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Effect of Integrated Use of Spent Grain and NPK (20: 10: 10) Fertilizer on Soil Chemical Properties and Maize (Zea Mays L) Growth

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ABSTRACT

A field experiment was conducted to determine the effect of spent grain and NPK fertilizer integration on the growth of maize (Zea mays L.) and some selected chemical properties of Igbariam soil at the teaching and research farm of the Department of Crop Science and Horticulture, Anambra State University, Igbariam Campus. The experiment was laid out in Randomized Complete Block Design (RCBD) with four levels of treatments consisting of 400kg/ha NPK (20:10:10) fertilizer (F), 10t/ha spent grain (Sg), 5t/ha spent grain + 200kg/ha NPK Fertilizer (SgF) and 0t/ha Control (CO). The treatments were subjected to the analysis of variances test based on randomized complete block design (RCBD). The treatment means were separated using Least Significant Difference (LSD 0.05). The results obtained showed that, plant height, stem girth and number of leaves increased as weeks after planting (WAP) increased. The integration of spent grain and NPK fertilizer significantly (P = 0.05) increased plant height at 8WAP, stem girth and number of leaves in all the WAP assessed. The soil chemical parameters were improved; organic carbon (OC) and total nitrogen (TN) content of the soil were significantly increased. The highest values of 1.52% (OC) and.0.179% (Total N) were however observed in spent grain treated plots. Based on the results obtained, it is evident that, spent grain as organic fertilizer and its integration with NPK fertilizer is good as soil amendment since it influenced the growth of maize and increased the soil nutrients.

Keywords: Growth, Maize, Soil properties, spent grain,

INTRODUCTION

Maize (*Zea mays L.*) is an important cereal crop production in Nigeria because virtually every farmer in this country cultivates maize either for subsistence or on commercial basis. It is equally a major economic base for many farmers especially, those in the rural areas. As was observed by Kaul *et al*., (2011), maize is one of the most widely distributed crops of the world, as the crop is capable of being produced during the appropriate season in all parts of the world where farming is done (Akande and Lamid, 2006). An important dietary protein source and energy supply (Bos *et al*., 2005), greater nutritional value such as 10% protein, 3% sugar, 72% starch, oil 8.5%, ash 1.7% and fibre 3% (Chaudhary, 1993). Maize is an exhaustive crop and therefore, it requires much nutrients, hence its productive potential which are comparable more than any cereal crop in tropical country like Nigeria, depends on nutrient management system employed by the farmer. However; the low fertility status of Nigerian soils are constraints to maize production. The low fertility status is as a result of continuous cultivation that breaks up soil aggregation making the soil particles easier to be carried by wind or water erosion, high rainfall that causes leaching and soil erosion among others. With this trend, the productivity of maize as well as soil nutrients decline progressively unless nutrient management system such as mineral fertilizer (inorganic) or organic fertilizer are used.

Brewer's spent grain is a by-product of brewing and can be utilized as organic fertilizer in a farmer's field for the replenishment of lost nutrients and to enhance soil aggregation. According to Tang *et al*., (2009) brewer's spent grains are of high nutritive value, it contains high protein content, cellulose, lignin and hemicelluloses. Mussato, (2009) observed that xylose, arabinose and glucose are the most abundant monosaccharide found in brewer's spent grain. Also vitamins and minerals of different kinds and levels as well as amino acids have been identified in brewer's spent grain by Huige (1994);

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Mussato and Roberts (2006) and Essien and Udotong (2008). With these characteristics, brewer's spent grain when used as an agro waste has the potentiality of improving soil productivity through the improvement of soil chemical, physical and biological properties. The accumulation of these products of brewer's spent grain can produce increases in the organic carbon content of which Anikwe and Nwobodo (2002) and Eneje and Ukwuoma, (2005) observed that they exert positive influences on soil nitrogen supply for crop production and could have a long term effect on the soil nitrogen, increase soil organic matter content which Angers and Canon (1998) found to play major role in improving and maintaining soil texture, water holding capacity; the micro biomass and in nutrient cycling.

These qualities notwithstanding, organic wastes when used as soil amendments have some problems associated with their application, such as slow release of its nutrients wide C;N ratio, high level of heavy metals, large amount or quantity needed to apply among others. Mineral (inorganic) fertilizers did not fair better either, as it was observed by Ayoola (2006) and Ayoola and Adeniyan (2006) not to have been sustained at farmer's level in Nigeria and not helpful under Intensive agriculture due to scarcity, cost, nutrient imbalance, reduced yield, leaching and pollution of groundwater.

Hence the need for integration of organic and inorganic fertilizer for optimum efficiency, the integration of organic and inorganic fertilizer can be a good soil fertility and nutrient management strategy for crop production, synergistic and complementary effect of growth, yield and quality parameters of crops can be observed (Lombin *et al*., 1991; Vasanthi and Kumaraswamy; 2000; Boating *et al*., 2006), Makinde *et al*., (2001) opined that, high and sustained crop yields can be achieved through judicious and balanced NPK fertilizers combined with organic manure. Soil conservation and management strategy to guide against reduced crop yield and decline in soil nutrients under intensive agricultural activities have become important areas of agronomic research. Therefore soil fertility maintenance may be a major factor aimed at achieving a stable and sustainable crop production. The most favourable rate of organic and inorganic integration and the most favourable rate of application has not been satisfactorily investigated, thus the essence of this research was to study the effect of integrated use of spent grain and NPK (20:10:10) fertilizer on soil chemical properties and maize growth.

MATERIALS AND METHODS

Site Location

The field experiment was conducted at the Teaching and Research farm of the Department of Crop Science and Horticulture, Faculty of Agriculture, Anambra State University, Igbariam Campus in Anambra East Local Government Area of Anambra State. Igbariam falls within the derived savanna zone of Nigeria and is located at latitude 06. 14^1N and longitude 06.45^1E (ANSU met, 2012).

Experimental Design and Treatment Allocation

The experiment was laid out in a Randomized complete Block Design (RCBD) with four treatment materials and four replications to give 16 plots. The field area was 13m x 14m ($182m^2$) and the size of each plot measured 2m x 2m with a distance 2m between the Blocks and 1m pathway between plots. The experimental site was cleared, ploughed, harrowed and then partitioned into plots using hoe. The treatment consisted of the appropriate rate of Brewer's spent grain and NPK (20:10:10) fertilizers, which were applied to their respective plots. The treatment summaries are:

I0t/ha Spent grain (Sq)

400kg/ha NPK (20: 10: 10) Fertilizer (F)

5t/ha Spent grain +200kg/ha NPK Fertilizer (SgF)

0t/ha Control (CO), a control that received no treatment.

The I0t/ha spent grain (Sq) was applied evenly on the plot and incorporated into the soil one week before sowing to allow mineralization of nutrients in the fertilizer. 400kg/ha NPK (20: 10: 10) fertilizer (F) was applied using band method at two weeks after planting. The integrated spent grain and NPK Fertilizer (SgF) was mixed thoroughly and applied using band method at two weeks after planting. Maize hybrid seeds (Oba Super 11) obtained from Anambra State Agricultural Development Programme (ASADP), Awka were planted two per hole at the spacing of 75cm x 25cm and at a depth of about 2cm. This was done one week after the incorporation of the Brewer's spent grain. The seedlings were 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 1). At the end of the study, soil samples were collected from respective plots and used for the determination of soil pH using digital pH meter, total nitrogen by Macro-Kjedahl method and organic matter was determined according to Walkley and Black method. Available Phosphorus was determined by Bray 11 method.

Six maize plants were randomly selected from respective plots and tagged. These were used to measure plant height, number of leaves and stem girth at 5, 6, 7, and 8 weeks after planting (WAP). Data generated from the study were subjected to analysis of variance test based on randomized complete block design (RCBD) according to Steel and Torrie (1980), while least significant difference (LSD) at 0.05 was used to compare treatment means.

Table1. *Physical and Chemical Properties of The Soil of The Experimental Site Before Treatment Application.*

Soil Properties	**Value**
Particle Size (%)	
Clay	21
Silt	28
Fine Sand	39
Coarse Sand	12
Textural Class	Sandy Clay Loam
Chemical Characteristics	
pH (H_2O)	5.7
pH (KCL)	4.2
Organic C%	1.21
Organic Matter %	2.08
Total Nitrogen %	0.07
Available P mgkg^{-1}	3.73
Exchangeable bases (Cmolkg^{-1})	
Na^+	0.25
K^+	0.39
Ca^{2+}	2.20
Mg^{2+}	2.60
CEC	22.0
Exchangeable acidity (Cmolkg^{-1})	
Al^{3+}	0.4
H^+	2.0
Base Saturation (%)	24.73

RESULTS

Effect of Integrated Use of Spent Grain and NPK Fertilizer on Growth Characteristics of Maize Plant and Soil Chemical Properties

The result of the study in Table 2 showed that integrated use of spent grain and NPK Fertilizer did not significantly affect the maize height in all the weeks after planting studied, except for maize height at 8 weeks after planting (WAP) where the treatments were at par but, significantly (P=0.05) better than the control. The spent grain treatment was observed to show the tallest maize plant in 6, 7 and 8 WAP except in 5WAP. The result equally showed that maize height increased as the weeks after planting increased. With the exception of 5WAP, the order of increase on maize plant height from 6 to 8 WAP was Sg > SgF > F > CO

The result of the stem girth of maize at 5WAP, 6WAP and 8WAP showed that, the treatments, NPK, spent grain + NPK were at par but significantly (P = 0.05) better than the control. At 7WAP, the spent grain + NPK (SgF) showed significant difference among the treatments although at par with spent grain (Sg). There was equally an increase in the stem girth of maize as the WAP increased except for control in 7WAP and SgF in 8WAP where there was a decrease in stem girth. The highest maize stem girth was observed in SgF in 6 and 7 WAP. The order of increase in maize stem girth with regard to the treatments in each of the WAP was; for 5WAP, NPK > SgF > Sg > Co; 6WAP, SgF > NPK > Sg > Co; 7WAP, SgF > Sg > NPK > Co; 8WAP, Sg > SgF > NPK > Co.

Table2. *Effect of Integrated use of Brewer's Spent grain and NPK (20:10:10) Fertilizers on the Growth Parameters of Maize*

Treatment	Plant Height (Cm)				Stem Girth (Cm)				Number of Leaves			
	Weeks After Planting				Weeks After Planting				Weeks After Planting			
	5	6	7	8	5	6	7	8	5	6	7	8
CO	42.75	47.54	68.33	96.58	4.06	5.42	4.88	6.23	6.50	8.75	9.21	10.83
F	53.16	56.84	93.71	137.79	5.86	6.75	7.65	8.00	7.71	10.50	11.54	12.37
Sg	54.86	62.63	125.17	155.79	5.44	6.34	8.00	8.21	7.92	10.61	11.79	12.96
SgF	55.33	57.62	106.0	142.75	5.83	6.77	8.37	8.15	8.38	11.21	11.25	1 3.00
LSD 0.05	NS	NS	NS	20.0	0.94	0.66	0.45	0.77	0.62	0.66	0.82	NS

Co - control without treatment application, F = NPK (20:10:10) Fertilizer

Sg = Spent grain; SgF = Spent grain + NPK Fertilizer; LSD = Least significance difference.

The analysis of the soil (Table 3) shows that, the integrated use of spent grain and NPK Fertilizer significantly (P=0.05) increased the value of OC and Total N relative to the control plots, while the values of pH, OM and available P were statistically similar. The highest values of OC, OM, pH and TN were obtained in Sg while the highest value of available P (7.93mgkg^{-1}) was obtained in SgF. The percentage increase of available P in SgF relative to other treatments was 26.48% (CO), 23.46% (NPK) and 8.33% (Sg).

Table3. *Effect of Integrated use of Spent grain and NPK Fertilizer on Soil Chemical Properties*

Treatment	pH H_2O	OC %	OM %	TN %	P mgkg^{-1}
CO	5.6	1.31	2.25	0.158	5.83
F	5.6	1.44	2.48	0.161	6.07
Sg	5.8	1.52	2.62	0.179	7.23
SgF	5.4	1.51	2.60	0.168	7.93
LSD0.05	NS	0.11	NS	0.01	NS

CO = Control without treatment application; F = NPK (20:10:10)Fertilizer; Sg = Spent grain;

SgF = Spent grain + NPK Fertilizer; LSD = Least significant difference.

DISCUSSION

Spent grains are the by-product of the brewing process, consisting of the solid residues remaining after mashing. This product consists primarily of grain husk and other residual compounds not converted to fermentable sugars by washing process. Its use as soil amendment and integration with mineral fertilizer like NPK fertilizer have shown to be positive. The integrating effect resulted in improving nutrient release and uptake by the maize plant leading to increase in values in most of the parameters assessed.

The height, stem girth and number of leaves of maize increased and were highest in spent grain + NPK Fertilizer (SgF) and spent grain (Sg) treatments. The higher values observed in Sg treatment relative to the SgF integration in some of the parameters measured could be attributed to higher levels of nutrients especially nitrogen and phosphorus in spent grain available for plant growth and their release as well as synchronization of nutrient released within the short period of growth of the maize plant. Hence, organic fertilizer with high content of nutrient and release ability can increase crop growth and yield. The differences in values of plant height stem girth and number of leaves recorded may be as a result of differences in plant nutrient in the rate of treatments applied.

The synergistic and complementary effect of spent grain and NPK integration (SgF) was also observed in values recorded for the parameters assessed. Synergistic and complementary effect of growth parameters and yield of maize were observed by Vasanthi and Kumaraswamy(2000); Boating et. al; 2006); Nweke and Nsoanya (2013) and Nweke et. al., (2013) with the integrated use of organic and inorganic fertilizer. The application of spent grain had significant effect on some of the soil parameters measured. The observed improvement in OC and Total N in the treated plots relative to the control plots could be attributed to higher level of OC and Total N in spent grain than the soil. Integrated use of organic wastes and mineral fertilizer was reported by Nweke and Nsoanya (2013) to be beneficial in improving crop yield and physical parameters of soil like Total porosity, Bulk density, Aggregate stability, Soil moisture content soil hydraulic conductivity and Dispersal ratio. While Rautaray *et.al*., (2003) observed the benefit of the organic waste and chemical fertilizer integration in soil pH, OC, available P, N, K and crop yield.

CONCLUSION

The findings of the study have shown that the application of spent grain can be used as good soil amendment to improve soil nutrient status and thereby increase crop growth. The integration of spent grain + NPK fertilizer significantly increased plant height at 8WAP, Stem girth and number of leaves at all the weeks after planting (WAP) assessed relative to control. The OC and total N content of the studied soil were equally improved significantly relative to the control. Based on the results obtained, it is therefore advisable to use spent grain in crop production activities in the studied area as it can ameliorate the nutrient status of the soil and can maintain crop production activities on sustainable basis than using sole inorganic fertilization.

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