PRODUCTIVITY RESPONSE OF MAIZE/SWEETPOTATO MIXTURES TO POULTRY MANURE RATES IN OWERRI SOUTHEASTERN NIGERIA

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ABSTRACT
The study evaluated the productivity of maize/sweet potato mixture to poultry manure rates at the Teaching and Research farm of the Federal University of Technology, Owerri. The treatments comprised of maize/sweet potato mixtures treated with 0, 3, 6, 9, 12 and 15t ha $^{-1}$ of poultry manure. The experiment was laid in a randomized complete block design (RCBD), and replicated 3 times. Data on the soil physicochemical properties, vegetative growth and yield parameters of the component crop mixtures were investigated and analyzed statistically . Results indicated that application of 12 t ha $^{-1}$ of poultry manure gave the highest leaf number (13.66), leaf area (475.20cm^2), number of cobs (3.00), fresh and dried grain weight (0.54 and 0.34kg) in maize, leaf number (240), vine length (191.56cm) and fresh tuber yield (12.19kg ha $^{-1}$) in sweet potato. However 0 t ha $^{-1}$ maize/sweet potato recorded the least leaf number(10.66), leaf area(46.43), number of cob (1.33), fresh and dried grain weight(440 and250)in maize , least leaf number(156.6)and fresh tuber yield(4.19kg ha $^{-1}$) in sweet potato. The soil pH status also increased with application of poultry manure, an indication of the liming ability of poultry manure. The application of 12 t ha^{-1} poultry manure to maize/sweet potato mixtures is therefore recommended to our farmers for adoption in southeast Nigeria.

Key word: maize sweet potato poultry manure productivity

Introduction

Maize (*Zea mays L.*) a cereal crop that belongs to the family, gramineae is the most important crop in sub-Saharan Africa(Abalu *et al*., 2001) Worldwide, maize, rice and wheat are produced in greater quantity than any other crop. The crop is commonly cultivated in the tropics and warm sub-tropics for food, livestock and industrial uses. In Nigeria, maize is an important food, fodder and industrial *crop* grown both commercially and at subsistence level (Eleweanya *et al.,* 2005). Maize is used for the production of indigenous and commercial food products that are relished for their unique and distinctive flavors. It is eaten fresh or milled into flour and serves as a valuable ingredient for baby food, cookies, biscuits, ice cream, pancake mixes, livestock feed and a variety of traditional beverages.

Sweet potato (*Ipomea batatas*) is one of the major food crops contributing to the world food requirement (Karam, *et al.,* 2009) and income generation through its exportation (Kandil et al., 2011). *Produced* in 130 nations (Snapp1 *et al*., 2003), ranking fourth in production volume after rice, wheat and maize, (Bowen., 2003;).

Sweet potato can be grown under a wide range of climates (Kandil, *et al*., 2011) and soil type more than any other crop.

The vast area of arable land in the humid tropics are comprised of strongly leached soil.-utisols and oxisols characterized by low inherent nutrient status(Onweremadu *et. al*., 2007) Soil fertility management on small scale farms in the tropics has become a major issue as a result of continued land degradation and rapid population growth . With the increasing population pressure in tropical Africa, shifting cultivation is no longer sustainable and the length of traditional bush fallow for *maintaining* the productivity of the soil is becoming shorter (Mbah and Mbagwu, 2006). Continuous cultivation of crop like maize/sweet potato on the same land will lead to soil nutrient exhaustion and low yield. In order to boost crop yield farmers use inorganic fertilizer to improve crop yield. The continuous use of mineral fertilizer indiscriminately by farmers has created serious environmental problems that have suppressed the expected benefits and is known to cause soil acidity, compaction and loss of soil organic matter (Juo, *et al.,* 1995). The addition of soil amendments such as poultry manure is thus inevitable in view of the current trend of soil physical, chemical and biological degradation (Obi and Ebo 1995). Poultry manure has been reported to reduce soil acidity to near neutrality at 15-20t ha^{-1} respectively (Duruigbo, *et al*.,2006). Poultry manure contains high percentage nitrogen and phosphorus for the healthy growth of plants (Ewulo, 2005).The use of animal waste such as poultry to boost soil fertility is economically justified (Smith, *et al.,* 2001). The production of maize and sweet potato mixture under the conventional mineral fertilizer application need to be reversed in favor of organic manure amendment due to its diverse potentials hence the current research to assess the productivity of maize/sweet potato mixture using poultry manure

Materials and Methods

The experiment was carried out in 2014 and 2015 cropping season at the Federal University of Technology Teaching and Research Farm Owerri, Imo state, located between latitude 5^0 to 7^0 N and longitude 7^0 to 10^0 E, altitude 55.7m above sea level and a relative humidity of 89-93%. Owerri is in the Tropical rainforest with its unique climate; bimodal

heavy rainfall(2500mm)and high temperatures(25 and 32^0C) The soil is an ultisol characterized by deep porous red soils derived from sandy deposits in the coastal plane which are highly weathered, coarse textured, low in mineral reserve and natural fertility. (Eshet 1993, Onweremadu *et al*., 2007)

The field originally planted with cassava and maize was manually cleared stumped and marked out at 3 x 2m plot seizes with 1.0m inter plot and 2.0m inter block alleys. Random augur soil samples (20.0cm) were collected and the soil physico –chemical characteristics determined before and after crop harvest on plot basis of the experiment.

All planting materials used for the experiment (Oba Super2 maize and sweet potato TIS 970097) were gotten from Imo State ADP. Poultry manure was collected from the University farm.

The experiment was laid out in a Randomized Complete Block Design (RCBD), with six (6) treatments replicated three (3) times. Each experimental plot measured 3.0x 2.0m. The treatments were application of six poultry manure rates(0, 3, 6, 9, 12 and 15t ha-1) to maize/sweet potato mixtures. **P**oultry manure rates were broadcasted uniformly on treatment plots basis and then incorporated into the soil manually by tilling. The plots were allowed one week before simultaneous planting of maize and sweet potato. Maize was sown at a spacing of 1.0 x 0.5m at four seeds/hole and later thinned down to two seeds/hole. Sweet potato was sown between rows of the maize stand at a spacing of 1.0 x 1.0m. Weeding was done manually, using hoe at 6 and 16 weeks after planting

Data were collected on soil properties at the beginning and end of the experiment, growth and yield parameters for the component crops at 4, 8 and 12 weeks after planting. All data collected were analysised statistically using Genstat(2012)

Results and Discussion

Soil chemical and physical properties (0-20cm) before and after the experiment

The result presented in Table 1 showed an increase in soil pH in the treatments that received poultry manure at the end of the experiment when compared with the pH value at the beginning of the experiment. There is also an increase in %organic matter, % organic carbon, total N and available phosphorous in all the treatments that received poultry manure, with highest value obtained from 15 t ha^{-1} poultry manure mixtures

It was observed from the pre-soil analysis that the soil of the experimental site was a sandy soil with a pH of 5.14. and very low in nutrient content. This is in line with Onweremadu, *et al., (* 2007) who confirmed that the ultisols of Owerri is highly acidic and poor in fertility. The post soil analysis showed that maize sweet potato mixtures with poultry manure increased the soil pH and it agreed with the findings of Duruigbo, *et al.,* (2006). The result also showed that poultry manure enhanced the soil chemical and physical properties, improved soil fertility and thus nutrient availability to both maize and sweet potato. This confirmed the report of Ayeni,2011, who stated that poultry manure is an important source of plant nutrient ,rich in organic matter that improves the physical property of the soil.

Table 1. Soil physical and chemical properties (0-20 cm) before and after planting.

Poultry manure (tons/ha)	pH	Org. C.	Org. M.	Total N	Exch. Cations				Avail. P (ppm)	Al + H	Al	Sand	Silt	Clay
	(H_2O)	%	%	%	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}				%	%	%
Pre-Planting	4.15	1.19	2.06	0.06	1.20	0.48	0.05	0.03	15.98	1.65	1.00	90.00	5.50	4.50
After planting														
0.0	4.16	1.19	2.11	0.06	1.20	0.48	0.05	0.03	15.99	1.65	1.00	90.00	5.50	4.50
3.0	5.23	1.55	2.62	1.14	3.82	5.69	0.06	0.72	22.01	1.68	0.64	87.00	8.70	4.30
6.0	5.57	1.86	3.12	1.40	5.26	5.73	0.08	0.11	24.12	1.87	0.76	85.56	9.43	4.01
9.0	5.72	2.41	3.44	1.86	6.41	5.84	0.08	0.12	29.26	2.06	0.85	85.74	10.37	3.89
12.0	5.75	2.63	3.75	2.24	8.64	5.99	0.09	0.14	31.70	2.19	0.87	83.61	12.75	3.64
15.0	6.01	2.80	3.97	2.57	8.97	6.01	0.12	0.15	34.50	2.24	0.91	82.00	14.80	3.20

Maize growth parameter

The effect of poultry manure rates on the height (cm), stem girth (cm) and number of leaves of maize plant at 4, 8, and 12 WAP are shown in Table 2. Maize/sweet potato mixture grown with 9 t ha^{-1}) poultry manure produced the tallest maize plant at 12 WAP (227.73 cm) which differed significantly (P= 0.05) from the height of maize treated with 0-6 t ha^{-1}. Maize/sweet potato mixture grown with 0 t ha^{-1} (control) produced significantly (p=0.05) shortest maize plant at 8 and 12 WAP (40-162.16cm).

Maize in sweet potato mixture manured with 12 t ha^{-1} of poultry manure produced the highest number of leaves at 8 and 12 WAP (11.66 and 13.66) which differed significantly (P= 0.05) from the maize plants which received 0-3 t ha^{-1} poultry manure. Maize in mixtures manured with 0 t ha^{-1} poultry manure had the least number of leaves (5-10.66) which was similar to that of 3 t ha^{-1} of poultry manure at 4 and 12WAP

Maize in sweet potato mixture grown with 9 t ha^{-1} poultry manure produced the largest stem girth at 4, 8 and 12WAP which is similar to those grown with 12 -15t ha^{-1} but differed significantly (P=0.05) from those grown with 0 and 3 t ha^{-1} crop mixtures. The application 0 t ha^{-1} poultry manure produced the least stem girth at 4, 8 and 12 WAP (1.63-4.40 cm) which was similar to those manured with 3t ha^{-1}.

The result showed great improvement in growth parameters of the treatment that received higher rate of poultry manure confirming the ability of poultry manure to supply basic nutrients necessary for plant growth. This agreed with Adejoro (1999); Gupta et al, (1997) who reported that poultry manure is very rich in nutrients.

Table 2. Effect of different rate of poultry manure on the mean plant height (cm), girth (cm) and of leaves of maize/sweet treatment at 4, 8 and 12 weeks after planting

	Plant Height (cm)			Girth (cm)			Leaf Number		
Poultry manure	……Weeks after planting…….								
(tons/ha)	4	8	12	4	8	12	4	8	12
0.0 (control)	27.70	63.63	162.16	2.53	4.46	4.20	6.00	8.33	10.66
3.0	27.26	74.20	203.63	2.80	5.03	4.66	6.66	9.66	11.67
6.0	38.06	99.16	207.50	3.50	5.93	5.46	8.00	11.00	13.00
9.0	43.10	97.23	227.73	4.00	6.26	5.3	8.00	11.66	13.66
12.0	39.16	116.23	225.73	3.90	5.56	5.00	7.33	11.66	13.66
15.0	43.43	84.53	212.16	3.66	5.80	5.13	8.00	11.00	13.33
$LSD_{(0.05)}$	6.73	19.76	19.09	0.40	0.33	0.44	0.81	0.00	1.30

Maize and sweet potatoes leaf area (cm^2)

At 6WAP, the application of 0 t ha^{-1} of poultry manure to maize/sweet potato mixture recorded the least leaf area (124.60 cm^2) in maize plant which was significantly different (P=0.05) from other treatments except those treated with 3 t ha^{-1}poultry manure while 9 t ha^{-1} poultry manure recorded the largest leaf area (233.80 cm^2). Sweet potato /maize mixture grown at 15 t ha^{-1} poultry manure recorded the highest leaf area (71.70cm^2) and the result is similar to those of sweet potato in 9 and 12 t ha^{-1} of poultry manure mixture but differed significantly from those in maize/sweet potato mixture grown at 0 t ha^{-1} poultry manure (control) which recorded the lowest leaf area in sweet potato plant (46.43cm^2) . This also confirmed the positive effect of poultry manure to plant growth. (Adejoro (1999); Gupta et al, (1997)

Table 3. Effect of different rate of poultry manure on the mean leaf area (cm^2) of maize/sweet treatment at 6 weeks after planting

	……Leaf Area (cm^2)……	
Poultry manure 6(tons/ha)	Maize	Sweet potato
0.0 (control)	124.60	46.43
3.0	133.00	52.53
6.0	191.83	59.93
9.0	233.80	69.13
12.0	216.76	68.00
15.0	213.43	71.70
$LSD_{(0.05)}$	45.54	6.79

Yield parameter of maize

Table 4 shows the effect of poultry manure rates on the days to 50% tasselling, number of cobs, fresh grain weight and 1000 seed weight in maize plant. Maize in sweet potato mixture grown with 9 t ha^{-1} of poultry manure matured earlier with least number of days to 50% tasselling (49.33) which was significantly different(P=0.05) from other treatments except those in mixtures manured 12 and 15 t ha^{-1} poultry respectively. Maize in sweet potato mixture grown with 3 t ha^{-1} poultry manure matured late with the highest number of days to 50% tasselling (56.33) which was similar to those which received 0 t ha^{-1} poultry manure though significantly different (P=0.05) from other treatments.

Maize in sweet potato mixture manured with 12 t ha^{-1} poultry manure recorded the highest number of cobs (3.0) and is similar to those manured with 9 and 15 t ha^{-1} poultry manure. Maize in control (0 t ha^{-1}) mixture recorded the lowest number of cobs/ maize plant at harvest (1.33) which was significantly different (P=0.05) from the 9, 12 and 15 t ha^{-1} of poultry manure treated mixtures

The application of 12 t ha^{-1} of poultry manure recorded the highest fresh grain weight with cob at harvest (0.54kg) and showed significant difference (P=0.05) from those treated with 0, 3 and 6 t ha^{-1} of poultry manure mixtures respectively, while maize/sweet potato mixture with 0 t ha^{-1} of poultry manure recorded the lowest fresh grain weight(0.44kg) in maize plant at harvest Maize/sweet potato mixture treated with 0 t ha^{-1} poultry manure (control) recorded the lowest 1000 grain weight (128.93g) which was significantly different (P=0.05) from other treatments. Maize/sweet potato mixture manured with 15 t ha^{-1} poultry manure recorded the highest 1000 grain weight (162.26g), which was significantly different (P=0.05) from other treatments.

The result indicated improvement on the yield of maize with increase on poultry manure application .This confirms the positive effect of poultry manure and it is in line with Akanbe, *et al.,* (2007) who reported that plants nourished with efficient amount of nutrient in the right proportion are expected to give higher yields.

Table 4. Effect of different rate of poultry manure on the mean days to 50% teaselling, mean number of cobs, fresh and dry grain weight (g)/treatment at harvest.

Poultry manure (tons/ha)	No of days to 50% tasseling	No of cobs	Fresh grain weight (g) with cob	1000 seed weight
0.0 (control)	55.66	1.33	460.00	128.93
3.0	56.33	1.66	440.00	134.66
6.0	53.33	2.00	440.00	145.96
9.0	49.55	2.66	510.00	153.06
12.0	50.66	3.00	540.00	155.43
15.0	50.00	2.33	510.00	162.26
$LSD_{(0.05)}$	2.64	0.71	0.05	3.03

Growth Parameters for Sweet Potato

Table 5 shows the effect of poultry manure rates on sweet potato number of leaves, vine length (cm) and number of branches. Maize/sweet potato mixture grown at 9 t ha^{-1} poultry manure recorded the highest number of leaves of sweet potato at 8 and 12 WAP, which was significantly different (P=0.05) from those manured with 0, 3, and 6 t ha^{-1}. The application of 15 t ha^{-1} poultry manure mixture recorded the highest number of sweet potato branches and vine length at 12 and 16 WAP which was similar to 9- 12 t ha^{-1} mixtures but significantly different (P=0.05) from 0,3 and 6 t ha^{-1} of poultry manure treatment. Maize/sweet potato mixture grown at 0 t ha^{-1} poultry manure (control) recorded the lowest number of leaves, branches and vine length (105.43 and176.66cm) for sweet potato, at 4 and 12WAP. This also confirmed the positive effect of poultry manure. (Adejoro, (1999); Gupta, *et al.*, (1997)

Table 5. Effect of different rate of poultry manure on the mean number of leaves, number of branches and vine length at 8, 12 and 16 weeks after planting.

	No of leaves			No of branches			Vine length (cm)		
	……..Weeks after planting……								
Poultry manure (tons/ha)	8	12	16	8	12	16	8	12	16
0.0 (control)	92.00	122.66	156.66	10.33	20.00	32.66	105.43	147.83	176.66
3.0	90.00	130.33	171.00	10.00	19.66	34.00	106.20	147.63	179.70
6.0	118.33	156.33	200.33	10.66	20.66	36.33	112.63	153.00	184.26
9.0	157.33	196.33	237.00	12.66	21.00	38.00	115.56	156.56	187.50
12.0	147.33	192.33	240.00	13.66	23.00	40.00	114.43	157.23	191.56
15.0	146.66	191.66	234.00	13.33	23.33	41.00	118.96	155.86	190.63
$LSD_{(0.05)}$	16.59	14.45	15.16	1.06	1.58	3.31	5.36	NS	3.89

Sweet potato yield

Maize/sweet potato mixture grown with 12 t ha^{-1} of poultry manure recorded the highest fresh tuber weight at harvest (12.19kg) which was similar to those of 9 and 15 t ha^{-1} poultry manure treatment but differed significantly(P=0.05) from other treatments. Maize/sweet potato mixture that received 0 t ha^{-1} poultry manure (control) recorded the lowest number of tuber and fresh tuber yield(3.66 and 4.19kg) at harvest which was significantly different (P=0.05) from other treatments. Maize/sweet potato mixture that were subjected to 9, 12, and 15 t ha^{-1} of poultry manure produced significantly (P=0.05) higher yield of the component crop than those subjected to 0, 3 and 6 t ha^{-1} of poultry manure. The improved maize/sweet potato yield was as a result of increased rate of poultry manure which must have supplied sufficient nutrient required for the crops development and yield. The absence of poultry manure impacted negatively on the yield of the component crops. This suggested that poultry manure supplied the basic nutrient needed for yield of the crops. This is in line with Adejoro (1999); Gupta et al, (1997) who reported that poultry manure is very rich in nutrient.

Table 6. Effect of different rate of poultry manure on the mean number of tuber of sweet potato/treatment at harvest.

Poultry manure (tons/ha)	No of tubers	Fresh tuber weight
0.0 (control)	3.66	4.19
3.0	5.66	6.44
6.0	6.33	7.68
9.0	8.33	12.15
12.0	8.00	12.19
15.0	8.00	11.79
$LSD_{(0.05)}$	0.88	2.17

Conclusion

Results indicated that poultry manure influences positively the growth and yield of maize / sweet potato mixture. The application of 12 t ha^{-1} of poultry manure improved growth and yield of the component crops in mixture and is recommended for adoption by farmers in Owerri southeastern Nigeria

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