EFFECT OF DIFFERENT RATES OF BREWER'S SPENT GRAIN (BSG) ON SOIL CHEMICAL PROPERTIES AND PERFORMANCE OF CUCUMBER (*Cucumissativus*) IN IGBARIAM, SOUTH-EASTERN NIGERIA.

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ABSTRACT

Effect of different rates of Brewer's Spent Grain (BSG) on some chemical properties of soil and performance of Cucumber (*Cucumis sativus*) was studied in the Teaching and Research Farm of the Faculty of Agriculture, Chukwuemeka Odumegwu Ojukwu University, Igbariam Campus, Anambra state, Nigeria. The experiment was laid out in Randomized Complete Block Design (RCBD) with five levels of treatments which consist of Control (No treatment), 4tha^{-1} Brewer's Spent Grain (BSG); 8 t ha^{-1} BSG, 4t ha^{-1} BSG + 200kg of NPK 20:10:10 and 8 t ha^{-1} BSG + 200kg of NPK 20:10:10.The treatments were replicated three times and data collected were analyzed following the Analysis of Variance (ANOVA) for Randomized Complete Block Design (RCBD) using GENSTAT Software Package, GENSTAT Edition 3 Release 7,2DE. Treatment means were separated with Least Significant Difference (LSD) at 5% level significance. Results obtained showed that there was significant($p=0.05$) difference among the different rates of Brewer's Spent Grain (BSG) on growth parameters of Cucumber(namely: number of leaves, vine length and Number of Branches); yield components and some chemical properties of soils of Igbariam. The value recorded for each of the different rates of Brewer's Spent Grain increased as the week after planting (WAP) increased. The highest values recorded at 8WAP where BSG was applied at the rate of 8t ha^{-1} are 29.6 (for number of leaves),72.3cm (for vine length) and 4.4 (for Number of branches. The highest value of leaf area (230cm^2) at 8WAP was obtained where BSG was applied at the rate of 4 t ha^{-1} +200kg NPK Fertilizer. The highest fruit weight (229.2g) as well as the highest values of Available Phosphorus (19.27mg kg^{-1}); Total Nitrogen (9 g kg^{-1}) and Organic Matter (11.3g kg^{-1}) were obtained at the treatment where brewer's Spent Grain was applied at the rate of 8t/ha. The study recommended 8t ha^{-1} of BSG and 4t ha^{-1} BSG + 200kg of the NPK Fertilizer for farmers in the agroecology.

Keywords: Brewer's Spent Grain (BSG), performance, soil chemical properties, Soil Fertility, Cucumber, .

INTRODUCTION

Cucumber (*Cucumis sativus* L.) a member of the Cucurbitaceae family is a native of Asia and Africa. Cucumber is subtropical crop requiring long warm days, grown worldwide and develops rapidly, with a shorter time from planting to harvest than for most crops (Wehmer and Guner 2004). Cucumber is grown all year round as out door vegetable in the tropics and as greenhouse vegetable In Northern Europe and North America (Mingbao, 1991.) According to Phu, (1998), Cucumber could be cultivated in the field during summer and winter in greenhouse using artificial heating. Jizhe(1993) also observed that Cucumber is a typical vegetable of warm temperate and cool tropical areas that can be cultivated at any time of the year. Cucumber is cultivated in most part of Northern Nigeria and some parts of Eastern Nigeria by peasant farmers who lack information on some of important cultural practices. This has resulted in very low yield and the production of poor quality fruits (Ekwu *et al.*, 2007).Anderson and Smith(2005) reported that, Cucumber is an excellent source of nutrients, vitamins and nutrients and their compositions are as follows: dietary fiber 1.5g, carbohydrates 11g, fat 0.3g, protein 2g, thiamine 0.31mg, riboflavin 0.02mg, calcium 14mg, iron 0.22mg, sodium 2mg, magnesium 12mg, zinc 0.17mg, copper 0.71mg, niacin 0.37mg, alpha carotene 8mg, vitamin C 3,2mg, vitamin E 0.03mg, vitamin K 7.2mg, phosphorus 21mg and potassium 136mg.However, the low fertility status of soils in Nigeria due to continuous cultivation that breaks up soil as well as rainfall which causes leaching and soil erosion thereby constituting serious constraints to cucumber production. Consequently, the productivity of cucumber as well as soil nutrients will be dependent on nutrient management system such as usage of inorganic or organic fertilizers.Brewer'sSpent grains (BSG) are the by-products of mashing process which is one of initial operations in brewery in order to solubilize the malt and cereal grains to ensure adequate extraction of the worth (water with extracted matter). Brewer's spent grains are of high nutritive value (*Tang et al.*, 2009) and contain cellulose, hemicelluloses, lignin and high protein content; others ,include vitamins, minerals and amino acids (Hulge, 1994; Mussatto *et al.*, 2006). High amounts of Calcium, magnesium silicon and phosphorus were reported to be

1038.5, 687.5, 242 and 1997 ppm, respectively (Khidzir *et al.*,2010). While other minerals such as Cobalt, Copper, Iron, Manganese, Potassium, Selenium, Sodium and Sulphur detected in BSG were of lower concentrations (Essien and Udotong, 2008).Attempts have been made in utilizing BSG in Animal feeds, production of Value-added Compounds (Xylitol, lactic acid, among others), microorganisms cultivation or as raw materials for extraction of compounds such as sugars, proteins, acids and antioxidants (Mussatto, 2009).

In recent time, researches have been carried out on the agronomic aspect of utilizing Brewer's spent grains as Organic Fertilizer as well as Soil amendment for improving soil productivity. The major objectiveof this study was to investigate the effect of different rates of Brewer's spent grain on soil chemical properties, growth and yield of Cucumber (*Cucumis sativus*) in Igbariam, South-eastern, Nigeria.

MATERIALS AND METHODS.

Site Location:

The field experiment was carried out at the Teaching and Research Farm of the Faculty of Agriculture, Chukwuemeka Odumegwu Ojukwu University, Igbariam Campus, Anambra State , Nigeria. Igbariam falls within the derived Savanna zone of Nigeria and is located at latitude $6^0 10^1$ and $6^0\ 30^1$N and longitude $6^0\ 40^1$ and $6^0$50'E (Anambra State Ministry of Science and Technology Meteorological . Station, Igbariam, Anambra State).The mean monthly temperature ranges between 23and 32^0C. Total annual rainfall ranges between 1800 and 2000mm. The weather data collected during the experimental period are shown in Table 1.Agriculture is the main socioeconomic activity of the area. Land preparation is by slash and burn technique.

Experimental Design and Treatment Allocation:

The experiment was laid out in a Randomized Complete Block Design (RCBD) with five treatment materials and three replications to give 15 plots. The area of experimental field was 14m x10m ($140m^2$) and the size of each plot measured 2m x 2m ($4m^2$) with a distance of 2m between the Blocks and 1m pathway between plots.Clearing of the experimental site was done, ploughed, harrowed and then partitioned into plots using hoe. The different rates of Brewer's spent grain and its combination with NPK 20- 10 -10 fertilizer were applied to their respective plots. The treatment consisted of five levels as listed below:-

4t /ha Brewer's Spent Grain (BSG)
8t/ha Brewer's Spent Grain
4t /ha BSG + 200kg NPK Fertilizer
8t / ha BSG + 200kg NPK Fertilizer
0t / ha – Control (No treatment)

The 4t /ha and 8t/ ha Brewer's Spent Grain were applied evenly on their respective plots and incorporated into the soil two weeksbefore sowing to allow for mineralization of nutrients in the organic fertilizer. The combination of brewer's Spent Grain at different rates with NPK (20:10:10) fertilizer was mixed thoroughly and applied using band method at two weeks after planting. Cucumber seeds (Marketer) obtained from Anambra State Agricultural Development Programme (ASADP), Awka were planted two per hole at the spacing of 50cm between rows and 40cm between plants at a depth of about 2cm. The seedlingswere thinned down to one plant per stand two weeks after germination; while empty stands were supplied.

Weeds were controlled manually using hoe at two weeks interval till harvest. Soil samples were collected from different locations after field preparation and bulked together and analyzed for the physical and chemical properties of the soil(Table 2). At the end of the study, soil samples were collected from respective plots at the depth 0 – 20cm and the following parameters were analyzed. Soil pH was determined by the glass electrodes pH meter (Maclean, 1982);Total Nitrogen was determined by the Macro Kjeldahl method (Bremner,1965); Available Phosphorous was determined using Bray 11 method (Page et al, 1982) and Organic Carbon by the Walkley and Black method (Nelson and Sommers, 1982); Particle size distribution was determined by the hydrometer method (Gee and Bauder, 1986). Six Cucumber plants were randomly selected from respective plots and tagged for the measurement of number of leaves, vine length, leaf area and number of branches at the 6^{th} and 8^{th} weeks after planting (WAP).Cucumber vine length was measured by using a flexible tape-rule. Number of leaves and number of branches were assessed by visual counting of the green leaves and branches. While leaf area was determined by the area destructive length x width method.Data collection on yield parameters of Cucumber plants such as number of fruits, fruit length, fruit girth and fruit weight was carried out at maturity stage.Number of fruits was done by visual counting; fruit length was measured by using a flexible tape. Fruit girth was measured by using a venier calliper. Fruit weight was determined using sensitive electronic scale.Data generated from the study were analyzed following the analysis of Variance (ANOVA) for Randomized Complete Block Design (RCBD)using GENSTAT software package; GENSTAT edition 3 released 7, 2 DE (GENSTAT,2007). Treatment means were separated with least significant difference (LSD) at 5% level significance.

Table 1. Weather Record for the Experimental Location (Igbariam) in 2015.

Month	Rainfall (mm)	Temperature (^{O}C)		Relative Humidity (%)
		Max	Mini	
January	0	33.7	20.3	54.5
February	64.1	734.7	24.9	77.1
March	116.5	34.7	24.9	76.8
April	14.5	32.7	23.8	78.3
May	30.3	33.1	24.0	81.0
June	164.4	31.0	23.4	85.3
July	370.7	31.0	23.2	89.4
August	122.4	30.0	23.5	89.0
September	413.9	30.8	23.2	88.9
October	217.6	31.6	23.5	86.8
November	68.3	33.4	23.8	81.0
December	0	34.1	20.1	50.4
Total	1855.4	390.8	278.6	938.4
Mean		23.6	23.2	78.2

Source: Anambra State Ministry of Science and Technology Met Station, Igbariam, Anambra State, Nigeria

Table 2. Physical and Chemical Properties of the Soil of the Experimental Site before Treatment Application:

Soil Properties	**Value**
Textural Class	L.s
Particle size(g kg^{-1})	
Clay	10
Silt	5
Fine Sand	46
Coarse sand	39
Chemical Characteristics	
pH (H_20)	6.2
pH (KCl)	5.3
Organic Carbon (g kg^{-1})	4.4
Total Nitrogen ((g kg^{-1}))	0.7
Available Phosphorus (mg kg^{-1})	16.79
Exchangeable base (cmol kg^{-1})	
Na^{+}	0.08
K^{+}	3.00
Mg^{2+}	0.80
CEC (**cmol kg^{-1}**)	9.20
Base Saturation (%)	44.24
Exchangeable acidity (cmol kg^{-1})	
$A1^{3+}$	-
$H^{+.}$	1.00

RESULT

The result of the experiment presented on Table 3; showed that, there was significant difference among the different rates of Brewer's Spent Grain used as regards the growth parameters of Cucumber (*Cucumus sativus*); Number of leaves, Vine length and Number of Branches at 6th and 8th weeks after Planting (WAP). The treatments had great effect on the growth parameters when compared with the control. The value recorded for each of the different rates of Brewer's Spent Grain increased as the week after planting increased. The highest performances of these growth parameters (number ofleaves, vine length and Number of Branches were recorded at 8 WAP where Brewer's Spent Grain at the rate of 8 t ha^{-1} was applied. The result on leaf area showed significant difference and the highest value was obtained where brewer's Spent Grain was applied at the rate of 4 t ha^{-1} in combination with 200kg / ha of NPK Fertilizer (20:10:10) at 8th weeks after planting. The lower values were obtained at the plots where Brewer's Spent Grain was applied at the rate of 4 t ha^{-1} but significantly (P = 0.05) better than Control. The order of increase in Number of leaves, vine length and Number of Branches of Cucumber at 6th and 8th WAP was BSG 8 t ha^{-1}> BSG 4t /ha+ F > BSG 8t ha^{-1}+F > BSG 4 t ha^{-1}> C0 ; while that of leaf area was BSG 4 t ha^{-1} + F > BSG 8 t ha^{-1}> BSG 8 t ha^{-1}+ F > BSG 4 t ha^{-1}> CO.

Table. 3 Effect of different rates of Brewer's Spent Grain on the growth parameters of Cucumber (*Cucumis sativus*).

	Number of leaves WAP		Vine Length (Cm) WAP		Leaf Area ($Cm^{2)}$ WAP		Number of Branches WAP	
Treatment.	6	8	6	8	6	8	6	8
CO	4.6	8.5	4.6	10.4	46	78.8	0.8	1.4
BSG 4t/ha	9.8	22.1	31.0	43.3	148.1	157.9	1.9	3.2
BSG 8t/ha	21.2	29.6	49.2	72.3	188.2	206.7	3.8	4.4
BSG 4t/ha + F	16.4	28.9	48.3	61.6	20.4	230.0	3.1	4.0
BSG8t/ha + F	15.6	22.3	38.9	53.9	172.3	202.1	2.1	3.1
LSD 0.05	0.26	0.42	2.54	1.80	20.04	20.18	0.09	0.11

Co–Control (No treatment) BSG –Brewer's Spent Grain ; F –NPK Fertilizer (20:10 :10)WAP – weeks after planting; LSD – least significant difference.

The results on yield components of Cucumber (Table. 4) showed that, the treatments BSG 4t ha^{-1}; BSG 8t ha^{-1}; BSG 4t ha^{-1} +F and BSG 8t ha^{-1} +F were at par but significantly(P =0.05) better than the Control. The highest performances on the yield components as regards Number of fruit, fruit length, fruit girth and fruit weight were obtained at the treatment BSG 8t /ha. The order of increase of fruit length, fruit girth and fruit weight was BSG 8t ha^{-1}> BSG 4t ha^{-1}> BSG 8t ha^{-1} + F > BSG 4t ha^{-1} + F > Co.

Table. 4 Effect of different rates of Brewer's Spent Grain on Yield Components of Cucumber (*Cucumis sativus*).

Treatment.	Number of Fruit	Fruit Length (Cm)	Fruit Girth (Cm)	Fruit weight (g)
CO	1.8	15.8	4.51	187.3
BSG 4t/ha	2.0	16.9	4.91	221.8
BSG 8t/ha	2.8	17.0	5.13	229.2
BSG4t/ha + F	2.1	16.3	4.57	217.9
BSG8t /ha + F	1.8	16.6	4.59	220.3
LSD 0.05	0.66	0.17	0.17	17.06

Co – Control (No treatment),BSG –Brewer's Spent Grain; F –NPK (20:10:10) Fertilizer LSD – least significant difference.

Results of the Soil Analysis (Table. 5) revealed that the application of Brewer's Spent Grain at 8t /ha and BSG 4t /ha +F significantly (P= 0.05) increased the values of Organic Matter, Total Nitrogen and Available Phosphoruswhencompared with the Control. The highest values of Organic Carbon (OC), Organic Matter (OM) and Total Nitrogen (T N) were at par and obtained in BSG 8t / ha and BSG 4t / ha = F. The highest value of available Phosphorus (19.2 7 ppm) was obtained at BSG 8t /ha, followed by BSG 4t /ha + F (18.75 ppm). The order of increase of Available Phosphorus was BSG 8t / ha > BSG 4t / ha + F > BSG 8t /ha + F > BSG 4t / ha > CO.

Table. 5 Effect of different rates of Brewer's Spent Grain on Soil Chemical Properties .

Treatment.	pH ,H_2^0	pH Kcl,	OC g kg-1	OM g kg-1	TN g kg-1	P mg kg-1
CO	5.7	5.5	0.56	0.85	0.07	14.27
BSG 4t/ha	6.2	5.6	0.62	1.03	0.08	15.2
BSG 8t/ha	5.8	5.0	0.65	1.13	0.09	19.27
BSG4t/ha + F	5.9	5.2	0.65	1.13	0.09	18.75
BSG8t /ha + F	5.8	5.0	0.63	1.08	0.08	17.75
LSD 0.05	0.22	0.91	0.04	0.04	0.02	0.24

Co – Control (No treatment), BSG – Brewer's Spent Grain; F – NPK (20:10:10) Fertilizer; LSD – least significant difference; OC – Organic Carbon, OM – Organic Matter and TN – Total Nitrogen.

DISCUSSION

The results obtained in this study revealed that, there were significant differences among the different rates of Brewer's Spent Grain used as regards the growth parameters of *Cucumis sativus* namely; Vine length, number of leaves, number of branches and leaf area) as well as the yield components of Cucumber (such as number of fruit, fruit length, fruit girth and fruit weight) .Application of different rates of Brewer's Spent Grain solely and its combination with NPK (20:10:10) Fertilizer, had positively effect on the growth parameters at 6^{th} and 8^{th}weeks after planting. The significant difference recorded in the values of both the growth parameters and yield components of Cucumber assessed in this study can be attributed to favourable climatic conditions and nutrient availability from both soil and Brewer's spent Grain.Results of the soil analysis done in this study also showed that, Brewer's Spent Grain significantly increased the values of Organic Matter; Total Nitrogen and Available Phosphorus when compared with the control. The higher values of Organic Carbon (OC), Organic Matter (OM), Total Nitrogen (TN) and Available Phosphorus recorded can be attributed to higher level of these nutrients in Brewer's Spent Grain than the soil.The usage of organic / Industrial wastes as soil amendment and their integration with NPK fertilizer to increase both the growth parameters and yield components of crops have been reported by some researchers (Phu,1998; Jizha, 1993; khidzr *etal*.,2010; Nweke and Nsoanya ,2013; Nsoanya and Nweke ,2015).

CONCLUSION

The results of this study showed that, Cucumber (*Cucumis sativus*) performs well in Igbariam area ofAnambraState, Southeastern Nigeria when the soil is rich in vital nutrients and well – drained. The findings of this research also revealed that Brewer's Spent Grain applied at the rate of 8t / ha as well as 4t /ha + 200kg of NPK (20:10:10) Fertilizer are ideal for the study area to improve the growth parameters, yield components of Cucumber and some soil chemical properties (namely: Organic Carbon,Organic Matter, Total Nitrogen and Available Phosphorus). Based on this, it is recommended that farmers apply 8t /ha of Brewer's Spent Grain or 4t /ha BSG+ 200kg NPK (2:10:10) Fertilizer in the study area.

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