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TWO YEARS EVALUATION OF PLANTAIN AND BANANA PEELS ON SOIL PROPERTIES AND DRY MATTER YIELD OF OKRA IN A SANDY SOIL

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ABSTRACT: *Plantain and banana peels are common wastes that when properly harnessed increased the organic matter (OM) content and fertility status of soils. Thus, the effect of plantain and banana peels on selected soil chemical properties and okra yield was evaluated for 2 years. The study was established in a completely randomized design (CRD) with four treatments and four replications. The treatments studied were; Plantain peels (PT), Banana peels (BN), Plantain + Banana peel (PB) and control (CO) that received no application of the peels. Results showed that for the 2 years study, plantain peels and banana peels influenced the soil chemical properties tested and the agronomic parameters of okra, though most of the parameters tested recorded non-significant difference ($P < 0.05$) among the treatments. In 2018 planting season, Ca and Mg content of the soil showed result variation of PT > BN > PB > CO and PT > CO > PB > BN respectively. OM content in 2019 season was observed to be significantly increased relative to its value in 2018 planting season and the initial value, while Ca and Mg values obtained in 2019 season were below their critical value for crop production in the study area. The root and shoot dry matter yield showed highest value of 5.25gkg^{-1} and 2.75gkg^{-1} respectively in PB in 2018 planting season, but the yield values for the two parameters in 2019 planting season was 0.05gkg^{-1} and 0.07gkg^{-1} respectively for BN and PN. The growth parameters increased as the WAP increased in both 2018 and 2019 seasons. The result of the study showed that the use of plantain peels and banana peels in crop production activities can improve the soil fertility and crop yield though it will require continuous application for reasonable yield to be achieved beyond first planting.*

KEYWORDS: Agronomic Parameters, Exchangeable Base, Crop Waste, Crop Peels, Organic Matter

INTRODUCTION

Declining soil fertility is a major production constraint in soils of south eastern Nigeria. Even increasing human population and industrialization as well as rampant land degradation problems in the area have added salt to the injury making it increasingly difficult to secure

sustainable soil productivity and crop yield. Soil is one of the most valuable natural resources be quitted to man by God, therefore maintaining its life and death is a moral responsibility. Soil organic matter content is a major life wire of soil. Its level in soil determines to greater extent the fertility status and structural stability of the soil. The maintenance of organic matter content in soil, especially the soils of southeast Nigeria is however a problem due to high temperature, rainfall and environmental degradation. Thus, concerted effort is required in the management of the soils of the area. Many strategies have been adopted by farmers in the area to increase crop yield, yet it has to be safer for the environment, man and sustainable for nutrient conservation. Organic manure which are found in form of crop wastes, animal wastes, sewage sludge, industrial wastes etc have been found to improve the physical, chemical and biological characteristics of soil and provide adequate amount of nutrients for the soil productivity, crop yield and guaranteed crops free from toxic elements (Cezar 2004; Qhureshi 2007; Asadu and Unagwu 2012; Nweke, 2018, 2019). Hence, the use of these wastes as means of improving and maintaining the organic matter content and boosting the crop productivity has become an economic proposition.

Farm application can serve as an alternative use of wastes suggested by Sim and Wu (2010), which will avoid disposal costs and attract economic value from the use of the waste's material. Banana and plantain peels are organic waste and manure rich in macro and micro nutrients that can be recycled to prevent their disposal in the environment, thus sustaining that balance between economic development and environmental protection (Menon et al., 2012). Banana as a whole waste according to the work of Doran and Kaya (2003) contain almost 50% nutrient. Further, Hussain (2000) opined that the application of plantain and banana wastes reduced the use of chemical fertilizer, thus saving huge amount of foreign exchange incurred for import of fertilizers, increases stress tolerance as well as improves soil physical parameters. Thus, in the era of organic farming, it is paramount important that aggressive studies are carried out in various types of organic manure wastes to reduce to barest minimum the use of chemical fertilizers, for the economic wellbeing of the farmer and the productivity of the soil, the bedrock of our existence. Hence, the essence of this study is to evaluate the effect of plantain and banana peels on the properties of a sandy soil and dry matter yield of okra.

MATERIALS AND METHODS

The experiment was carried out in the Department of Soil Science Chukwuemeka Odumegwu Ojukwu University, Igbariam Campus, located within the latitude 06º 45', elevates 122M above sea level in south-eastern Nigeria. The sandy soil used for this study was collected from the premises of Faculty of Agriculture, Chukwuemeka Odumegwu Ojukwu University, Igbariam Campus. After collection of the soil, stones and pebbles were removed to ensure fine tilth before measuring out the soil. 3.5kg each of the sandy soil was weighed out into 16 plastic containers, perforated at the bottom and plugged with cotton wool to avoid excessive drainage. Ripe plantain and Banana peels collected from market dustbins and the hawkers were tied up in a polythene bags for three (3) days after which it was finally chopped into pieces with kitchen knife. 300g each of the chopped plantain and Banana peels were thoroughly mixed differently with 3.5kg of sandy soil. The treatment symbols are as follows:

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PT (plantain) = 300g plantain + 3.5kg sandy soil

BN (Banana) = 300g Banana + 3.5kg sandy soil

PB (Plantain + Banana) = 150g plantain + 150g banana + 3.5kg sandy soil

CO (Control soil) = 3.5g sandy soil.

The treatments were replicated into 4 times and 75cl of water was used to moisten each of the treatment pots. The pots were properly covered with polythene bags for two weeks to allow for ageing. The treatment pots were then laid out in a greenhouse made with white tarpaulin for the control of temperature and water. After two weeks of ageing, okra seeds were planted at 5 seeds per pot, two weeks after planting, the plants were thinned down to one plant per pot. Throughout the growing period of the plant, the pots were kept weed free by hand weeding and the plants were watered at 50cl at every other day. The agronomic parameters tested were; plant height, leaf area, number of leaves which were assessed every two weeks till harvest as well as the dry matter weight assessed at the end of the experiment. The same procedure was repeated in the second year of the experiment but without application of plantain and banana peels to test the residual effect. At the end of each planting year, soil samples were collected from each pot and sieved with 2mm sieve. The sieved soil samples were subjected to chemical analysis as outlined in Black (1965). Data collected from the study was subjected to analysis of variance based on CRD while statistically significant difference ($P < 0.05$) among the treatment means was estimated using LSD.

RESULTS

Initial soil properties

The soil is acidic with pH of 4.48; the available phosphorous (P) content of the soil was 10.80mgkg^{-1}. The values of total nitrogen 0.03% (TN), organic carbon 0.49% (OC), and exchangeable bases (Ca^{2+}, Mg^{2+}, K^{+}, and Na^{+}) were generally low. The chemical characteristics of the studied soil indicated low level in all the parameters tested. Hence the studied soil is considered poor in these essential plant nutrient elements.

Table 1 chemical properties of soil sample before experiment

Parameter	value
pHH_2O	4.48
Avail. P	10.03mgkg^{-1}
N	0.03%
OC	0.49%
OM	0.84%
Ca	2.80cmolkg^{-1}
Mg	1.20cmolkg^{-1}
K	0.09cmolkg^{-1}
Na	0.13cmolkg^{-1}
EA	0.72cmolkg^{-1}
ECEC	4.98cmolkg^{-1}

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Two years evaluation of plantain and banana peels on the growth parameters of okra

The result presented in Table 2a indicated non-significant difference ($P < 0.05$) among the treatments for okra growth except for plant height, leaf area and number of leaves (4WAP), leaf area and number of leaves (6WAP) and leaf area (8WAP) in 2018 planting season. For the 2019 planting season in Table 2b, the tested parameters recorded non-significant difference ($P < 0.05$) among the treatments studied except for plant height (4WAP), plant height and leaf area (8WAP). The plantain and banana peels positively influenced the growth of the okra plant as the value recorded for the assessed parameters increased as weeks after planting (WAP) increased in both 2018 and 2019 planting seasons. Although in 2019, it was not strictly followed. The result variation for plant height in 2018 planting season showed PT > PB > BN > CO for 2, 4, 6 and 8 WAP. The result scenario was equally true for leaf area result except for 6WAP and 8 WAP that showed PT > BN > PB > CO the number of leaves result recorded among the treatments were relatively alike for all the weeks after planting observed. The result of plant height in 2019 planting season indicated PT > PB > BN > CO for 4, 6 and 8 WAP results (Table 2). The 2WAP results showed that BN and CO recorded the same value. The result of leaf area showed that highest value was recorded by PT in 4WAP, 6WAP and 8WAP relative to other treatments. The number of leaves result showed higher value in PT compared to the other treatments in 2, 4 and 6 WAP.

Table 2a Two years evaluation of plantain and banana peels on the growth parameters of okra

Treatment	2018 planting season											
	2 WAP			4 WAP			6 WAP			8 WAP		
	Plant height cm	Leaf area cm^2	No of leaves	Plant height cm	Leaf area cm^2	No of leaves	Plant height cm	Leaf area cm^2	No of leaves	Plant height cm	Leaf area cm^2	No of leaves
PT	16.55	15.95	3.75	24.68	65.67	5.0	36.60	144.55	5.50	53.08	203.09	7.25
BN	10.81	8.89	2.63	14.44	38.83	3.75	23.85	87.70	3.75	39.16	136.52	4.25
PB	12.87	16.56	3.75	22.96	70.99	5.50	26.45	82.58	5.75	52.20	200.35	6.50
CO	7.49	7.49	3.38	15.91	18.50	4.88	20.07	49.17	3.75	22.58	71.53	3.75
LSD P <0.05	NS	NS	NS	9.83	12.93	0.88	NS	19.39	2.09	NS	22.06	NS

Table 2b Two years evaluation of plantain and banana peels on the growth parameters of okra

Treatment	2019 planting season											
	2 WAP			4 WAP			6 WAP			8 WAP		
	Plant height cm	Leaf area cm^2	No of leaves	Plant height cm	Leaf area cm^2	No of leaves	Plant height cm	Leaf area cm^2	No of leaves	Plant height cm	Leaf area cm^2	No of leaves
PT	14.40	9.50	3.80	21.20	41.07	2.0	19.40	25.79	1.75	19.50	43.70	1.75
BN	7.6	8.95	2.9	13.90	37.40	1.50	14.30	24.10	1.25	7.90	8.93	0.75
PB	11.6	11.88	3.0	17.70	32.75	1.75	18.20	24.20	1.25	12.80	19.38	1.50
CO	7.6	4.0	2.0	11.20	29.07	1.50	10.90	14.20	1.0	11.80	19.17	1.75
LSD P < 0.05	NS	NS	NS	2.07	NS	NS	NS	NS	NS	1.59	1.98	NS

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Two years evaluation of plantain and banana peels on dry matter yield of okra

The shoot and root dry matter yield of okra presented in Table 3 showed positive influence of plantain and banana peels in 2018 planting season. The PB treatment recorded the highest value in shoot (5.25gkg^{-1}) and root (2.75gkg^{-1}) dry matter relative to the other treatments. The result scenario for the two parameters in 2018 planting season indicated PB > PT > BN > CO. The 2019 planting result recorded in Table 3 indicated that the residual effect of plantain and banana peels on okra yield was not effective as the recorded values are poor and non-significant among the treatments. The BN, PB and CO recorded the same value (0.05gkg^{-1}) for shoot dry matter while BN and PB recorded the same value (0.07gkg^{-1}) for root dry matter. The highest recorded value of 0.08gkg^{-1} (shoot dry matter) and 0.1gkg^{-1} (root dry matter) was obtained from PT treatment.

Table 3 Two years evaluation of plantain and banana peels on dry matter yield of okra

Treatment	2018 Dry matter weight		2019 Dry matter weight	
	Shoot gkg-1	Root gkg-1	Shoot gkg-1	Root gkg-1
PT	4.00	1.75	0.08	0.10
BN	2.50	1.50	0.05	0.07
PB	5.25	2.75	0.05	0.07
CO	2.00	1.00	0.05	0.05
LSD P < 0.05	1.37	NS	NS	NS

PT =Plantain peels, BN = Banana peels, PB = Plantain + Banana peels, CO = Control

Two years evaluation of plantain and banana peels on selected soil chemical properties

The selected soil chemical properties result presented in Table 4 showed that plantain and banana peels enriched the studied soil, though recorded values for the assessed parameters indicated non-significant difference (P < 0.05) among the treatments except for organic matter (OM) result. The Ca and Mg values of the soil (Table 4) were found to be increased relative to their values in the control pots and their initial values (Table 1) in 2018 planting season. The OM and exchangeable acidity (EA) values were found to be less compared to the initial values in Table 1. Ca and Mg content of the soil showed result variation of PT > BN > PB > CO and PT > CO > PB > BN respectively. The plantain and banana peels effect on the studied soil in 2019 planting season showed strong residual effect on the OM content of the soil. The parameter (OM) was found to be significantly increased compared to its recorded value in 2018 planting season and the initial value in Table 1. The treatment PT recorded the same value (0.04cmolkg^{-1}) for Ca and Mg, while BN, PB and CO recorded 0.05cmolkg^{-1} for both Ca and Mg and PT and CO recorded 0.2cmolkg^{-1} for exchangeable acidity (EA).

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Table 4 Two years evaluation of plantain and banana peels on selected soil chemical properties

Treatment	2018				2019			
Treatment	OM %	Ca $cmolkg^{-1}$	Mg $cmolkg^{-1}$	EA $cmolkg^{-1}$	OM %	Ca $cmolkg^{-1}$	Mg $cmolkg^{-1}$	EA $cmolkg^{-1}$
PT	0.75	4.60	2.20	0.64	1.86	0.04	0.04	0.20
BN	0.77	4.20	1.70	0.66	2.73	0.05	0.05	0.24
PB	0.47	3.70	1.80	0.72	2.44	0.05	0.05	0.28
CO	0.89	3.60	1.83	0.56	3.48	0.05	0.05	0.20
LSD $P < 0.05$	NS	NS	NS	NS	1.16	NS	NS	NS

PT = Plantain peels, BN = Banana peels, PB = Plantain + Banana peels, CO = Control

DISCUSSION

Table 1 presents the result of initial soil analysis data. The sandy soil was acidic in reaction and lower values in other chemical parameters. Therefore, it is expected that the plantain and banana peels application will be beneficial to the studied soil and okra plant. The increased yield and yield components of okra observed in amended pots relative to the control pots in both 2018 and 2019 planting seasons in most of the parameters assessed could be attributed to higher content of plant nutrients due to enrichment of the amended sandy soil with plantain and banana peels. Organic matter impact water holding to soils it is applied; mobilize plant nutrients of which are mineralized in the process of OM breakdown. According to Paul (2011), it provided food for soil microbes whereby increased activity help in converting the unavailable plant nutrients into available forms, that is from organic to inorganic forms and practically supplies all the elements of fertility of which the plants require for adequate development and yield (Zia et al., 2012). The observed differences in values obtained may be due to differences in plant nutrients and availability status in the type of organic materials applied and the type of soil studied. The reduction in values obtained for the tested parameters in 2019 planting season of okra may be as a result of non-application of the plantain and banana peels and the type of soil used for the study. Hence the residual impacts of the plantain and banana peels were so small especially with regard to shoot and dry matter result of the okra. The implication of the result being that without further application, a farmer may not realize reasonable yield with respect to sandy soil. The result of selected soil chemical properties (Table 4) tested in this study showed that the plantain and banana peels applied enriched the sandy soil with nutrients that are higher in values compared to the control value in most of the parameters and their initial values in Table 1. This attest that the soil was ameliorated by the organic materials (plantain and banana peels) applied. The organic matter content of the 2018 planting season was observed to be lower relative to the result of 2019 planting season in all the amended pots even in the control pot. This may be attributed to high productivity and reduced decomposition of plantain and banana peels in 2018 planting season. The increased OM content value in 2019 planting season can be explained in the light of the residual effect of the 2018 planting season and rate of decomposition. The value recorded for Ca and Mg in 2019 planting season was observed to be low. This may be attributed partly to the uptake of the nutrients by the okra plant as they are adequately needed at various development stages of the okra plant. Calcium in soil help to

maintain chemical balance in the soil, reduce soil salinity and improve water penetration and magnesium, a building block of the chlorophyll, but these two parameters were not increased in 2019 planting season and they were all less than 0.1cmolkg^{-1} compared to 2018 results and their initial values (Table 1). The result may have been associated with the OM content and soil properties of which depends on the amount, type and size of OM (plantain and Banana) applied. The exchangeable acidity (EA) of the studied soil was observed to be generally low. This indicates the absence of possibility of Al toxicity.

CONCLUSION

The results of this study have shown that appropriate application of crop wastes (plantain and banana peels) at different levels can increase yield of okra and that plantain and banana peels are sources of many plant nutrients. Result finding also attest that plantain and banana peels vary in the amount of plant nutrients that they contain and supply to soil. The draw back to the use of plantain and banana peels for crop production is that it requires continuous application for farmers to make a reasonable yield. It was evidence in the 2019 planting season result with no application of plantain and banana peels.

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