EFFECT OF OIL PALM REFUSE BUNCH ASH ON THE GROWTH AND YIELD OF CUCUMBER (*Cucumis sativus* L.) VARIETIES IN HUMID ULTISOLS PEDOENVIRONMENT†

[EFECTO DE LA CENIZA DE DESECHOS DE PALMA ACEITERA EN EL CRECIMIENTO Y RENDIMIENTO DE VARIEDADES DE PEPINO (*Cucumis sativus* L.) EN PEDOAMBIENTES ULTISOLES HÚMEDOS]

Kolawole E. Law-Ogbomo* and Sunday A. Ogedegbe

Department of Crop Science, Faculty of Agriculture, University of Benin, PMB 1154, Benin City, Nigeria. Email:edomwonyi.law-ogbomo@uniben.edu
**Corresponding author*

SUMMARY

Field experiment was conducted in the late growing season (August- November) of 2016 and 2017 at the experimental Farm of the Faculty of Agriculture, University of Benin, to determine the effect of oil palm refuse bunch ash (OPRBA) application on the growth and yield of three cucumber varieties. The experiment was laid out as a 3×5 split-plot arrangement fitted into a randomized complete block design and replicated three times. The main plots consisted of three cucumber varieties (Poinsett, Supermarketer and Marketer), while the sub-plots were made up of five levels (0, 2, 4, 6 and 8 t ha^{-1}) of OPRBA. Data were collected on growth variables (vine length, vine girth, number of leaves/plant, number of branches per plant and leaf area index) at 50 % flowering day while yield components (fruit length, fruit girth, number of fruits per plant, fruit weight and fruit yield) were assessed at harvesting. The results showed that Poinsett and Supermarketer were significantly ($p<0.05$) higher in growth variables than Marketer. The application of the OPRBA significantly ($p<0.05$) enhanced the growth and yield of cucumber and fruit yield was maximized at 6 t ha^{-1} (15.05 t ha^{-1}). The highest fruit yield (17.80 t ha^{-1}) recorded by Supermarketer treated with 8 t ha^{-1} OPRBA but comparable to Supermarketer treated with OPRBA of 6 t ha^{-1} and Poinsett grown plots treated with OPRBA at 6 and 8 t ha^{-1}. Conclusively, the application of OPRBA at 6 t ha^{-1}and Supermarketer variety is recommended for cucumber farmers in the humid ultisols environment.

Keywords: Fruit yield; leaf area index; number of leaves; OPRBA; varieties.

RESUMEN

El experimento de campo se llevó a cabo a fines de la temporada de crecimiento (Agosto – Noviembre) de 2016 y 2017 en la granja experimental de la Facultad de Agricultura de la Universidad de Benin, para determinar el efecto de la aplicación de la ceniza de la pila de aceite de palma (OPRBA) en el crecimiento y Rendimiento de tres variedades de pepino. El experimento se presentó como una disposición de parcelas divididas de 3x5 en un diseño de bloques completos al azar y se replicó tres veces. La parcela principal consistía en tres variedades de pepino (Poinsett, Supermarketer y Marketer), mientras que las subparcelas estaban compuestas por cinco niveles (0, 2, 4, 6 y 8 t ha^{-1}) de OPRBA. Los datos se recopilaron sobre las variables de crecimiento (longitud de la vid, crecimiento de la vid, número de hojas/ planta número de ramas por planta e índice de área de abandono) al 50% del día de floración, mientras que los componentes de rendimiento (longitud de fruto, nacimiento de fruto, número de fruto por planta, peso del fruto y el rendimiento de la fruta) se evaluaron en la cosecha. Los resultados mostraron que Poinsett y el Supermarketer fueron significativamente más altos ($p<0,55$) en las variables de crecimiento que el Marketer. La aplicación de la OPRBA significativamente ($p<0.55$) mejoró el crecimiento y el rendimiento del pepino y el rendimiento de la fruta se maximiza a 6 t ha^{-1} (15.05 t ha^{-1}). El mayor rendimiento de fruta (17.80 t ha^{-1}) registrado en el Supermarketer tratado con 8 t ha^{-1} OPRBA, pero comparable al Supermarketer tratado con OPRBA de 6 t ha^{-1}y en la parcela cultivada con Poinsett tratada con OPRBA a 6 y 8 t ha^{-1}. En conclusión, la aplicación de OPRBA 6 t ha^{-1}variedad de supermercado se recomienda para los encuadernadores de pepinos en el ambiente de ultisoles húmedos.

Palabras clave: Rendimiento de fruta; índice de área foliar; número de hojas; OPRBA; variedades.

†*Submitted December 20, 2018 – Accepted April 25, 2019.*
ISSN: 1870-0462

INTRODUCTION

Cucumber (*Cucumis sativus L.*) is an important vegetable and one of the most popular members of the Curcibitaceae family (Thoa, 1998). Its production in Nigeria is rapidly gaining popularity due to high medicinal and nutritive values, as well as being a chief ingredient in the preparation of salad and other Nigerian dishes. It is also consumed raw as a snack by many Nigerians, thus the demand for this fruit is high (Eifediyi and Remison, 2010).

In the bid to bridge the gap between the supply and demand of cucumber, many farmers have resorted to the use of fertilizers (both inorganic and organic) to enhance soil fertility and nutrient uptake by plants, thus leading to greater yields (Ayoola and Adeniran, 2006). However, the use of inorganic fertilizer has not been completely beneficial under intensive agriculture because of its high cost. It is also associated with reduced crop yields, soil degradation, nutrient imbalance and acidity (Obi and Ebo, 1995). Organic fertilizers have the potential to increase physical and biological storage mechanisms of soils through high organic matter content that improves soil structure, aeration, moisture holding capacity and water infiltration (Ojeniyi *et al*., 2009). In addition, increased organic matter content of the soil provides a source of food and energy for a myriad of beneficial soil macro and microorganisms (Ojeniyi, 2000).

Oil palm refuse bunch ash (OPRBA) is an organic fertilizer, environmentally friendly product that is 40 % cheaper than inorganic fertilizer and used commercially for neutralizing acidic soil effectively (Agriscape, 2007). Its supplemented soil nutrients especially potassium and furnished liming materials for increased soil fertility, pH and nutrient uptake by maize (Awodun *et al*., 2007).

There is dearth of literature on the effect of oil palm refuse bunch ash on yields of crops even though few authors who worked with OPRBA reported high yields. Safo *et al*. (1997) found that oil palm refuse bunch ash application increases grain yield of cowpea as well as soil organic matter. Ojeniyi *et al.* (2009) observed high root yield of cassava with oil palm refuse bunch ash application. This study was hence carried out to evaluate the effect of OPRBA on the growth and yield of cucumber (*Cucumis sativus* L.) varieties in humid ultisols pedoenvironment.

MATERIALS AND METHODS

Study site

Field experiment was conducted during the late growing season (August- November) of 2016 and 2017 at the Experimental Farm of the Department of Crop Science, Faculty of Agriculture, University of Benin, Benin City in the rain forest zone of Nigeria. The site is situated at Latitude 6° 44′ N and Longitude 5° 40′ E. The area is characterized by a bimodal rainfall pattern with a long rainy season which commences in March and the short rainy season that extends from September to late October after a dry spell in August (EADP, 1995). Prior to planting, the site was dominated by *Mimosa pudica* and *Panicum maximum* weeds that fallowed the soil after the previous growing season.

Soil sample collection, organic fertilizers and laboratory analysis

Prior to sowing, soil samples were collected from the experimental site at a depth of 0-15 cm using auger and bulked together to form a composite sample for the physical and chemical analysis. The composite soil sample was air-dried and sieved through a 2 mm sieve before analysis. Similarly, OPRBA was sub-sampled and analyzed for its chemical composition before application to the plots.

Particle size distribution was determined by the hydrometer Method (Day, 1965), soil pH 1:1 (soil to water ratio) was determined with a digital glass electrode pH meter. Organic carbon was determined by the wet dichromate acid oxidation Method (Page, 1982). Total nitrogen was determined by Micro-Kjedahl Method (Bremmer and Mulvancy, 1982). While available phosphorus was extracted using calcium chloride extraction Method (Houba *et al.*, 2000) and exchangeable bases (Ca, K, Mg and Na) were extracted using 1N ammonium acetate solution at pH 7.0. Calcium and magnesium contents were determined volumetrically by ethylenediaminetetra-acetic acid (EDTA) titration procedure (Black, 1965) whereas potassium and sodium were by flame photometer. Exchangeable acidity was ascertained by titration Method (Anderson and Ingram, 1993). The OPRBA was analyzed for its pH, organic carbon, total nitrogen, phosphorus, potassium, calcium, magnesium and sodium using similar procedures as for soil sample.

Experimental design and treatments

The experiment was laid out as a 3×5 split-plot arrangement fitted into a randomized complete block design giving rise to 15 treatment combinations with three replicates. The main plots were cucumber varieties (Poinsett, Supermarketer and Marketer) while the sub-plots were five OPRBA rates (0, 2, 4, 6, 8 t ha^{-1}). Each plot had a dimension of 2.5 x 3.5m with 0.5m between plots and 1m between blocks.

Planting and agronomic practices

Prior to seed sowing, previous fallow vegetation comprising mainly *Mimosa pudica* and *Panicum maximum* was cleared manually and the land was tilled and marked out according to experimental design. Sowing of seeds commenced in early October 2016 with 3 seeds per stand at a depth of 3cm using a spacing of 70 x 90 cm and emergence rate was closely monitored. Supplying of seeds and thinning to one seedling per stand was done 8 days later. Application of OPRBA was carried out two weeks after sowing according to the design of the experiment. Watering was done daily by supplying and amounts (250 ml per plant) to plots with watering can. Weeding was done first at two weeks after sowing and subsequently as required using hoe. Cucumber plants were staked before flowering at 5 weeks after sowing. Harvesting commenced at 7 weeks after sowing and was done continuously on a daily until 10 weeks after sowing.

Data Collection

Growth variables were assessed at 50% flowering day on three randomly selected plants from the inner row of each plot. Cucumber vine length was measured with a flexible tape rule from the ground level to the tip of the three randomly selected plants and the mean estimated. Number of leaves and branches was assessed by visual count of fully expanded green leaves and developed branches of the three randomly selected plants and the means estimated. Leaf breadth and length for randomly selected leaves from the three sampled plants were measured using a ruler. The mean was calculated and used to estimate the leaf area based on the formula Blanco and Folegatti, 2003):

$$LA = 0.889(LW) + 2.7 \times \text{number of leaves}$$

Where, LA = Leaf area, L = length, W= width

From the leaf area, leaf area index (LAI) was computed as Remison and Lucas (1982):

$$LAI = \frac{Leaf\ area}{Land\ area}$$

Where, LAI = leaf area index

Vine girth was measured by rolling a twine around the circumference before transcribing from a ruler.
Yield variables evaluated were fruit length measured with a flexible tape rule, number of fruits per plant that was counted during harvesting, fruit girth measured using a flexible tape and fruits weighed using a digital weighing balance. Fruit yield (t ha^{-1}) was calculated using the formula:

Fruit yield (t ha^{-1}) =

$$(\text{weight of fruit} \times \text{number of fruits per plant} \times 10000) \div 0.63$$

Statistical Analysis

Year-wise data were analyzed using analysis of variance, followed by combined analysis for the two years to determine the significant effect of OPRBA rates and variety and their interactions on measured parameters with GENSTAT statistical package (GENSTAT, 2005). Differences among treatment means were separated using the Least Significance Difference (LSD) test at $P<0.05$.

RESULTS

Pre-cropping physical and chemical properties of soil and chemical composition of OPRBA

The soil was texturally sandy loam. The reaction of the experimental site was moderately acidic with low organic carbon, total nitrogen, available phosphorus and exchangeable cations (K^+, Ca^{2+}, and Mg^{2+}) in both years of study (Table 1). The pH of the oil palm refuse bunch ash was alkaline in nature. Similarly, the OPRBA showed the presence of potassium, calcium, magnesium, and total nitrogen in appreciable amounts (Table 1).

Growth variables of cucumber

The results of the effects of variety and OPRBA on plant growth variables of cucumber are presented in Tables 2 and 3. Longer vines were observed in Poinsett and Supermarketer than in Marketer. Only plants treated with 6 and 8 t ha^{-1} of OPRBA were significantly ($p<0.05$) longer than non-OPRBA treated plants. Similar results were for vine girth. The longest vines (74 cm) were observed in Supermarketer treated with OPRBA at 8 t ha^{-1} (Table 3). Supermarketer variety had the thickest vine that was significantly thicker than Poinsett and Marketer. The thickest vines (4.40cm) were observed on Supermarketer treated plants with 6 t ha^{-1} OPRBA (Table 3).

Variety had no significant effect on number of branches per plant. Only plants treated with 8 t ha^{-1} of OPRBA had significantly higher number of branches per plant than non-OPRBA treated plants. Supermarketer treated with OPRBA at 8 t ha^{-1} exhibited the highest number of branches (9.57) (Table 3).

Table 1. Pre-cropping physical and chemical properties of the soil and chemical composition of oil palm refuse bunch ash (OPRBA)

Parameter	Soil		OPRBA
	2016	2017	
Sand (g kg^{-1})	892.00	887.00	N/A
Silt (g kg^{-1})	53.00	65.00	N/A
Clay (g kg^{-1})	55.00	48.00	N/A
Textural class	Sandy loam	Sandy loam	N/A
pH (H_2O)	5.65	5.60	8.40
Organic Carbon (g kg^{-1})	15.70	12.03	58.20
Total Nitrogen (g kg^{-1})	0.83	0.85	0.50
Available Phosphorus (mg kg^{-1})	6.02	7.24	238.00
Exchangeable cations (cmol kg^{-1})			
Calcium	0.78	0.81	138.20
Magnesium	0.30	0.25	120.40
Potassium	0.15	0.22	334.50
Sodium	0.12	0.14	36.80
Aluminum	0.16	1.25	
Hydrogen	0.53	0.26	
Effective cation exchange capacity (cmol kg^{-1})	1.96	2.93	

Similar number of leaves observed on Poinsett and Supermarketer was significantly more than number of leaves of marketer variety (Table 2). All plants with OPRBA treatments had significantly a greater number of leaves per plant than non-OPRBA treated plants (Table 3). Supermarketer and Poinsett varieties treated with OPRBA at 8 t ha^{-1} had the highest number of leaves with 24.72 and 24.67, respectively. Highest leaf area index was observed on Poinsett variety (Table 2). Plants treated with 8 t ha^{-1} of OPRBA had higher ($p<0.05$) leaf area index than non-OPRBA plants (Table 2).

Yield and attributes of cucumber

Effects of variety and OPRBA on yield and yield attributes of cucumber are presented in Tables 4 and 5. Supermarketer had the longest fruits. Only plants treated with 4, 6 and 8 t ha^{-1} of OPRBA produced significantly longer fruits than non-OPRBA treated plants. The largest fruits (18.06 cm), widest fruit girth (16.12 cm) and heaviest fruit yield (17.80 t ha^{-1}) were obtained from Supermarketer variety that received 8 t ha^{-1} of OPRBA (Table 5). All OPRBA treated plants had fruits that were significantly thicker than non-OPRBA plants.

Number of fruits produced per plants was similar amongst varieties. Plants treated with 6 and 8 t ha^{-1} of OPRBA had higher number of fruits than non-OPRBA treated plants. Higher fruit yield was obtained in Poinsett and Supermarketer than marketer. The fruit yield varied between 11.74 for non-OPRBA treated plants and 15.58 t ha^{-1} for plants with OPRBA applied at 8 t ha^{-1} (Table 4).

DISCUSSION

Cucumber varieties evaluated in this study had different growth and yield characteristics. Poinsett and supermarketer were to the marketer variety with good vegetative growth and higher fruit yields. The variation in the performance of cucumber varieties has been widely documented by Manyvong (1997), who attributed this phenomenon to genetic composition or environmental factors. The findings in this work align with the reports of Eifediyi and Reminson (2009) that showed significant differences among cucumber varieties in growth variables.

Table 2. Growth of cucumber varieties as influenced by OPRBA at 50 % flowering day.

Treatment	Vine length (cm)		Vine girth (cm)		No. of branches plant^{-1}		No. of leaves plant^{-1}		Leaf area index	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Variety										
Marketer	41.10^{b}	67.07^{c}	2.88^{b}	4.27^{a}	2.27^{b}	12.35	16.33b	18.38^{a}	1.13^{b}	0.50^{b}
Poinsett	56.80^{a}	67.59^{ab}	3.13^{ab}	3.94^{b}	3.93^{a}	11.32	23.93^{a}	17.07^{b}	3.27^{a}	4.90^{a}
Supermarketer	56.50^{a}	69.26^{a}	3.35^{a}	4.35^{a}	3.80^{a}	12.65	22.80^{ab}	18.30^{ab}	2.72^{a}	0.70^{b}
LSD (0.05) variety	10.930	1.496	0.475	0.290	1.126	ns	5.452	1.273	1.238	2.550
OPRBA (t ha^{-1})										
0	39.00^{c}	65.28^{c}	2.61^{b}	4.07^{b}	2.11^{c}	11.73	15.22^{c}	15.63^{c}	1.08^{d}	0.40^{b}
2	49.00^{bc}	67.20^{bc}	2.90^{d}	3.93^{b}	2.89^{bc}	11.71	20.67^{b}	17.93^{b}	1.93^{c}	0.50^{b}
4	48.60^{bc}	67.21^{bc}	3.93^{a}	4.23^{a}	3.11^{b}	12.25	20.56^{b}	16.91^{bc}	2.08^{bc}	0.50^{b}
6	50.00^{b}	68.52^{b}	3.18^{c}	4.12^{a}	4.00^{a}	11.02	21.78^{b}	19.57^{a}	2.66^{b}	0.70^{b}
8	64.80^{a}	71.67^{a}	3.63^{b}	4.57^{a}	4.56^{a}	13.83	27.22^{a}	19.54^{a}	4.15^{a}	8.10^{a}
LSD (0.05) OPRBA	10.222	1.931	0.178	0.375	0.920	ns	3.945	1.643	0.652	3.290
Interaction	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

ns - not significant at 0.05 level of probability
Means followed by the same letter(s) within each column are statistically not significant at 0.05 level of probability

Table 3. Interactive effect of cucumber varieties and levels of oil palm refuse bunch ash application on growth at 50 % flowering.

	Vine length (cm)					Vine girth (cm)			
OPRBA	Variety				OPRBA	Variety			
	Marketer	Poinsett	Supermarketer	Mean		Marketer	Poinsett	Supermarketer	Mean
0	45.36^{e}	53.45^{d}	57.60^{c}	52.14	0	3.17^{d}	3.42^{c}	3.43^{c}	3.34
2	53.85^{d}	60.19^{c}	60.33^{c}	58.12	2	3.27^{cd}	3.37^{c}	3.62^{bc}	3.42
4	53.47^{d}	60.06^{c}	60.12^{c}	57.88	4	3.35^{cd}	3.60^{bc}	3.80^{ab}	3.58
6	57.48^{c}	66.95^{b}	62.35^{c}	62.26	6	3.55^{bc}	3.42^{c}	3.98^{ab}	3.65
8	60.37^{c}	70.28^{ab}	74.00^{a}	68.22	8	4.05^{a}	3.85^{b}	4.40^{a}	4.10
Mean	54.11	62.18	62.88		Mean	3.48	3.53	3.85	
LSD (0.05) Variety				4.156	LSD (0.05) Variety				0.199
LSD (0.05) OPRBA				5.365	LSD (0.05) OPRBA				0.257
LSD (0.05) Interaction				4.156	LSD (0.05) Interaction				0.363

	Number of leaves plant^{-1}					Number of branches plant^{-1}			
OPRBA	Variety				OPRBA	Variety			
	Marketer	Poinsett	Supermarketer	Mean		Marketer	Poinsett	Supermarketer	Mean
0	13.36^{d}	15.92^{cd}	17.00^{b}	15.43	0	6.50^{d}	6.72^{cd}	7.54^{c}	6.92
2	16.95^{bc}	19.95^{bc}	21.00^{ab}	19.30	2	7.12^{c}	7.37^{c}	7.40^{c}	7.30
4	17.74^{bc}	18.98^{bc}	19.48^{bc}	18.73	4	7.40^{c}	7.35^{c}	8.29^{b}	7.68
6	18.47^{bc}	23.00^{ab}	20.54^{b}	20.67	6	6.80^{d}	7.41^{b}	8.31^{b}	7.51
8	20.75^{ab}	24.67^{ab}	24.72^{a}	23.38	8	8.71^{b}	9.49^{a}	9.57^{a}	9.19
Mean	17.45	20.50	20.55		Mean	7.31	7.63	8.22	
LSD (0.05) Variety				1.856	LSD (0.05) Variety				ns
LSD (0.05) OPRBA				2.396	LSD (0.05) OPRBA				1.110
LSD (0.05) Interaction				4.151	LSD (0.05) Interaction				1.923

ns - not significant at 0.05 level of probability.
Means with the same superscript do not differ significantly at 0.05 level of probability.

Table 4. Fruit yield and its components of cucumber varieties as influenced by OPRBA.

Treatment	Fruit length (cm)		Fruit girth (cm)		Number of fruits plant^{-1}		Fruit yield (t ha^{-1})	
	2016	2017	2016	2017	2016	2017	2016	2017
Variety								
Marketer	16.20	15.44^{a}	13.39	15.57^{a}	3.17	3.93^{b}	9.47^{b}	14.53^{b}
Poinsett	16.87	14.61^{b}	15.93	13.95^{b}	4.17	3.24^{c}	14.16^{a}	13.28^{c}
Supermarketer	18.11	15.25^{a}	15.32	15.22^{a}	4.13	4.35^{a}	13.57^{a}	16.32^{a}
LSD (0.05) variety	ns	0.662	ns	0.390	ns	0.300	3.807	1.158
OPRBA (t ha^{-1})								
0	15.90^{b}	14.25^{b}	14.76^{b}	13.58^{c}	3.67^{b}	3.28^{c}	9.84^{c}	13.56^{b}
2	16.36^{b}	14.63^{b}	14.90^{b}	14.26^{b}	3.33^{b}	3.30^{c}	9.93^{c}	14.56^{b}
4	16.69^{b}	15.32^{a}	15.34^{b}	14.65^{b}	3.27^{b}	3.65^{c}	10.28^{c}	14.95^{b}
6	17.93^{a}	15.71^{a}	16.34^{a}	15.04^{a}	4.17^{a}	4.18^{b}	15.10^{b}	15.00^{ab}
8	18.52^{a}	15.60^{a}	16.38^{a}	15.38^{a}	4.67^{a}	4.78^{a}	16.84^{a}	15.58^{a}
LSD (0.05) OPRBA	0.859	0.855	0.823	0.503	0.559	0.387	0.652	1.494
Interaction	ns	ns	ns	ns	ns	ns	ns	ns

ns - not significant at 0.05 level of probability.
Means followed by the same letter(s) within each column are statistically not significant at 0.05 level of probability.

Table 5. Interactive effect of cucumber varieties and levels of oil palm refuse bunch ash application on fruit components.

OPRBA	Fruit length (cm)				Fruit girth (cm)				Fruit yield (t ha^{-1})			
	Variety				Variety				Variety			
	Marketer	Poinsett	Supermarketer	Mean	Marketer	Poinsett	Supermarketer	Mean	Marketer	Poinsett	Supermarketer	Mean
0	14.9^{c}	15.1^{c}	15.1^{c}	15.0	14.2^{bc}	14.2^{bc}	14.0^{c}	14.1	9.4^{e}	12.9^{c}	12.7^{c}	11.7
2	15.3^{c}	15.4^{c}	15.6^{c}	15.4	14.7^{bc}	14.6^{bc}	14.3^{c}	14.5	1.7^{a}	10.9^{d}	13.6^{c}	12.1
4	16.0^{b}	15.6^{c}	16.2^{bc}	16.0	15.0^{b}	14.9^{bc}	15.0^{b}	15.0	12.3^{c}	12.9^{c}	12.5^{c}	12.6
6	16.3^{b}	16.6^{b}	17.4^{ab}	16.8	15.4^{ab}	15.8^{ab}	15.7^{ab}	15.6	12.7^{c}	16.8^{ab}	15.5^{b}	15.0
8	16.2^{b}	16.8^{b}	18.0^{a}	17.0	15.7^{ab}	15.6^{ab}	16.2^{a}	15.8	14.2^{b}	16.5^{ab}	17.8^{a}	16.2
Mean	15.8	15.9	16.4		15.0	15.0	15.0		12.0	14.0	14.4	
LSD (0.05)				0.46				ns				0.64
LSD (0.05)				0.59				0.53				0.83
LSD (0.05) Interaction				1.02				0.92				1.43

ns - not significant at 0.05 level of probability.
Means with the same superscript do not differ significantly at 0.05 level of probability.

The OPBRA on analysis indicated that it contained plant nutrients and organic carbon that may can be used as nutrient supplements to improve nutrient uptake by plants. In addition, its suitability as a liming material was manifested with a high pH value. This agrees with the reports of Hasnol *et al.* (2005) and Adjei-Nsiah (2012) that oil palm refuse bunch ash supplied organic matter, nitrogen, phosphorus, calcium and magnesium to the soil. Hence, Awodun *et al.* (2007) suggested OPBRA as an effective source of N, P, K, Ca and Mg and effective liming material for maize for maize production under acidic soil condition.

Vine length, number of leaves, leaf area index including number of branches is among the most important growth variables directly linked with the potential productivity of plants (Saeed *et al.*, 2001). The results from the current study showed that there was a corresponding increase in growth variables of the three evaluated cucumber varieties with increasing OPRBA rates. Higher vegetative growth variables observed in OPRBA treated plants as compared to non-OPRBA treated plants suggests that organic matter, N, P, K, Ca and other nutrients where added to the soil which enabled the pronounced differences in growth characteristics of cucumber.

At the application rate of 8 t ha^{-1}, vine length, number of branches per plant, number of leaves per plant and leaf area index was significantly higher. This suggests that amongst the OPRBA application rates, 8 t/ha improved better the vegetative growth of the three evaluated cucumber varieties. This is in consonant with the works of Adikiru *et al.* (2016) that showed that OPRBA application rate of 8 t ha^{-1} significantly increased maize height by 36.6%.

Furthermore, fruit yields of cucumber obtained with OPRBA application rate of 8t/ha were the highest recorded. This may be ascribed to the high vegetative attributes at that application rate which is in accordance with the opinion emphasized by Saeed *et al.* (2001) that an optimum plant height, number and leaf area of maize were positively correlated with maize grain yield. Results from the present study showed that OPRBA significantly increased fruit length, fruit girth, fruit size and fruit yield at application rates of 6 and 8 t ha^{-1}. This infers that OPRBA contained the necessary nutrient elements for optimum productivity of cucumber.

CONCLUSION

The study showed that OPRBA application improved vegetative growth and increased yield of cucumber. Supermarketer variety and OPRBA application rate of 8 t ha^{-1} produced the highest fruit yield. Our study suggests that farmers in the oil palm growing area of Nigeria where there is an abundant quantity of oil palm refuse bunches should be encouraged to utilize OPRBA for soil fertility which could improve food production in Nigeria. In subsequent studies, higher application rates of OPRBA will be evaluated with cucumber varieties to ascertain the concentration of plant nutrient at which fruit yield will be maximized.

REFERENCES

Adikuru, N.C., Okafor, S.U., Anyanwu, C.P., Ihem, E.E. 2016. Comparative study of lime and palm bunch ash effects on soil pH and maize performance in Owerri, Southeastern Nigeria. Nigerian Journal of Agriculture, Food and Environment. 12(2):166-170.

Adjei-Nsiah, S. 2012. Response of maize (*Zea mays* l.) to different rates of palm bunch ash application in the semi-deciduous forest agro-ecological zone of Ghana. Applied and Environmental Soil Science. 6:1-5. dx.doi.org/10.1155/2012/870948

Agriscape 2007: http:// forum. Agriscape.com/ thread/1720015/1.

Anderson, F. and Ingram, I. 1993. Tropical soil biology and fertility. A handbook of Methods. 2nd Edition CAB International p.231.

Awodun M.A, Ojeniji S.O, Adeboye A, Adedina S. A. 2007. Effect of oil palm bunch refuse ash on soil and plant nutrient composition on yield of maize. American Eurasian Journal of Sustainable Agriculture, 3:50- 54. http://www.aensiweb.net/AENSIWEB/aejsa/aejsa/2007/50-54.pdf

Ayoola, O.T. and Adeniran, O.N. 2006. Influence of poultry manure and NPK fertilizer on yield and yield components of crops under different cropping systems in South West Nigeria. African Journal of Biotechnology. 5:1336-1392. https://www.ajol.info/index.php/ajb/article/view/43121/26666

Black, C. A. 1965. Methods of soil analysis. American Society of Agronomy. Monograph Madison, Wisconsin

Bremmer, J.M. and Mulvancy, C.S. 1982. Total nitrogen. In: Page, A.L. (ed) Methods of soil analysis. Part 2. Chemical and microbial properties, 2nd Agronomy Series Madison, USA p.9

Day, P.R. 1965. Particle fractionating and particle size analysis. In: Methods of soil analysis. Part 1. Agronomy, 9: 549-552.

EDAP (Edo State Agricultural Development Project) 1995. Edo State agricultural Development Project Annual Report 1995.

Eifediyi, E.K and Remison, S.U 2009. The effects of inorganic fertilizer on the yield of two varieties of cucumber (*Cucumis sativus* L.). Report and Opinion. 1(5):74-77. www.sciencepub.net/report/report0105/report0105.pdf#page=77

Eifediyi, E.K and Remison, S.U. 2010. Growth and yield of cucumber (*Cucumis sativus* L.) as influenced by farm yard manure and inorganic fertilizers. Plant Breeding and Crop Science. 2(7):216-222. https://academicjournals.org/journal/JPBCS/article-full-text-pdf/61B16B33756

Flavio, F.F. and Folegatti, M.V. 2003. A new method for estimating the leaf area index of cucumber and tomato plants. Horticultura Basileira. 21(4):666-669. http://cms.horticulturabrasileira.com.br/index.php?option=com_content&view=article&id=5&Itemid=121&artigo=http://cms.horticul

turabrasileira.com.br/images/stories/21_4/200321418.pdf

GENSTAT. 2005. Genstat release 8.1. Statistical Software. VSN International Ltd, Rothamsted UK

Hasnol, O., Ahmed, T.M., Mohd, T.D. 2005. Bunch ash: an efficient and cost-effective K fertilizer source for mature oil palm on peat under high rainfall environment, Malaysian Palm Oil Board, Ministry of Plantation Industries and Commodities, ISSN 1511-7871.

Houba, V. J. G., Temminghoff, E. M. J., Gaikhorst, G. A. and Van-Vark, W. 2000. Soil analysis procedures using 0.01 $CaCl_2$ as extraction reagent. Community Soil and Plant Analysis, 31: 1299-1396

Manyvong, V. 1997. Cucumber varietal trial. ARC/AVRDC Training workshop, Thailand. http://avrdc_arc.org.

Obi, M.E and Ebo, P.O. 1995. The effect of different management practices on the soil physical properties and maize production in severely degraded soil in /Southern Nigeria. Biological Resource Technology. 51:117-123.

Ojeniyi, S.O. 2000. Effect of goat manure on soil nutrients and okra yield in a rain forest area of Nigeria. Applied Tropical Agriculture, 5:20-23.

Ojeniyi, S.O., Ezekiel, P.O., Asawalam, D.O., Awo, A.O., Odedina S.A., Odedina, J.N. 2009. Root growth and NPK status of cassava as influenced by oil palm bunch ash. African Journal of Biotechnology. 8(18):4407-4412. https://www.ajol.info/index.php/ajb/article/viewFile/62392/50363

Page, A. L. 1982. Methods of soil analysis. Agronomy No 9. Part 2 American Society of Agronomy, Madison, W1.

Remison, S. and Lucas, E. 1982. Effects of planting density on leaf area and productivity of two maize cultivars in Nigeria. Experimental Agriculture. *18*(1):93-100. doi:10.1017/S0014479700013478

Saeed, I. M. Abbasi, K., Kazim, M. 2001. Response of maize (*Zea mays*) to nitrogen and phosphorus fertlization under agro-climatic condition of Rawalokot Azad Jammu and kasmir. Pakistan Journal of Biological Science. 4:949-952.

Safo, E.Y. Aukomah, A.B., Brandford-Arthur, J. 1997. Palm bunch ash effects on growth of cowpea and the characteristics of a Ghanian soils. African Crop Science. 5(3):303-308. dx.doi.org/10.4314/acsj.v5i3.27849

Thoa, D.K. 1998. Cucumber seed multiplication and characterization. AVRDC/ARC Training Thailand.