Full Length Research Article

NJBAS

Available online at http://www.ajol.info/index.php/njbas/index
Nigerian Journal of Basic and Applied Science (June, 2018), 26(1): 88-95
DOI: http://dx.doi.org/10.4314/njbas.v26i1.10

ISSN 0794-5698

Response of Sweet Maize (*zea mays l. Saccharata strut*) and Soil Chemical Properties to Compost in Asaba, Delta State

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ABSTRACT

Experiment was conducted in Delta State University, Asaba Campus during the early and late seasons of 2016 to monitor the response of sweet maize and soil chemical properties to compost. The compost was formulated with rice husk and cowdung at a ratio of 7:3. The compost was applied at 0 (control), 5, 10 and 15 t/ha to 15kg soil per polythene bag. The soil was analyzed to determine the initial nutrient content. The bags were arranged in a completely randomized design in three replicates and maize variety Sammaz 37 was used. Four seeds were sown and later thinned to one stand two weeks after sowing. Plant height, leaf area, stem girth, dry mater, weight of green ear and weight of dehusked green ear were measured. Soil samples were collected after harvest for post harvest soil analysis. Data were subjected to analysis of variance and means were separated with Duncan Multiple Range Test at 5% level of probability. Results revealed that treated plant had outstanding performance than untreated, 15 t/ha of compost had higher plant height (144.5±7.3 and 146.8±16.6 cm), stem girth (8.3±0.43 and 8.6±0.47 cm), leaf area (247.5±41.5 and 148.8±30.3 cm^2), dry matter (2.9±0.82 and 3.2±1.0 t/ha), weight of green ear (0.24±0.04 and 0.30±0.01 kg) and weight of dehusked green ear (0.16±0.03 and 0.16±0.4 kg) in both seasons respectively. It also had higher soil chemical properties. Therefore, the compost could be recommended at 15 t/ha in the study area.

Keywords: sweet maize, soil fertility, rice husk, cowdung, compost

INTRODUCTION

Waste generated during crop processing poses potential treat as a result of improper management. Its accumulation can cause pathogen that are harmful to human and the environment (De Araujo *et al*., 2009). Rice being the second largest produced cereal has corresponding percentage of crop residues. Over 600,000 tonnes of rice husk are produced during rice processing annually in Nigeria (Chukwudebelu *et al*., 2015). Rice husk represents about 20% of the harvested rice and about 80% of it is made up of organic matter and mineral elements (Oko *et al*., 2012). Rice husk play valuable role in increasing soil fertility, substituting inorganic fertilizer and improving soil properties through addition of organic matter (Njoku *et al.*, 2011). Rice husk removed during rice processing causes disposal problem due to low commercial interest and difficulties in transportation due to its low density (Kumar and Bhatt, 2012). The rice husks are either burnt or dumped as waste, constituting threat to the surrounding environment. Therefore, use of the accumulated waste as manure will help to overcome the problem of waste disposal.

Sweet maize (*Zea mays L. Saccharata strut*) also known as sugar corn or vegetable corn is a cereal crop that is grown in a range of agro-ecological zones (FAO 2012). It is one of the mostly consumed compared to dent maize (*Zea mays indenata*) and flint corn (*Zea mays indurata*) (Bhatt 2012). It is distinguished from other varieties by its sweet taste due to its high sugar content. Production of cereal crop is increasing especially in areas with export capacity, but one major problem that hinders high productivity is poor soil fertility and or uncontrolled inorganic fertilizer application that affects soil properties negatively (Onwudiwe *et al*., 2014). Sweet maize is a heavy feeder and produce well in optimum soil fertility. Soil fertility improvement and environmental management are important aspect of agricultural development strategies. Hence, efforts are made to promote use of organic fertilizer that has the potential of improving soil properties and also boost crop yield without negative effects on the environment. Basha *et al*. (2005) stated that increasing soil fertility with organic fertilizers is a sustainable approach. Hence, this study was conducted to monitor the response of sweet maize and soil chemical properties to rice husk and cow dung compost in Asaba, Delta State, Nigeria.

MATERIALS AND METHODS

Description of study Location

Pot experiment was carried out in the Department of Agronomy, Delta State University, Asaba Campus. Asaba lies between Longitude 06° 49'E and Latitude 06° 14'N of the equator and located in the humid tropical rainforest with moderate rainfall. Rainy season is from April to October with an annual rainfall that ranges from 1500 to1849 mm. It has a bi-modal rainfall distribution and peaked at July and September with low precipitation in August. Annual temperature is 37.3°C with relative humidity of 73.2% (NIMET 2015).

Methods

The study was conducted in early (March to May) and late (August to October) planting seasons in 2016**.** Sweet maize variety of TZ (Sammaz 37) used was purchased from International Institute of Tropical Agriculture (IITA), Ibadan, Oyo State. Fifteen kilogram (15kg) of soils was taken from Agronomy Department experimental field and weighed into each experimental polythene bag. The soil was analyzed to measure the nutrient content before compost application. The compost was prepared with rice husk and cow dung in ratio 7:3 (weight). It was applied at 0, (control) 5.0, 10.0 and 15.0 t/ha and replicated three times. Nine polythene bags were used in each replicate, this make up to 108 bags. The bags were arranged in a completely randomized design (CRD). Four seeds were sowed per bag but were later thinned to one plant per bag after two weeks of sowing and water was added to keep the soil moist.

Data Collection

Data measurement started three weeks after sowing at weekly intervals. Plant height was taken from the base to the tip of the last leaf with a meter rule. Numbers of leaves was determined by counting all the visible leaves. Stem girth was measured at 10 cm height with a vernier caliper. The leaf area was obtained by taking the length and the breath of three leaves per plant (highest, middle, and lowest) and the value were multiplied by the correction factor (0.75) (Montgomery, 1911). Dry matter was oven-dried after harvesting and weighed. The weight of green ear and weight of dehusked green ear was taken after harvest. Soil samples were taken from each polythene bag to form the composite sample for each treatment for post-harvest soil analysis. Parameter measured were soil pH, soil organic carbon, total nitrogen, potassium, phosphorus, calcium, magnesium, sodium, exchangeable acidity, exchangeable cations, Base saturation and effective cation exchange capacity. The soil samples were analysed at Department Agronomy, University of Ibadan following standard procedures.

Statistical Analysis

Data were analysed with analysis of variance (ANOVA) and treatment means were compared with Duncan Multiple Range Test at 5% level of probability.

RESULTS

Soil texture and nutrient content before compost application

Table 1 shows the nutrient content of soil before application of compost; the pH value was 6.3, organic carbon and total nitrogen were 4.8 and 0.9 g/kg respectively. Available phosphorus was 9.8 mg/kg while effective cation exchange capacity (ECEC) was 4.8 cmol/kg. The soil textural class was sandy clay loam with base saturation of 83.3 %.

Table 1: Pre-sowing soil physio-chemical properties

Parameters	Values
pH (H_2O) 1:2	6.3
Organic carbon (gkg^{-1})	4.8
Total Nitrogen (gkg^{-1})	0.9
Available P ($mgkg^{-1}$)	9.8
Potassium ($cmol\ kg^{-1}$)	0.5
Magnesium ($cmol\ kg^{-1}$)	1.4
Calcium ($cmol\ kg^{-1}$)	1.1
Sodium ($cmol\ kg^{-1}$)	1.0
Exch. Acidity ($cmol\ kg^{-1}$)	0.8
ECEC ($cmol\ kg^{-1}$)	4.8
BS %	83.3
Particle Size (gkg^{-1})	
Sand	735
Silt	85
Clay	180
Textural Class	**Sandy clay loam**

ECEC – Effective cation exchange capacity
BS – Base saturation

Soil chemical properties after harvest

Effect of compost on soil chemical properties is shown in Table 2. Soil pH of control plot was (6.3) while at 10 and 15 t/ha of the compost, the soil pH value was 6.6. The soil organic carbon increases from 4.8 g/kg before compost application to 9.5 g/kg with application of 15 t/ha of compost. Similarly, total nitrogen followed same trend. Available phosphorus increased with increase in the compost. Also, 15t/ha had the highest ECEC and percentage base saturation at the early season. In late season, application of 15 t/ha of compost gave the highest soil chemical properties measured.

Effects of compost on sweet maize growth

Plant Height: Effects of compost on plant height at both seasons are shown in Table 3. There were significant differences among the level of compost at both sowing seasons. Tallest plants were with application of 15 t/ha in both seasons. The control had the shortest plants in both seasons.

Numbers of Leaves: Effect of compost on numbers of leaves is shown in Table 4, there were significant differences in both seasons except at 5 WAS in early season. Application of 15 t/ha of compost gave the highest number of leaves at both seasons except at 5 weeks after sowing (WAS), were 10 t/ha gave the highest in first season while 5 and 10 t/ha were highest in second season.

Table 2: Post-harvest soil chemical properties

Treatments t/ha	pH (H_2O)	Org.C g/kg	N g/kg	P Mg/kg	K^+	Ca^{+2}	Mg^{+2}	Na^{+2}	ExA	ECEC	BS %
					---------------------cmol/kg-----------------						
Early season											
0	6.3	4.2	0.8	8.6	0.4	1.0	1.1	0.9	0.7	4.1	82.9
5	6.5	8.4	0.9	9.1	0.5	1.3	1.4	1.2	0.6	5.0	88.0
10	6.6	9.4	0.9	9.6	0.5	1.4	1.5	1.2	0.6	5.2	88.5
15	6.6	9.5	1.1	9.9	0.6	1.4	1.5	1.3	0.5	5.3	90.6
Late season											
0	6.4	4.0	0.7	8.1	0.3	0.8	1.0	0.7	0.8	3.6	77.8
5	6.4	9.1	0.9	9,8	0.7	1.5	1.5	1.2	0.6	5.5	89.1
10	6.6	11.2	0.9	11.2	0.8	1.6	1.7	1.3	0.5	5.9	91.5
15	6.7	13.4	1.1	13.5	0.8	1.8	1.8	1.4	0.5	6.3	92.1

Table 3: Influence of rice hush and cowdung compost rate on plant height (cm) of sweet maize

	Weeks after sowing			
Compost rate (t/ha)	**3**	**4**	**5**	**6**
Early season				
0	55.3b	68.7b	92.2b	128.0b
5	60.3a	66.7b	89.2b	126.5b
10	62.9a	76.5a	87.9b	128.8b
15	66.4a	81.9a	105.9a	144.5a
SD	**3.98**	**6.10**	**7.16**	**7.29**
Late season				
0	49.4c	62.2d	89.0c	101.3c
5	65.7b	69.4c	93.6b	129.2b
10	68.8b	78.8b	95.3b	133.4b
15	76.9a	85.6a	110.4a	146.8a
SD	**11.0**	**12.4**	**8.0**	**16.6**

Means within each column with the same letters are not significantly different at $\alpha_{0.5}$.
SD – Standard Deviation
$\alpha_{0.5}$ – Significant at 5% level of probability

Table 4: Influence of rice husk and cowdung compost rate on number of leaves of sweet maize

	Weeks after sowing			
Compost rate (t/ha)	**3**	**4**	**5**	**6**
Early season				
0	7.0bc	9.7b	11.3	9.1c
5	6.3c	9.7b	11.5	10.3b
10	8.0a	9.7b	11.7	10.7ab
15	8.2a	11.3a	11.6	11.7a
SD	**077**	**0.69**	**0.15**	**0.93**
Late season				
0	6.6b	8.8c	9.4c	9.0b
5	6.7b	10.1b	12.5a	12.2a
10	8.2a	10.4b	12.2a	12.2a
15	8.8a	11.8a	12.0a	12.4a
SD	**0.95**	**0.66**	**1.24**	**1.42**

Means within each column with the same letters are not significantly different at $\alpha_{0.5}$.
SD – Standard Deviation
$\alpha_{0.5}$ – Significant at 5% level of probability

Stem Girth: Effects of compost on plants stem girth is shown in Table 5. Plants girth was significantly different at both seasons. The 15 t/ha had the highest stem girth in both seasons.

Leaf area: Table 6 showed the **e**ffects of compost on leaf area (cm^2), significant differences were recorded in all the weeks data were collected. In early season, plants that received 5 t/ha had the highest leaf area except at 3 WAS were 5 t/ha had the highest. Also, application of 15 t/ha produced the highest leaf area in late seasons 3 to 5 WAS, while 5 t/ha gave the highest at 6 WAS.

Table 5: Influence of rice husk and cowdung compost rate on stem girth (cm) of sweet maize

	Weeks after sowing			
Compost rate (t/ha)	**3**	**4**	**5**	**6**
Early season				
0	4.3b	6.7a	7.6	7.3b
5	4.7b	5.4b	6.9	7.2b
10	4.7b	6.0ab	7.5	7.6ab
15	5.4a	6.6a	7.8	8.3a
SD	**0.40**	**0.52**	**0.34**	**0.43**
Late season				
0	4.0b	6.1c	7.2	7.3b
5	5.2a	6.5b	7.7	8.0ab
10	5.6a	6.6b	7.9	8.2a
15	5.8a	7.2a	8.0	8.6a
SD	**0.70**	**0.39**	**0.31**	**0.47**

Means within each column with the same letters are not significantly different at $\alpha_{0.5}$.
SD – Standard Deviation
$\alpha_{0.5}$ – Significant at 5% level of probability

Table 6: Influence of rice husk and cowdung compost rate on leaf area (cm^2) of sweet maize

	Weeks after sowing			
Compost rate (t/ha)	**3**	**4**	**5**	**6**
Early season				
0	78.9b	85.0c	95.7d	143.1c
5	94.2a	83.5c	156.3b	203.2b
10	67.4c	105.7b	126.6c	241.2a
15	78.5b	117.7a	207.0a	247.5a
SD	**9.5**	**14.4**	**41.0**	**41.5**
Late season				
0	60.2c	83.4d	89.4c	121.3c
5	99.3b	102.3c	122.8b	204.6a
10	98.7b	110.2bc	126.6ab	148.4b
15	110.0a	118.2a	134.5a	148.8b
SD	**18.9**	**12.9**	**17.2**	**30.3**

Means within each column with the same letters are not significantly different at $\alpha_{0.5}$.
SD – Standard Deviation
$\alpha_{0.5}$ – Significant at 5% level of probability

Effects of compost on sweet maize yield

Dry matter yield: The dry matter yield of sweet maize as influenced by compost is shown in Table 7. Plants that received 15 t/ha significantly had the highest dry matter yield in both seasons while control had the least.

Weight of green ear: Weights of green ear was significantly (Table 7). Application of 15 t/ha produced the highest weight of green ear in both seasons while control had the least.

Weight of dehusked green ear: Weights of dehusked green ear was significantly higher at 15 t/ha and it was significantly higher than the lower rates of compost (Table 7). The control had the lowest weight of dehusked green ear at both seasons.

Table 7: Influence of rice husk and cowdung compost on dry matter yield and cob weight of sweet maize

Compost rate (t/ha)	Dry matter (t/ha)	Weight of green ear (kg)	Weight of dehusked green ear (kg)
Early season			
0	0.7d	0.14d	0.08c
5	1.3c	0.19c	0.13b
10	2.0b	0.21bc	0.15a
15	2.9a	0.24a	0.16a
SD	**0.82**	**0.04**	**0.03**
Late season			
0	0.5d	0.12d	0.06d
5	1.4c	0.20c	0.13c
10	2.2b	0.26b	0.16a
15	3.2a	0.30a	0.16a
SD	**1.0**	**0.07**	**0.04**

Means within each column with the same letters are not significantly different at $\alpha_{0.5}$.
SE – Standard Deviation
$\alpha_{0.5}$ – Significant at 5% level of probability

DISCUSSION

Soil organic carbon, total N and available P of the experimental soil were low indicating poor soil fertility. The soil had total N, available P and exchangeable K lower than the critical level of 2% N, 25 mg/kg P and 0.4 cmol/kg K. This shows that the soil fertility is low and cannot sustain sweet maize production (Adeleye *et al*., 2010). It means soil enrichment is necessary to support the growth and yield of sweet maize in the study area. The rice husk and cow dung compost contain macro and micro nutrients that can be used to boost fertility of the soil for sweet maize production. The rice husk and cowdung compost improve soil pH, Islam et al. (2011), attributed the increase cation released during microbial decomposition of the rice husk compost. According to Uwah *et al*. (2014), decomposition of organic fertilizer releases cations into the soil that hydrolyse and form calcium hydroxide which react with soluble aluminum ions to form insoluble $Al(OH)_3$. Hydrogen ion reacts with $Ca(OH)_2$ to form water, increasing soil pH recorded in this study.

The higher ratio of rice husk/cowdung compost formulation increased the soil fertility in relation to the control which supported sweet maize growth as observed in the study. Treatments that received 15 t/ha of compost had higher stem girth at 6 weeks after sowing. This could be attributed to the high nutrient present in the formulation and subsequent uptake by the plants. This observation is supported by the findings of Oworu *et al*. (2010), who reported that compost can stimulates root development, nutrient uptake and thus plant growth.

Maize plants that received 15 t/ha of rice husk and cow dung compost recorded the highest numbers of leaves. Ridge (1991) reported that the number of leaves produced by a plant is directly proportional to the photosynthetic activity. This could be attributed to enhanced plant growth rate due to high availability of nutrients with corresponding increase of compost. Plants that received 15 t/ha of compost attained tassel stage before those that received 10 t/ha and below. The sweet maize growth parameters responded to increasing rate of compost. The rate of nutrient release at 15 t/ha of the compost could be responsible for the higher growth rate recorded compared to the lower levels, as a result of higher nutrient uptake (Uwah *et al*., 2011). The nutrient released can cause fast growth rate of sweet maize leading to higher plant height, leaf area, stem girth and yield parameters recorded. Resent work by Uwah *et al*. (2011), also supported this findings, they found out that nutrients released from applied organic manure increases the growth and yield of sweet maize. Increased release of nutrient from the compost to the sweet maize at higher rate led to production of dry matter, weight of green ear and weight of dehusked green ear. Adequate nutrient availability due to application of higher rate of compost led to more production.

CONCLUSION

The study was conducted to investigate the response of sweet maize and soil chemical properties to rates of rice husk and cowdung compost. The results revealed that 15 t/ha of the compost gave the highest value of soil physicochemical properties suitable for growth and yield of maize.

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