers needs to be applied to give a desirable crop yield. Gaunt and Cowie (2009) in an assessment of biochar's ability to reduce greenhouse gases, estimated that 10%–30% reduction of nitrogen fertilizer use will be effective. Zhang *et al.* (2013) estimated that for approximately every tonne of nitrogeneous fertilizer that is used, 13.5 tonnes CO_2 is emitted into the atmosphere. Sohi *et al.* (2009), however suggested the concept of using syngas from the pyrolysis process to replace the natural gas to produce nitrogen. Combining the biochar and nitrogen that is produced the same process can create a powerful carbon and nitrogen rich fertilizer (Day *et al.,* 2005).

Soil fertility management ranges from fertilizer applications to low external input agriculture based on organic sources of nutrients (Sanchez and Leakey, 1997). Fertilization in tropical agriculture has the potential to dramatically increase production because the soils of the tropics are highly weathered and have limited reserves of nutrients (IBI, 2012). These should be at the core of strategies to restore soil fertility and raise crop productivity. As farmers are unable to meet the nutrient needs of all crops, they prefer to apply fertilizer to cereals and rarely target fertilizers directly to grain legumes which are mostly grown on residual fertility (Zingore *et al.,* 2008). In many African countries, the main use of fertilizer is on maize, sorghum/millet, and rice (Camara and Heinemann, 2006) with cowpea receiving little attention from farmers in terms of fertilizer application. It is generally believed by most cowpea growers that the production of legumes does not require anfertilizer application (Kan'ankuka, 1999). This is due to the excessive vegetation at expense of grain production of this crop under fertilized fields. Cowpea can fix about 40 kg N per hectare from the presence of right *rhizobia* strain in the root nodules, which can satisfy the crop nitrogen requirements (Singh *et al*., 1997). Some reports indicated that in poor soils, cowpea hardly satisfies N requirements but the crop performance is improved by fertilization (Chiezey *et al*., 1990; Kan'ankuka, 1999; FAO, 2005) .

Modern agriculture depletes nutrients and reduces soil organic matter levels through continuous cropping. This decline in soil nutrient continues until management practices are improved, additional nutrients are applied, rotation with nitrogen-fixing crops is practiced, or until a fallow period occurs allowing a gradual recovery of the soil through natural ecological development. As the natural stores of the most important nutrients for plant growth decline in the soil, growth rates of crops are inhibited and yield reduced. Agricultural activities in South Western Nigeria generate large quantities of crop residues such as rice husk, which are left unused. As the amount of nutrients for plant growth decline in soil, growth of crop is inhibited and yield reduced. This necessitates the need to find ways to amend poor soils and help maintain high yields and food stability therefore the main objective of this study was to evaluate the effects of rice husk biochar on soil physiochemical properties and performance of Cowpea at Ikorodu agroecological zone.

2. MATERIALS AND METHODS

2.1 Experimental location, experimental materials, experimental design and treatments

The experiment was carried out at the Teaching and Research Farms of Lagos State Polytechnic, Ikorodu, Lagos State Nigeria and IAR&T Sub-station Ikenne, Ogun state. The materials that were used in this experiment include cowpea (Ife brown variety), Rice husk biochar, insecticide, knapsack sprayer, hoe, cutlass, land, measuring tape, sign-post. The cowpea seeds (1.00 kg)

(Ife brown variety) were sourced from Genetics Resource Center of International Institute of Tropical Agriculture (IITA) Ibadan, Oyo State. The feedstock that was used for biochar production in this study was obtained from rice bran. The waste biomass was collected from a rice mill in Imota, Ikorodu, Lagos State and was processed into biochar using a pyrolyser. The experiment was laid out in Randomized Complete Block Design (RCBD) with three treatments (0t/ha, 1.25 t/ha and 2.5 t/ha biochar) replicated three times.

2.2 Crop establishment and maintenance
Cowpea seeds were sown at a spacing of 70 cm x 20 cm with two seeds per hole. Thinning to one plant per stand was carried out at two weeks after emergence (WAE). Weeding was done at two weeks interval manually and insect pests were controlled by spraying cypermethrin 10% EC at two week interval at the rate of 1.5 l/ha (7.2 ml/481 m^2) in 400 l/ha (19.2l/481 m^2) of water.

2.3 Preparation of biochar
The feedstocks used for biochar production in this study was solely rice bran. The waste biomass was collected from a rice mill in Imota, Ikorodu, LagosState. The biochar was processed by first removing the moisture content by sun drying, and then the material was loaded into the Reactor. Heat was applied for five hours at a temperature of >700^{0}C when there was no more smoke coming from the reactor, the content was unloaded from the reactor and then allowed to cool under ambient temperature.

2.4 Data collection and Statistical Analysis
Six (6) plant stands was randomly sampled and tagged per plot for data collection. The data collected were: plant height, number of leaves, number of branches, and stem girth at 3, 5 and 7 weeks after planting as growth parameters, as well as number of pods, grain yield per hectare as yield parameters and soil pH, soil organic matter, total nitrogen, available phosphorus, exchangeable potassium, Soil exchangeable magnesium Soil exchangeable acidity, and Cation exchangeable capacity as soil physiochemical parameters. Data collected were subjected to Analysis of Variance (ANOVA), and significant means of treatments were compared using Duncan Multiple Range Test (DMRT) at 5% level of probability using SAS statistical software version 9.4 of 2012.

3. RESULTS

3.1 Pre-planting soil physicochemical properties and biochar analysis
Data presented in Table 2, shows the soil preplanting soil physical, chemical and biochar analysis. In Ikorodu, the soil was slightly acidic (5.6), with orghanic carbon and total nitrogen of 1.81% and 1.96% respectively. The soil contained 5.96 mg/kg, 1.15 mg/kg, 129mg/kg, 185 mg/kg and 41.50 mg/ks of zinc, copper, iron, manganese and available phosphorus, respectively. The soil textural class was sandy clay loam with 80.40% sand, 15.20% silt and 4.40% clay. The soil contained 1.06 cmol/kg sodium, 0.59 cmol/kg potassium, 0.55 cmol/kg calcium and 0.92 cmol/kg magnesium. The soil had a CEC of 8.89 cmol/kg.

At Ikenne, the pH was strongly acidic (5.42) with organic carbon of 1.62% and total nitrogen of 1.76%. the soil contains 4.70 mg/kg, 1.01 mg/kg, 120 mg/kg, 165 mg/kg and 38.50 mg/kg of zinc, copper, iron, manganese and available phosphorus respectively. The soil textural class was also sandy loam with 76.40% sand, 16.00% silt and 7.60% clay. The soil contains 1.01 cmol/kg sodium, 0.49 cmol/kg potassium, 0.45 cmol/kg calcium and 0.72 cmol/kg magnesium. The soil had a CEC of 3.29 cmol/kg.

ISBN- 978-978-57388-7-2

The result from rice husk biochar analysis showed that the biochar had alkaline pH (8.13) and contains high organic carbon (63.71%) than the soils at the experimental locations but lower total nitrogen (0.86%) than both locations. The biochar also contains higher available phosphorus (75.35 mg/kg) than the soil at both locations. With regards to the exchangeable bases, the biochar had higher potassium (1.76 cmol/kg), calcium (11.70 cmol/kg) and magnesium (13.01 cmol/kg) but lower sodium (0.05) compared to the soil at both locations. The biochar also had higher CEC of 14.27 cmol/kg than the soils.

Table 1: Pre-planting soil chemical properties, particle size analysis and nutrient composition of biochar:

Physicochemical Properties		Ikorodu	Ikenne	Biochar
Chemical				
pH		5.6	5.4	8.1
Organic Carbon (%)		1.81	1.62	63.71
Total Nitrogen (%)		1.96	1.76	0.86
Zn (mg/kg)		5.96	4.70	
Cu (mg/kg)		1.15	1.01	
Fe (mg/kg)		129	120	
Mn (mg/kg)		185	165	
Available Phosphorus (mg/kg)		41.50	38.50	75.35
Exchangeable Bases (cmol/kg)	Na	1.06	1.01	0.05
	K	0.59	0.49	1.76
	Ca	0.55	0.45	11.70
	Mg	0.92	0.72	13.01
Cation exchange capacity (cmol/kg)		8.89	3.29	14.27
Physical				
Particle size (g/kg)	Sand	800.40	760.40	
	Silt	150.20	160.00	
	clay	40.40	70.60	
		Sandy Loam	Sandy Loam	

Table 2: Effect of biochar on soil chemical properties at Ikorodu and Ikenne.

	pH		SOM		Total N		Available P		Exch. K	
	(H_2O)		(%)		(%)		(mg/kg)		(cmol/kg)	
Treatments	Ikorodu	Ikenne	Ikorodu	Ikenne	Ikorodu	Ikenne	Ikorodu	Ikenne	Ikorodu	Ikenne
0	6.04	4.44c	3.44	3.53	0.10	0.13b	0.22	1.38c	0.92b	0.72
1.25	6.36	4.81a	3.59	3.77	0.10	0.14b	0.26	1.45b	1.09ab	0.74
2.5	6.05	4.64b	4.04	3.87	0.12	0.19a	0.27	1.52a	1.36a	0.75
S.E.	0.09	0.09	0.14	0.08	0.01	0.02	0.01	0.03	0.1	0.01
Significance	Ns	*	ns	ns	ns	*	ns	*	*	ns

Effect of biochar on soil chemical properties at Ikorodu and Ikenne.

Soil pH

Soil pH values were significantly (p≤0.05) influenced by biochar application at Ikenne (Table 2), 2.5 t/ha biochar treated soils had the highest soil pH (4.81) while least (4.44) was observed in 0 t/ha biochar. Soil pH was not significantly (p≤0.05) influenced by biochar at Ikorodu.

Soil Organic Matter

Soil organic matter was not significantly (p≤0.05) influenced by biochar application at both locations and Lime at Ikorodu (Table 3).

Total Nitrogen

Soil Total nitrogen (N) was significantly (p≤0.05) influenced by biochar application at Ikenne (Table 2). The highest soil Total N (0.19%) was observed with 0 t/ha biochar while the least was observed in 1.25 t/ha biochar treated soils. Soil Total N was not significantly (p≤0.05) influenced by biochar application at Ikorodu (Table 2).

Available Phosphorus

Soil available phosphorus (P) was significantly (p≤0.05) influenced by biochar application at Ikenne (Table 2). The highest available P values (1.52 mg/kg) were obtained with 1.25 t/ha biochar, while the lowest (1.38 mg/kg) was observed with 0 t/ha biochar treatment. Soil available P values were not significantly (p≤0.05) influenced by application of biochar at Ikorodu (Table 2).

Exchangeable Potassium

Soil exchangeable potassium (K) values were significantly (p≤0.05) influenced by biochar at Ikorodu (Table 3). At Ikorodu, the highest soil exchangeable K (1.09 cmol/kg) was observed with 1.25 t/ha biochar (1.36 cmol/kg) while the lowest (0.92 cmol/kg) was observed with 0 t/ha biochar. Soil exchangeable K values were not significantly (p≤0.05) increased by biochar at Ikenne (Table 2).

Exchangeable Acidity

Soil exchangeable acidity were not significantly (p≤0.05) influenced by biochar at both locations (Table 3).

Table 3: Effect of biochar on soil chemical properties (exchangeable acidity and CEC) at Ikorodu and Ikenne.

	Exch. Acid (H^+&Al3$^+$)		CEC (cmol/kg)	
Treatments (t/ha)	Ikorodu	Ikenne	Ikorodu	Ikenne
0	0.17	0.16	14.93	9.23b
1.25	0.17	0.15	17.22	12.26a
2.5	0.15	0.17	15.02	10.53b
S.E.	0.01	0.01	0.61	0.72
Significance	ns	Ns	ns	*

Cation Exchange Capacity

Soil cation exchangeable capacity were significantly ($p \leq 0.05$) influence by biochar at Ikenne (Table 4) with the highest observed in 1.25 t/ha biochar (12.26 cmol/kg) while the lowest (9.23 cmol/kg) observed in 0 t/ha biochar. Soil cation exchangeable capacity were not significantly ($p \leq 0.05$) biochar at Ikorodu (Table 3).

Effects of Rice husk biochar on plant height (cm) of cowpea in Ikorodu and Ikenne

Plant heights of cowpea were significantly ($p \leq 0.05$) affected boichar at 5 WAS and 7 WAS at Ikene (Table 5). At 5 WAS and 7WAS 1.25 t/ha of biochar had the tallest plants (60.14 cm and 143.01 cm) as compared to other rates of biochar application. There was no significant difference observed in the rates of biochar at all weeks of consideration in Ikorodu and 3WAS at Ikenne.

Effects of Rice husk biochar on number of leaves of cowpea in Ikorodu and Ikenne

Number of leaves of cowpea were significantly ($p \leq 0.05$) affected by biochar at 3, 5, and 7 WAS at Ikenne (Table 6). At 3 WAS, 0 t/ha biochar had the highest number of leaves (14.18) followed by 1.25 t/ha biochar. At 5 WAS, 1.25 t/ha biochar had the highest number of leaves (69.66) followed by 0 t/ha biochar (65.29) with 2.5 t/ha biochar having the least number of leaves (57.94). At 7 WAS, 2.5 t/ha biochar had the highest number of leaves (141.99) followed by 0 t/ha lime (134.88), with 1.25 t/ha biochar having the least number of leaves. There were no significant ($p \leq 0.05$) differences in the number of leaves of cowpea as affected by biochar at 3, 5, and 7 WAS at Ikorodu.

Effects of Rice husk biochar on number of branches of cowpea in Ikorodu and Ikenne

Number of branches of cowpea were significantly ($p \leq 0.05$) affected by biochar at 3 WAS at Ikorodu and 7 WAS at Ikenne, and NPK fertilizer at 5 WAS at Ikorodu (Table 7). At 3 WAS in Ikorodu 1.25 t/ha biochar had the highest number of branches (5.00) followed by 0 t/ha biochar (4.56) with 2.5 t/ha biochar having the least number of branches (4.39). At 7 WAS at Ikenne, 1.25 t/ha biochar had the highest number of branches (86.84) followed by 0 t/ha biochar (63.93) with 2.5 t/ha biochar having the least number of branches (59.14). There were no significant ($p \leq 0.05$) differences in the number of branches of cowpea as affected by biochar at 5, and 7 WAS at Ikorodu and 3 and 5 WAS at Ikenne.

Effects of Rice husk biochar on stem girth (cm) of cowpea in Ikorodu and Ikenne

Cowpea stem girth was significantly (p≤0.05) increased by, biochar at 3 WAS at Ikorodu, (Table 8). At 3 WAS, plant treated to 1.25 t/ha biochar had the thickest stem (1.93 cm) in Ikorodu. There were no significant (p≤0.05) differences in the stem girth of cowpea as affected by biochar at 5, and 7 WAS at Ikorodu and 3, 5 and 7 WAS at Ikenne.

Effects of Rice husk biochar on number of pods and pod weight of cowpea in Ikorodu and Ikenne.

There was no significant different observed in the number of pods and pod weight as influenced biochar at both locations (Table 9).

Table 5: Effects of Rice husk biochar on plant height (cm) of cowpea in Ikorodu and Ikenne:

	Weeks after Sowing					
	3		5		7	
Biochar(t/ha)	Ikorodu	Ikenne	Ikorodu	Ikenne	Ikorodu	Ikenne
0	13.65	14.16	42.18	53.88b	104.39	134.28ab
1.25	14.21	15.23	48.35	60.14a	114.97	143.01a
2.5	13.82	13.92	42.98	56.27ab	103.18	131.62b
S.E.	0.14	0.33	1.58	1.49	3.06	2.81
Significance	ns	ns	Ns	*	ns	*

S.E: Standard error, ns: not-significant at p≤0.05 *: Significant at p≤0.05

Table 6: Effects of Rice husk biochar on number of leaves of cowpea in Ikorodu and Ikenne

	Weeks after Sowing					
	3		5		7	
BIOCHAR (t/ha)	Ikorodu	Ikenne	Ikorodu	Ikenne	Ikorodu	Ikenne
0	15.00	14.18a	74.79	65.29ab	129.06	128.67b
1.25	16.01	13.64ab	80.22	69.66a	139.92	119.59b
2.5	14.50	13.17b	74.39	57.94b	138.22	141.99a
S.E.	0.36	0.24	1.54	2.79	2.75	5.31
Significance	ns	*	ns	*	ns	*

S.E: Standard error, ns: not-significant at p≤0.05*: Significant at p≤0.05

Table 7: Effects of Rice husk biochar on number of branches of cowpea in Ikorodu and Ikenne

	Weeks after Sowing					
	3		5		7	
BIOCHAR (t/ha)	Ikorodu	Ikenne	Ikorodu	Ikenne	Ikorodu	Ikenne
0	4.56ab	5.20a	25.94	29.06	45.39	63.93b
1.25	5.00a	5.22a	28.06	30.19	49.50	86.84a
2.5	4.39b	5.22a	26.00	30.00	47.22	59.14b
S.E.	0.15	0.01	0.57	0.29	0.97	6.98
Significance	*	ns	ns	ns	ns	*

S.E: Standard error, ns: not-significant at p≤0.05*: Significant at p≤0.05

Table 8: Effects of Rice husk biochar on stem girth (cm) of cowpea in Ikorodu and Ikenne

	Weeks after Sowing					
	3		5		7	
BIOCHAR (t/ha)	Ikorodu	Ikenne	Ikorodu	Ikenne	Ikorodu	Ikenne
0	1.77b	1.89	2.36	2.54	3.09	2.87
1.25	1.93a	1.22	2.37	1.95	3.01	2.77
2.5	1.83b	1.83	2.26	2.48	3.03	2.86
S.E.	1.40	2.82	0.03	0.69	0.02	0.03
Significance	*	ns	ns	ns	Ns	ns

S.E: Standard error, ns: not-significantat p≤0.05*: Significant at p≤0.05

Table 9: Effects of Rice husk biochar on number of pods, pod weight and days to 50% flowering of cowpea in Ikorodu and Ikenne.

	Number of pods		Pod weight (g)	
Treatments	Ikorodu	Ikenne	Ikorodu	Ikenne
0	26.56	30.93	0.22	0.24
1.25	25.67	30.33	0.21	0.24
2.5	26.50	29.85	0.18	0.23
S.E.	0.23	0.26	0.01	0.00
Significance	ns	Ns	ns	Ns

4. DISCUSSION

Results from Ikenne shows that plots treated with 1.25 t/ha biochar had a considerable increase in soil pH as compared to the treatments with no lime or biochar applications, this might be due to the ability of biochar to increase soil pH and capable of reclaiming acidic soil, this is in line with the findings of Liang *et al.* (2006), Peng *et al.* (2011), Karhu *et al.* (2011), Herath *et al.* (2013), and Martinsen *et al.* (2015), who in their various researches observed that the application of biochar to soils resulted in changes in soil chemical and physical properties such as an increase in soil pH, CEC, and water retention capacity.

Results from Ikenne sites show that the application of 2.5 t/ha biochar significantly increased soil Total nitrogen as compared to the rate and the control (no application). This result might be due to the increase in nutrient use efficiency as influenced by biochar application which facilitated an increase in soil pH which made plants use more of the nitrogen in the soil, resulting in the low soil total nitrogen in treatments with biochar application. This result is supported by the findings of Herath *et al.* (2013), in their experiment carried out to evaluate the effect of biochar on nutrient availability and yield of cowpea which showed a significant increase in yield and availability of nutrients

Application of 1.25 t/ha biochar led to an increase in the soil available phosphorus at ikenne as compared to other rates of biochar, this is hypothesized to be due to the increase in nutrient use efficiency as increased by biochar application which facilitated an increase in soil pH hence made plants use more of the phosphorus in the soil which resulted in the low soil available phosphorus post experiment in treatments with lime and biochar combinations.

This is in line with the findings of Sudharmaidevi *et al*. (2012). The result is also in agreement with the findings of Osundwa *et al*. (2013) from Kenya who in their experiment found out that biochar increases available phosphorus which in turn increases the yield of their test crop (wheat).Biochar at the rate of 2.5 t/ha in Ikorodu had high soil exchangeable potassium which might be due to the effects of biochar in making soil nutrients more available and also making the potassium in the soil available for efficient use by plants, which is in line with the findings of Biederman and Harpole (2013), who found out that the addition of biochar to soils resulted in increased above ground productivity, crop yield, soil microbial biomass, rhizobia nodulation, plant potassium tissue concentration, soil phosphorus (P), soil potassium (K), total soil nitrogen (N), and total soil carbon (C) compared with control conditions.

1.25 t/ha Biochar had the highest CEC which is hypothesized to be due to the biochar effect in improving soil CEC by increasing the soil pH. This is in agreement with the findings of various authors that biochar application leads to improved soil pH (Chan *et al*., 2007; Novak *et al*., 2009; Laird *et al*., 2010; Van Zweiten *et al.*, 2010; Peng *et al*., 2011).1.25 t/ha of Biochar performed best in improving the growth of cowpea at both locations especially at ikenne. This might be due to the fact the biochar is from organic source which not only helps to reduced the pH of the soil to make nutrients more available for crop growth but also help release organic matter which is rich in nutrients into the soil, this hypothesis is supported by the findings of Chan *et al.* (2007); Novak *et al*. (2009); Van Zweiten *et al*. (2010); and Peng *et al*. (2011)..

The result is supported by Carter *et al.* (2013) who observed an increase in plant height in plots with biochar application. The result is however in contrast with the findings of Boukar (2015), who found out that biochar application, had no effect on plant height. From literatures, different authors found out that biochar application leads to improved cation exchange capacity, reduces nitrogen leaching. Steiner *et al*. (2008) established that biochar can help in increasing nitrogen use efficiency and Rondon *et al*. (2007) observed that biochar application improved biological nitrogen fixation.

The non-significant effect observed in number of pods and pod weight of cowpea might be due to other reason as it has been reported Brandstaka *et al*., (2010) that biochar application enhances soil fertility and crop yields and Yilangai *et al* .(2014) who reported that biochar application increases the fruit yield of tomato.

5. CONCLUSION

It can be concluded statistically, based on the outcome of this study that 1.25 t/ha of biochar has a very good potential at increasing the soil physiochemical properties, growth and yield of cowpea as it was observed to perform best as compared to other rates of application.

6. RECOMMENDATION

From the results observed in this study, it is recommended that Biochar at the rate of 1.25 t/ha should be adopted as an organic substitute for chemical lime as it was observed in this current research to not only improve soil pH but also make nutrient available for good crop performance. Further research is however recommended with more focus on more rates of application.

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