

Influence of different fertilizer application rates on growth and yield components of two maize varieties in a forest-savannah-transition agro - ecology zone

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ABSTRACT

Field study on the influence of fertilizer application on growth and yield components of maize was carried out in 2015 and 2016 at the Institute of Agricultural Research and Training (I.A.R&T), Ibadan Station. Two maize varieties (ILE-1-OB and TZPBSR-W) were evaluated under three rates of NPK 20-10-10: 0, 50 and 100 kg N ha⁻¹, one rate of *Tithonia* compost; 10 t ha⁻¹ (representing 10.7 kg N ha⁻¹) and two rates of NPK and *Tithonia* compost combinations (50 kg N ha⁻¹+10 t ha⁻¹ and 100 kg N ha⁻¹+10 t ha⁻¹) using randomized complete block design (r=3) arrangement. Selected maize plants were assessed for plant height (cm), leaf area (cm²), stem diameter (cm), number of ears per plant, number of rows per cob, number of kernels per row, number of kernels per cob, 1000-kernel weights and grain yield. Various growth and yield components evaluated increased significantly with increased fertilizer application. Combinations of 50 kg N ha⁻¹+ 10 t ha⁻¹ and 100 kg N ha⁻¹+10 t ha⁻¹ enhanced growth and yield performances of maize better than sole applications of 50 or 100 kg N ha⁻¹. Highest grain yield was obtained under 50 kg N ha⁻¹ +10 t ha⁻¹ (5.26, 5.82 t ha⁻¹) and 100 kg N ha⁻¹ + 10 t ha⁻¹ (5.78, 5.91 t ha⁻¹) in 2015 and 2016 respectively. The use of 50 kg N ha⁻¹ inorganic fertilizer in combination with 10 t ha⁻¹ (10.7 kg N ha⁻¹) *Tithonia* compost adequately enhanced growth and yield performance of maize in the Forest-Savannah-Transition agro - ecology zone of Nigeria.

KEY WORDS: Grain yield, Plant height, Stem diameter, *Tithonia* compost.

INTRODUCTION

Maize is a staple food for more than 300 million people in Africa and helps to provide immediate food succor after a very long hunger period associated with dry season in Nigeria (Olakojo, 2010). The crop has a wider range of uses and widely distributed compared to other cereals (Olaniyan, 2015). Globally, rising demand for protein have tremendously increased the need for maize in livestock feed formulation (FAO, 2015). However, the production potential of maize in the sub-

Saharan African (SSA) has not been fully maximized due to several production challenges which include: drought, pest, diseases and poor soil fertility. Most soils in the SSA are often associated with declined soil fertility as a result of erosion and several other poor soil management practices (Ngetich *et al.*, 2012). Nutrient depletion due to continuous cropping and non-replenishment limits maize grain yield in southwest Nigeria (Amujoyegbe and Elemo, 2011). However, judicious use of fertilizers has potentials to replenish soil

nutrients and enhance maize grain yield. Maize requires major nutrients especially nitrogen (N), phosphorus (P) and potassium (K) as well as micronutrients for proper growth and development. These nutrients are available as chemical fertilizers (inorganic), manure and composts (organic fertilizer). Commercially available inorganic fertilizers include; N.P.K, Single Super phosphate (S.S.P) and Urea provide nutrients in readily available form for plant use (Marenja and Barrett, 2009). However, high cost of procurement and potential to pollute the environment are some of the limiting major factors to the use of chemical fertilizer in crop production (Larson, 1996). So also, most commercial fertilizers are often deficient in micronutrients which are vital for proper plant functioning (Peterschmidt, 2013). Organic fertilizer (manure and composts) are affordable and capable of improving soil health (Jaime & Viola, 2011). Apart from adding N.P and K to the soil, organic fertilizer also have the advantage of adding micronutrients (copper, iron, manganese and zinc) to soil for plant use (Peterschmidt, 2013). However, the use of organic fertilizers is not without certain limitations such as bulkiness, too laborious to prepare and slow nutrient release. The use of inorganic fertilizer in combination with organic fertilizer have been reported to possess complimentary benefits of enhancing soil nutrients, maintaining soil physical properties and increasing grain yield (Nzabi *et al.*, 1997; Amujoyegbe *et al.*, 2007; Ibeawuchi *et al.*, 2007; Tambone *et al.*, 2007). Organic fertilizers are available in large quantities from industrial waste from brewery fertilizers like molasses, agricultural and domestic waste such as cocoa pods, rice bran, bean pod, yam and cassava peelings, rice straws, grasses, *Tithonia* leaves, sorted town refuse, sewage and city wastes, poultry droppings, animal dungs, human faeces and urine and so on (Usman *et al.*, 2015). Main challenge of using compost with

inorganic fertilizer is finding the optimal combinations of organic and inorganic fertilizer input rates for specific crop production. Over time, recommended dose of N application for South west, Nigeria had been put at 60 - 70 kg N ha⁻¹ and 100 kg N ha⁻¹ for the savanna agro ecology (Onasanya *et al.*, 2009). Increased deforestation and land exploration leading to declined soil fertility are features of forest-savannah-transition agro - ecology zone of Nigeria. It is therefore pertinent to intensify efforts into studies that would enhance soil fertility and productivity. The present study aimed at evaluating the impact of organic, inorganic fertilizer and their combinations on the growth and yield performance of two maize varieties grown in Forest-Savanna-Transition agro-ecological zone of Nigeria.

MATERIALS AND METHODS

A field experiment was carried out at the Institute of Agricultural Research and Training, Ibadan, Nigeria, Lat. 7° 22.5'N and Long. 3° 50.5'E. Ibadan has a bimodal rainfall pattern, with a long rainy season, usually between March and July and a short rainy season, usually extending from September to early October, after a short dry spell in August and a longer dry period from November to February. The soil which was a Typic Kanhaplustalf classification series was ploughed and harrowed and sampled for routine analyses before planting.

Six treatments were arranged in an experiment laid out in a randomised complete block design with three replicates. Seeds of two maize varieties namely ILE-1-OB and TZPBSR-W were planted at three seeds per hill at 75 cm x 50 cm inter rows and intra rows spacing respectively in six (6) rows in each plot size of 4 m x 3.75 m. Each experimental unit was separated by a distance of 1.5 m thereby aggregating to a total of 36 plots. The three seedlings were later thinned to two vigorous seedlings after one week of

emergence. Six fertilizer application rates including; three rates of inorganic fertilizer; NPK 20-10-10 at 0 kg N ha⁻¹ (unfertilized plot), 50 kg N ha⁻¹ and 100 kg N ha⁻¹, one rate of *Tithonia*-poultry compost (TPC) 10 t ha⁻¹ (representing 10.7 kg N ha⁻¹) as well as two combinations of NPK 20-10-10 and TPC at 50 kg N ha⁻¹ + 10 t ha⁻¹ and 100 kg N ha⁻¹ + 10 t ha⁻¹ were applied to the designated plots. Inorganic fertilizer was applied to the sole and combined fertilizer designated plots two weeks after planting. The compost was prepared using cuttings of freshly harvested Mexican sunflower (*Tithonia diversifolia*) and 'cured' poultry fecal droppings according to "heap method" described by Fernhill, (2011). Samples of the matured compost was analysed for physical and chemical properties in the laboratory.

The compost was applied two weeks before planting to the designated (sole and combine application) plots. The field was irrigated to field capacity and was allowed to stay for a period of two weeks for the compost to mineralise and commence early nutrient release after planting. Pre - emergence weed control was done by applying Atrazin® 4 kg ha⁻¹ and Glyphosate, while subsequent weeding was complemented with rouging using hand hoes. The plots were well irrigated twice in a week to field capacity throughout the duration of the experiment using sprinklers.

DATA COLLECTION AND STATISTICAL ANALYSIS

Data on growth and yield components of maize were obtained on ten randomly selected and tagged plants from the two middle rows. Data on growth parameters were taken at six weeks after emergence; plant height (measured in cm, using the meter rule in cm), stem diameter (measured in cm, using the Vernier caliper), leaf area was obtained by measuring the length of a fully expanded tagged leaf and the breadth at mid leaf. The

product of the length and the width was multiplied by 0.75 which is the calibration factor for maize leaf (Francis *et al.*, 1969), Number of ears per plant, Number of rows per cob, Number of kernels per row, Number of kernels per cob and 1000-kernel weight were also recorded. Total grain yield was determined in grams at 15.0 % moisture content level by weighing grains obtained after air drying and shelling. Data collected were subjected to analysis of variance (ANOVA) using the General Linear Model of SAS (2009). Significant means were separated using Duncan Multiple Range Test at $\alpha=0.05$.

RESULTS

The N content in the soil were very low in both 2015 (0.06%) and 2016 (0.05%), respectively. The P was lower in 2015 (1.16) than 2016 (6.84 mg/kg) (Table 1). The compost was rich in organic carbon (5.25) with carbon - nitrogen ratio (7.47), the quantity of Iron (959.0), Zinc (436.0) and Manganese (597.0) in the compost were also high.

There was no significant difference in the plant heights of the two maize varieties due to fertilizer rates in 2015 (Table 2 & 3). Similarly, the two maize varieties were also not significantly different across the various fertilizer application rates in 2015 (Table 2 & 3). Fertilizer significantly influenced plant height of the two maize varieties in 2016 ($p<0.05$). Highest plant height was observed when 50 kg N ha⁻¹ + 10 t ha⁻¹ (153.92 cm) was applied, this was however not significantly different from plant heights obtained at the other fertilizer application rates, while the control had the least plant height of 126.15 cm. Maize variety TZPBSR-W (150.25 cm) were taller than ILE-1-OB (138.82 cm) in 2016 (Table 2 & 3).

Stem diameters of the maize varieties were significantly influenced by varying rate of fertilizer application in 2015 and 2016

respectively ($p < 0.001$) (Table 2). In 2015, 100 kg N ha⁻¹ (27.78 cm) produced widest stem diameter followed by 100 kg N ha⁻¹ + 10 t ha⁻¹ (22.72 cm) which was not significantly different from 50 kg N ha⁻¹ + 10 t ha⁻¹ (21.87 cm) (Table 3). The control however gave the least stem diameter size of 17.77 cm. In 2016, 100 kg N ha⁻¹ + 10 t ha⁻¹ (25.02 cm) gave widest stem diameter, though not significantly different from 50 kg N ha⁻¹ + 10 t ha⁻¹ (23.92 cm) (Table 3). There was no significant difference in the sizes of stem diameters obtained at 10 t ha⁻¹ (21.63 cm), 100 kg N ha⁻¹ (20.53 cm) and 50 kg N ha⁻¹ (19.37 cm), but the control had least stem diameter of 16.22 cm. The stem diameters of the two maize varieties were not statistically different in 2015 and 2016 seasons.

Leaf area was significantly influenced by rate of fertilizer in 2015 and 2016 ($p < 0.001$) (Table 2). The two maize varieties were not significantly different in leaf area sizes in the two years of the trial. Largest leaf area was obtained in 2015 under 50 kg N ha⁻¹ + 10 t ha⁻¹ (647.47 cm²), 100 kg N ha⁻¹ + 10 t ha⁻¹ (653.48 cm²) or 100 kg N ha⁻¹ (623.42 cm²) (Table 3). The leaf areas were however not significantly different among the rates while the control produced the least leaf area of 464.28 cm². In 2016, 50 kg N ha⁻¹ + 10 t ha⁻¹ produced largest leaf area of 647.4 cm² though not significantly different from leaf areas obtained under 100 kg N ha⁻¹ + 10 t ha⁻¹, 100 kg N ha⁻¹ or 10 t ha⁻¹ respectively while the control had the least leaf area of 411.31 cm².

There were no significant differences in the number of ear per plant under the various fertilizer rates as well as between the two maize varieties in the two years of the trials (Table 2 & 3).

Fertilizer rates significantly influenced number of rows per cob, while the effect of variety was not significant in both 2015 and 2016 (Table 2). In 2015, application of 100 kg N ha⁻¹ + 10 t ha⁻¹ (16.06) produced

highest numbers of rows per cob followed by 10 t ha⁻¹ (14.42), 50 kg N ha⁻¹ + 10 t ha⁻¹ (14.13) which were not significantly different while the control gave the least number of rows per cob (11.42). In 2016, application of 10 t ha⁻¹ of compost gave highest number of row per cob, followed by 100 kg N ha⁻¹ + 10 t ha⁻¹ (13.92), 50 kg N ha⁻¹ + 10 t ha⁻¹ (13.90), 100 kg N ha⁻¹ (13.98), 50 kg N ha⁻¹ which were not significantly different while the control gave the least number of row per cob (13.01).

Number of kernels per row was significantly influenced by different fertilizer rates in 2015 and 2016 while the number of kernels per row of the two maize varieties was not significantly different (Table 4). In 2015, application of 10 t ha⁻² (33.59) resulted in highest number of kernels per row, which was not statistically different from those of 100 kg N + 10 t ha⁻¹ (33.28), 50 kg N ha⁻¹ + 10 t ha⁻¹ (32.23), 100 kg N ha⁻¹ (33.24), while the least number of kernels per row (20.01) was observed in the control (Table 5). In 2016, 100 kg N ha⁻¹ + 10 t ha⁻¹ (34.95) produced highest number of kernels per row followed by 50 kg N ha⁻¹ + 10 t ha⁻¹ (31.92), 10 t ha⁻¹ (32.40) and 100 kg N ha⁻¹ (30.92) while the control produced least number of kernels per row (25.26) (Table 5).

Number of kernels per cob differed significantly ($p < 0.01$) under the varied fertilizer application rates, but the two varieties were not significantly different in 2015 and 2016 respectively (Table 4). In 2015, application of 100 kg N ha⁻¹ + 10 t ha⁻¹ (541.74) produced highest number of kernels per cob, followed by 10 t ha⁻¹ (485.35) which was not significantly different from number of kernels of 50 kg N ha⁻¹ + 10 t ha⁻¹ (454.62) and 100 kg N ha⁻¹ (460.22), while the control gave least number of kernels per cob (227.92) (Table 5). In 2016, application of 100 kg N ha⁻¹ + 10 t ha⁻¹ (488.13) produced highest number

of kernels per cob, followed by 50 kg N ha⁻¹ + 10 t ha⁻¹ (442.67), 10 (457.80), 100 kg N ha⁻¹ (414.95) which were not significantly different while the control was least (326.95) (Table 5).

Weights of 1000-kernels were significantly influenced by vary rates of fertilizer application while the varieties were similar in 2015 and 2016 (Table 4). Weights of 1000-kernels were highest but not significantly different under 100 kg N ha⁻¹ + 10 t ha⁻¹ (268.38 g), 50 kg N ha⁻¹ + 10 t ha⁻¹ (263.70 g), 10 t ha⁻¹ (251.55 g) and 100 kg N ha⁻¹ (256.90 g) in 2015 (Table 5). Each of 50 kg N ha⁻¹ (222.95 g) and the control (216.50 g) gave significantly least 1000-kernel weights in 2015 (Table 5). In 2016, 50 kg N ha⁻¹ + 10 t ha⁻¹ (268.56) gave highest 1000-kernel weight though

not significantly different from 10 t ha⁻¹ (263.46) and 100 kg N ha⁻¹ + 10 t ha⁻¹ (259.38). Least 1000-kernel weights were observed in the control (221.09) and 50 kg N ha⁻¹ (210.63) (Table 5).

Grain yield differed significantly under varying rate of fertilizer application but the two varieties were not significantly different in 2015 and 2016 (Table 4). Applications of 100 kg N ha⁻¹ + 10 t ha⁻¹ (5.82 t ha⁻¹) and 50 kg N ha⁻¹ + 10 t ha⁻¹ (5.26 t ha⁻¹) produced similar and higher grain yield and significantly more than the control (2.37 t ha⁻¹) in 2015 (Table 5). In 2016, 100 kg N ha⁻¹ + 10 t ha⁻¹ (5.91 t ha⁻¹) gave highest grain yield, followed by 50 kg N ha⁻¹ + 10 t ha⁻¹ (5.78 t ha⁻¹) and 10 t ha⁻¹ (5.44 t ha⁻¹) while the control was lowest (3.14 t ha⁻¹) (Table 5).

Table 1: Physical and chemical properties of soil and compost used

Property	Soil		Compost
	2015	2016	
pH (H ₂ O)	6.00	7.25	8.30
Organic carbon (%)	0.44	0.86	5.25
C/N			7.47
Total nitrogen (%)	0.06	0.05	0.70
Available P (mg/kg)	1.16	6.84	0.91
Bulk density (Mg m ⁻³)	1.31	1.31	
ECEC(cmol)	7.11	5.56	
Base saturation (%)	99.02	99.28	
Exchangeable cation (cmol kg⁻¹)			
K	0.22	0.37	0.61
Na	0.39	0.63	0.62
Ca	5.53	3.80	4.95
Al+H	0.07	0.04	
Mg	-	-	0.92
Exchangeable micronutrient (mg/kg)			
Fe	7.10	0.06	959
Zn	3.60	0.65	436
Cu	1.10	0.15	31.0
Mn	22.8	44.10	597
Soil particle analysis			
Sand g/kg	854	842	
Silt g/kg	82	86	
Clay g/kg	64	72	
Textural class	loamy-Sandy	Loamy--Sandy	

Table 2: Analysis of variance of the mean square of growth and yield components of two maize varieties evaluated under different fertilizer application rates in Ibadan.

	D.F	Plant height (cm)		Stem diameter (cm)	Leaf Area (cm ²)		Number of ear per plant		Row per cob		
		2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Fertilizer (F)	5	316.85	719.71	25.79	60.76	29101.8	29035.64	0.04	0.37	15.98	1.06
		ns	*	***	***	2 ***	***	ns	ns	***	ns
Varieties (V)	1	560.1	1175.35	5.34	12.30	10229.6	6080.10	0.01	0.08	0.36	0.22
		ns	*	ns	ns	4 ns	ns	ns	ns	ns	ns
F x V	5	192.15	132.8	8.03	4.25	923.2	1266.4	0.09	0.13	1.31	2.20*
		ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Mean		156.97	144.54	20.69	21.12	592.79	604.8	1.38	1.69	13.70	13.72
S.E		2.67	2.99	0.53	0.57	13.21	13.63	0.04	0.07	0.31	0.15
C.V		9.98	10.8	13.49	8.93	8.40	9.37	17.54	23.22	9.64	5.63

* ** *** significant at $p < 0.05$, 0.01 and 0.1, ns not significant.

Table 3: Mean of fertilizer and variety on yield components of two maize varieties evaluated under different fertilizer application rates in Ibadan.

	Plant height (cm)		Stem diameter (cm)		Leaf Area (cm ²)		Number of ear per plant		Row per cob	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Fertilizer rates										
0 N ha ⁻¹	148.78a	126.15b	17.77c	16.23c	465.94c	411.31d	1.30a	1.21a	11.42d	13.01b
50 kg N ha ⁻¹ (A)	154.77a	136.44a	21.98ab	19.37b	567.42b	534.28c	1.47a	1.65a	12.37cd	13.41ab
100 kg N ha ⁻¹ (B)	152.73a	136.77a	22.72a	20.53b	623.42a	636.35a	1.30a	1.80a	13.84bc	13.98ab
10 t ha ⁻¹ (C)	167.60a	153.20a	18.40bc	21.63b	620.29ab	630.22a	1.50a	1.83a	14.42b	14.10a
A + C	164.63a	153.92a	21.87ab	23.92a	647.47a	648.40a	1.37a	1.87a	14.13b	13.93ab
B + C	153.87a	146.95a	22.43ab	25.02a	653.48a	637.14a	1.37a	1.77a	16.06a	13.92ab
Varieties										
ILE-1-OB	153.03a	138.82b	21.08a	20.53a	575.95a	591.83a	1.40a	1.65a	13.60a	13.80a
TZPBSR-W	160.92a	150.25a	20.30a	21.70a	609.65a	617.82a	1.36a	1.74a	13.80a	13.64a
F-test										
Fertilizer (F)	ns	*	***	***	***	***	ns	ns	***	ns
Varieties (V)	ns	*	ns	ns	ns	ns	ns	ns	ns	ns
F x V	ns	ns	ns	ns	ns	ns	ns	ns	ns	*
Mean	156.97	144.54	20.69	21.12	592.79	604.8	1.38	1.69	13.70	13.72

* ** Significant at p<0.05, 0.01, 0.1. ns= not significant † Means not followed by the alphabets are not significantly different according to Duncan Multiple Range Test.

Table 4: Analysis of variance of the mean square of yield components of two maize varieties evaluated under different fertilizer application rates in Ibadan.

	Number of kernels per row		Number of kernels per cob		1000 Kernel weight		Grain yield (t/ha)	
	2015	2016	2015	2016	2015	2016	2015	2016
Fertilizer (F)	184.64***	65.432*	80339.72***	18480.76**	2599.31**	3460.55***	14.74***	6.66***
Varieties (V)	1.50 ns	17.03 ns	97.9 ns	2142.19 ns	228.01 ns	548.73 ns	0.006 ns	0.14 ns
F x V	8.32 ns	7.67 ns	2637.39 ns	2906.53 ns	182.20 ns	149.14 ns	1.03	0.77 ns
Mean	29.92	30.76	416.53	422.80	245.82	243.63	8.30	4.87
S.E	0.95	0.76	19.72	12.27	4.52	4.31	0.27	0.23
CV	9.52	12.56	13.45	13.73	8.96	5.87	9.39	23.74

* ** *** significant at $p < 0.05$, 0.01 and 0.1, ns not significant.

Table 5: Effect of fertilizer application rates and variety on yield components of two maize varieties evaluated under different fertilizer application rates in Ibadan.

	Number of kernels per row		Number of kernels per cob		1000 Kernel weight		Grain yield (t/ha)	
	2015	2016	2015	2016	2015	2016	2015	2016
Fertilizer rates								
0 N ha ⁻¹	20.01c	25.26c	227.92d	326.95c	216.50b	210.63c	2.37d	3.14c
50 kg N ha ⁻¹ (A)	26.66b	29.13bc	329.34c	406.67b	222.95b	221.09c	3.97c	4.34bc
100 kg N ha ⁻¹ (B)	33.28a	30.92ab	460.22b	414.75ab	256.90a	238.68b	4.85b	4.63ab
10 t ha ⁻¹ (C)	33.59a	32.40ab	485.35ab	457.80ab	251.55a	263.46a	4.61bc	5.44ab
A + C	32.23a	31.92ab	454.62b	442.67ab	263.70a	268.56a	5.26a	5.78ab
B + C	33.28a	34.95a	541.74a	488.13a	263.38a	259.38a	5.82a	5.91a
Varieties								
ILE-1-OB	30.13a	30.08a	418.18a	430.54a	243.31a	239.73a	4.42a	4.42a
TZPBSR-W	29.73a	31.45a	414.88a	415.11a	248.34a	247.54a	4.54a	4.54a
F-test								
Fertilizer (F)	***	*	***	**	**	***	***	***
Varieties (V)	ns	ns	ns	ns	ns	ns	ns	ns
F x V	ns	ns	ns	ns	ns	ns	ns	ns
Mean	29.92	30.76	416.53	422.80	245.82	243.63	8.30	4.87

* ** *** Significant at p<0.05, 0.01, 0.1. ns= not significant. † Means not followed by the alphabets are not significantly different according to Duncan Multiple Range Test.

DISCUSSION

Poor soil fertility is a major feature of most tropical soils and one of the major challenges to profitable maize production in Nigeria. Nutrient depletion as a result of continuous cropping without supplementary nutrient replacement is synonymous with farming practices in South west Nigeria. However, appropriate application of soil nutrients in form of inorganic fertilizer and compost has potentials to enhance grain yield of maize. In this study, increased nutrient availability had greater effect on the various growth and yield components of the maize varieties. This could be attributed to the importance of nitrogen at increasing uptake of other nutrients. Nitrogen has been reported to enhanced the development of small roots and root hairs which in turn could facilitate the absorption ability per unit of dry weight of plant (Satchithanantham and Bandara, 2001; Gheysari *et al.*, 2009; Hammad *et al.*, 2011). Nitrogen is a major constituent of endosperm storage protein and also needed to establish and maintain enzymatic processes essential for carbon utilization and plant growth (Cazetta *et al.*, 1999). Improved general crop performances were observed in treatments which received both inorganic and organic fertilizers. The use of compost had been earlier reported to enhance both soil nutrient and the water holding capacity of soils as well as buffering rapid changes in soil pH (Shiralipour *et al.*, 1992; Tambone *et al.*, 2007). Application of 10 t ha⁻¹ of *Tithonia*-poultry compost alone in this trial produced taller maize plants with broader leaves better than maize plants which were supplied with 0, 50 and 100 kg N ha⁻¹ inorganic fertilizer. However, application of 10 t ha⁻¹ compost alone could not sustain the plant adequately beyond the vegetative developmental stage. The evidence of this was the rapid appearance of yellow lower leaves in treatments with 10 t ha⁻¹ *Tithonia* poultry compost. Explanations for this could be that the N supply by the

application of 10 t ha⁻¹ compost alone at the transition stage from vegetative to reproductive was not adequate for the N demand for post pollination activities. Hence, the need for remobilisation of N from the lower leaves for grain filling becomes inevitable. Whereas, in treatments with combine use of both fertilizers, the inorganic fertilizer may have complimented the nutrient requirement essential for the post pollination processes in maize under this study. The increase in total grain yield observed as a result of increased application of soil amendment could be attributed to increase in the various yield components. Stem diameter size was significantly influenced by increased nutrient application in this study, higher stem diameter size has been reported to have potential to remobilized stem reserves to the cob especially during the reproductive stage when the needs be (Sangoi *et al.*, 2001). Onasanya, (2009) was of the opinion that increased grain yield under N application could be attributable to increased number of gains per cob, weights of 1000 grains.

Increased maize grain yield were obtained under increased soil amendment application rates especially when 10 t ha⁻¹ of compost was added to each inorganic fertilizer rates of 50 and 100 kg N ha⁻¹ respectively. There was no much difference in grain yield obtained when 10 t ha⁻¹ of compost was applied to each of 50 kg and 100 kg N ha⁻¹ inorganic fertilizer. Application of inorganic fertilizer with compost to crop has been reported to have the advantage of providing nutrients to meet crop nutrition requirements and maintain soil health (Abedi *et al.*, 2010; Efthimiadou *et al.*, 2010; Kazemeini *et al.*, 2010). *Tithonia* (Mexican sunflower) decompose rapidly and is a very good source of N, P and K for crops (Jamal *et al.*, 2000). Hence, maize plants grown under combination of both inorganic fertilizer and *Tithonia* compost benefitted from quick release of plant nutrient

especially the macronutrient in readily available form (inorganic fertilizer) as well as high micronutrients contained in the compost (Table 1). The complimentary benefit of the use of inorganic and organic fertilizer for general crop performance was also reported by Ojeniyi, (2002). Meanwhile, combined use of inorganic fertilizer alongside with organic fertilizer had been earlier shown to be vital for the sustainability of soil productivity under intensive continuous land cultivation in Nigeria (Adepetu, 1997). Ayoola and Makinde (2001) reported that application of combined organic and inorganic fertilizer increased yield of maize (*Zea mays* L.) than sole applications of inorganic or organic fertilizers. Similarly, significance yield increase in maize was also reported when poultry manure was used in combination with inorganic fertilizer on ultisol soil of Southeastern Nigeria (Asadu and Unagwu, 2012). Similarly, Akande *et al.*, (2003) reported significant improvement in growth and yield of okra (*Abelmoschus esculentus* Moench) when ground phosphorous rock phosphate was mixed with poultry manure. Application of 50 kg N ha⁻¹ of inorganic fertilizer in combination with 10 t ha⁻¹ (10.7 kg N ha⁻¹) of *Tithonia* poultry compost is adequate to enhanced grain yield of maize in Ibadan and this recommendation could effectively replaced the 60 - 70 kg N ha⁻¹ of chemical fertilizer established recommended economic application rate for South-west Nigeria (Onasanya *et al.*, 2009).

CONCLUSION

Growth and yield components of maize were significantly enhanced with fertilizer application. Application of 50 kg N ha⁻¹ in combination with 10.7 kg N ha⁻¹ of *Tithonia* compost adequately increased growth and grain yield of maize in the Forest-Savannah-Transition agro - ecology zone of Nigeria.

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