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Impact of organic and inorganic fertilizers on growth, fruit yield, nutritional and lycopene contents of three varieties of tomato (*Lycopersicon esculentum* (L.) Mill) in Ogbomoso, Nigeria

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Field experiments were carried out to assess the impact of 100% NPK fertilizer recommendation (300 kg NPK 20:10:10), 100% Tithonia compost (TC), 75% NPK + 25% TC, 50% NPK + 50% TC, 25% NPK + 75% TC and control (non-fertilized plant) on the growth, fruit yield, nutritional and lycopene contents of three tomato varieties (Raoma VF; Ogbomoso local and Califonia wonder). The experiment was a split plot fitted into a randomized complete block design replicated three times. Data were collected on growth and reproductive parameters, fruit and seed attributes, and fruit proximate and nutritional contents. Data collected were subjected to analysis of variance to determine significant means. Significant varietal differences were observed among the tomato varieties in terms of growth, fruit yield and nutritional attributes. The plant dry matter yield was highest in Ogbomoso local and least in Roma VF. Fruit yield obtained with Ogbomoso local was 45 and 56% higher than what was obtained for Roma VF and Califonia wonder, respectively. In terms of vitamin C content, Roma VF fertilized with 50% NPK + 50% TC gave the highest value which is 23 to 67% higher than values obtained from the other treatment combinations. Again, irrespective of variety, organically grown tomato contains higher content of lycopene. It was also observed that the higher the proportion of TC compost in the treatments, the better the lycopene content. It could be concluded that the use of organic fertilizer has potential in improving the growth, fruit yield and nutritional contents of any of the three tomato varieties studied.

Key words: *Lycopersicon esculentum*, compost, inorganic fertilizers, fruit yield, nutritional quality, lycopene content.

INTRODUCTION

Tomato (*Lycopersicon esculentum* (L.) Mill) of the family Solanaceae, is one of the most important vegetable crops in the world. It is consumed fresh and as paste in all parts of the world (Alofe and Somade, 1982). Tomato plays a

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Abbreviations: TC, Tithonia compost; **WAT,** week after transplanting; **TSS,** total soluble solid.

vital role in the improvement of the diet of mankind. The fruit is adapted to various culinary uses either in the fresh form in salad or as puree in gravies, stew and soups, for the diet of the diverse cultures of the world. More than 90% of the vitamin C in human diets is supplied by fruits and vegetables (of which tomato is the most important) (Vallejo et al., 2002). Tomato fruits contain high amount of ascorbic acid and lycopene (Tindall, 1983). Lycopene, an antioxidant, is the pigment that imparts red color to some fruits, most notably tomato and watermelon. It is also a highly efficient oxygen radical scavenger and has been implicated in human health as providing protection against cardiovascular disease and some cancers, particularly that of the prostate.

Many pre- and post harvest factors influence the phytochemical contents of horticultural crops. Large genotypic variation in vitamin content was reviewed by Kurilich et al. (1999) and Vallejo et al. (2002). Other preharvest factors include climatic conditions and cultural practices (Howard et al., 1999; Lisiewska and Kmiecik, 1996; Jeffery et al., 2003). Among the cultural practices, fertilizers and soil fertility can influence the level of functional food components in crops.

The society has been increasingly concerned about environmental damage caused by agricultural activities, especially with regard to health hazards resulting from the use of agrochemicals (Van der Berge et al., 2000). Many alternative cropping systems have been developed and among them, organic agriculture has been established and certified in many countries (Adediran et al., 2003). Organic agriculture is characterized by the absence of synthetic fertilizer and pesticides in addition to the frequent utilization of organic fertilizers as sources of crop nutrients (Van der Berge et al., 2000; Adediran et al., 2003). The acceptance of crop produced can be influenced by the source of nutrients involved in its production. In the recent past, some studies have been conducted to elucidate the beneficial effects of adding crop residue compost into the soil. The practice improves soil physical, chemical and biological activities as well as improving crop yields and nutritional values (Manna et al., 1999; Akanbi and Togun, 2002; Adediran et al., 2003; Maharishnan et al., 2004; Ghosh et al., 2004; Ashutosh et al., 2006). The supply of organic materials on farms, even with the use of farm yard manure and or compost from crop residues, will likely be insufficient to overcome soil nutrient deficiency. The integration of small amount of inorganic fertilizer with the organic materials available on farms offers a strategy to meet the nutrient requirements of crops. It minimizes nutrient leaching, particularly in poor sandy soil and subsequent groundwater contamination (Manna et al., 1999). This maximizes the use of available organic resources and minimizes the use of costly purchased mineral fertilizers (Manral and Saxena, 2003; Ghosh et al., 2004). Crop growth, yield and product quality in relation to application of agro waste compost has been widely reported (Togun et al., 2003). For instance, high fruit yield due to compost application were reported on tomatoes with combine application of 2 t/ha compost and 30 kg N/ha. In most of these studies, compost application was observed to have positive effects which aid crop growth and development thereby improving the crop phytonutritional components (Togun et al., 2003).

Despite many investigations in the area of nutrition, knowledge on how organic fertilizers in combination with genotypic variation influences physical and phytochemical contents of tomato fruit is inadequate. This study assessed variability of plant growth, fruit physical and nutritional qualities among three commonly cultivated tomato varieties in Nigeria as influenced by organic and inorganic fertilizers.

MATERIALS AND METHODS

The studies were conducted at the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso in 2005 and 2007. Ladoke Akintola University of Technology Ogbomoso is located on latitude 8° 10'N and longitude 4° 10' and the altitude is about 420 m above sea level. Ogbomoso lies in the transitional zone between forest and guinea savanna. It has a bimodal rainfall pattern with peaks in July and September, with a short rainfall break in August. The bimodal rainfall of the area is between 150 and 125 mm. The temperature regime is high all the year round. The mean minimum temperature is 28°C and the maximum temperature is 33°C with a high relative humidity of about 74% all year round except in January when the dry wind blow from the north.

The vegetation of the area is composed of weed species like wild sunflower (*Tithonia diversifolia), Tridax procumbens, Talinum triangulare, Imperata cylindrica*, Sedges sp. and guinea grass mixed with scattered shrubs and trees notably locust bean trees (*Parkia biblobosa*). The experimental site has been under cassava cropping for 2 years before being cleared for use.

Two field experiments were conducted in early 2005 and 2007 cropping seasons, using a split plot in randomized complete block design replicated three times. The factors tested were three tomato varieties (Califonia wonder, Ogbomoso local and Roma VF) and six fertilizer types {0% NPK or Tithonia compost (TC); 100% NPK fertilizer recommendation (300 kg NPK 20:10:10); 100% TC; 75% NPK + 25% TC; 50% NPK + 50% TC and 25% NPK + 75% TC}. The tomato variety formed the main plot, while the six fertilizer types formed the subplot factors. The three varieties form the bulk of tomato cultivars being cultivated and adapted to most agro ecological zones in Nigeria. The Roma VF and Califonia wonder are determinate types, while Ogbomoso local is indeterminate one. The seeds of Roma VF and Califonia wonder were obtained from the Genetic and Seed Resources Unit of National Institute for Horticultural Research and Training, Ibadan, while that of Ogbomoso local was obtained from 'Arada' open market, Ogbomoso, all in Nigeria. The 100% NPK treatment was chosen based on general fertilizer recommendation for tomato plant in south west Nigeria (FPDD, 1990), while quantity of Tithonia compost (TC) applied in the 100% TC treatment was arrived at by considering the tomato N nutrient recommendation (60 kg N/ha) and the N content of TC (2.4% N). Each replicate contained all the 18 treatments combinations. The crop was spaced out 50 x 50 cm with 1 plant per stand. A subplot measured 2.5 x 2.5 m (6.25 m^2) and contained six rows of crop and each row had 6 plants making 36 plants per subplot. Each main plot measured 20 x 2.5 m (50 m^2) and gaps of 1 m separated all the sub and main plots. A replicate was 20 x 9.5 m (190 m^2) in dimension and adjacent replicates were separated by gaps of 2 m. The total experimental area was 64.0 x

9.5 m (608.0.m^2).

The seeds of the 3 tomato cultivars were sown in a box containing 1:3 top soil: compost proportion by weight (Akanbi et al., 2002). The seedlings were allowed to grow for a period of 28 days. At transplanting, healthy seedlings of each cultivar were selected and transplanted into well prepared beds on 20th of April, and 26th of April, for 2005 and 2007 experiment, respectively. Supplying of vacant stand was done a week after transplanting (WAT). Compost treatments were applied at transplanting, while NPK mineral fertilizer treatments were applied two WAT. Manual weeding was done thrice starting from 2 WAT and repeated every 3 weeks interval by hoeing. Insect pests were controlled by spraying the crops with Karate at the rate of 40 ml / 20 L water at two weeks interval starting from 2 WAT. The crops were individually staked with 1 m stake between 4 and 5 WAT.

Six plants were randomly tagged per plot for data collection. The growth parameters measured were per plant number of functional leaves and offshoots, plant stem girth and dry matter yield, while the reproductive and fruit/seed traits considered were number of flowers and fruit/plant, percentage fruit sets, fruit length and diameter, total fruit number and weight, number and weight of seeds / fruit and total fruit yield.

For determination of fruit phytochemical contents at full ripening, 12 (for 2005 experiment) and 8 (for 2007) fruit samples of uniform ripening were randomly selected per subplot and analysed for pH, total soluble solid (TSS), moisture content, crude protein, crude fibre, ether extract, vitamin C and lycopene contents. Proximate compositions were determined using AOAC (1984) method. The fruits were first homogenized in Wiley Micro-Hammer Stainless mill. The pH of the homogenized pulp was determined using pH meter. The total pulp N was determined by a semi micro-kjeldahl procedure (Bremner, 1965; Ulger et al., 1997) and fruit protein was calculated from the Kjeldahl nitrogen using the conversion factor 6.25. Crude fibre content was estimated from the loss in weight of the crucible and its content on ignition. 50 g homogenized pulp is digested in 1.25% tetra-oxo-sulphate (IV) acid and 1.25% sodium hydroxide. The digest was put in crucible and transferred into a muffle furnace at 550 for 3½ h. The weight difference expressed as a percentage of the fresh weight constitutes the percent crude fibre. Ether extract was estimated by exhaustively extracting a known weight of sample with petroleum ether (BP 60°C) using a Tecator Soxhlet apparatus. The TSS was determined by using the hand refractometer (Adebooye et al., 2006) and vitamin C content was determined by using the indolphenol dye method (Jagdish et al., 2007). The lycopene content was determined by grinding 20 ml of the homogenized pulp in 25 ml acetone and 20 ml hexane and the absorbance was read at 50 l nm using a colourimeter. Mineral elements were estimated using the AOAC (1984) method. The atomic absorption spectrometer was used to determine Ca, K and Fe. Phosphorus (P) was determined using the colorimetric molybdenum-blue procedure (Murphy and Riley, 1962).

The analysis of variance was performed on the data following procedure of Gomez and Gomez (1984) and significant means were compared using Duncan's multiple range test ($P \leq 0.05$). Correlations were run among parameters to test their association.

RESULTS AND DISCUSSION

Variability of tomato vegetative parameters in response to applied fertilizer types are presented in Table 1. Number of leaves and offshoot/plant, stem girth and dry matter yield were all significantly ($P \leq 0.05$) affected by tomato variety and fertilizer types. Ogbomoso local had the highest number of leaves/plant; this is followed by Roma VF, while Califonai wonder had the least. Combined application of 25% NPK + 75% TC produced highest number of leaves which is significantly better than what was observed with other treatments with the exception of 100% NPK treatment. Among the treatments that contained compost, there was an improvement in the parameter as the compost content increased. Variability of stem girth in relation to tomato variety and fertilizer combination was significant. Roma VF had the most robust stem, while Califonia wonder had the least. Among the fertilizer combinations, the use of 100% TC gave the best stem girth which was not significantly different from 75% NPK + 25% TC and 25% NPK + 75% TC treatments. The Roma VF fertilized with 100% TC gave the best stem girth. Number of offshoot /plant varied significantly in line with what was observed with number of leaves/plant. However, observation made on this parameter in response to applied fertilizer combination was not the same. The offshoot of tomato plant nourished with 100% TC was significantly better than values obtained for all other treatments. Dry matter production varied significantly across the varieties and fertilizer combination. The main effect of variety showed that Ogbomoso local accumulate the highest dry matter (38.5 g/plant) which was 40 and 53% higher than dry matter obtained for Califonia wonder and Roma VF, respectively. The dry matter content of tomato fertilized with 50% NPK + 50% TC was significantly higher than the ones accumulated using other fertilizer types, while Ogbomoso local fertilized with 50% NPK + 50% TC gave the highest interactive effect (80 g/plant). Variability of vegetative development of the 3 tomato varieties used could be attributed to differences in genetic makeup and variation in the source and quantity of nutrients used. Large genotypic variation in vegetative and vitamin content of some crops had been reported by Kurilich et al. (1999) and Vallejo et al. (2002). Ogbomoso local, being indeterminate one, produce more vegetative parameters over other varieties. This is in line with the report of Vallejo et al. (2002). Application of 100% NPK and 25% NPK + 75% TC gave the best vegetative development. Availability of optimum amount of nutrients for plant use is to enable plants to exhibit their optimum potential. The use of 100% NPK or 25% NPK + 75% TC could be regarded as optimum rate for tomato vegetative development. These rates contained sufficient amount of needed nutrients hence plants nourished with them have better performance. Such observation on tomato was reported by Akanbi and Togun (2002).

The interactive effects of fertilizer types and tomato variety on number of flowers/plant and percent fruit sets are presented in Figure 1. Irrespective of fertilizer types, Ogbomoso local produced the highest number of flowers, followed by Roma VF, while Califonia wonder had the least. In term of percentage fruit set, Califonia wonder had the highest followed by Roma VF, while Ogbomoso local had the least. This observation could be attributed to higher leaves and offshoot produced by the Ogbomoso

Table 1. Effect of fertilizer types and variety on vegetative growth of tomato at 8 weeks after transplanting.

Fertilizer type	Tomato variety			Mean
	Califonia wonder	Ogbomoso local	Roma VF	
Number of leaves/plant				
0 kg	5.8	22.1	8.2	12.0^{d}
100% NPK	5.2	23.0	17.2	15.1^{ab}
100% TC	10.6	22.8	10.2	14.5^{c}
75% NPK +25% TC	7.0	21.6	10.0	12.9^{c}
50% NPK + 50% TC	6.2	18.3	19.8	14.8^{c}
25% NPK + 75% TC	8.0	27.3	19.6	18.3^{a}
Mean	7.1^{c}	22.5^{a}	14.2^{b}	
Stem girth (cm)				
0 kg	1.8	2.75	2.9	2.5^{c}
100% NPK	2.8	3.1	3.3	3.0^{b}
100% TC	2.7	2.7	4.1	3.2^{a}
75% NPK + 25% TC	2.8	3.2	3.2	3.1^{ab}
50% NPK + 50% TC	2.5	3.1	3.1	2.9^{b}
25% NPK + 75% TC	2.9	3.1	3.2	3.1^{ab}
Mean	2.6^{c}	2.9^{b}	3.3^{a}	
Number of offshoot/plant				
0 kg	2.7	9.0	4.5	5.4^{e}
100% NPK	3.5	7.5	7.5	6.2^{d}
100% TC	9.0	9.2	9.2	9.2^{a}
75% NPK + 25% TC	4.7	10.3	6.5	7.2^{c}
50% NPK + 50% TC	5.5	9.3	7.2	7.3^{c}
25% NPK + 75% TC	7.5	11.5	5.7	8.3^{b}
Mean	5.5^{c}	9.5^{a}	6.8^{b}	
Dry matter (g/plant)				
0 kg	15.5	57.5	9.6	27.5^{b}
100% NPK	22.1	16.2	14.8	17.7^{d}
100% TC	21.5	37.0	11.5	23.3^{c}
75% NPK + 25% TC	27.5	19.0	19.5	22.0^{c}
50% NPK + 50% TC	20.6	80.1	39.1	46.6^{a}
25% NPK + 75% TC	14.7	21.8	13.8	15.9^{e}
Mean	20.3^{b}	38.5^{a}	18.0^{c}	

Means followed by the same letter along the column are statistically similar (DMRT, 5%).

local. The primary and secondary vines (offshoot) provided axis and loci for flower production. However, higher number of flowers may not translate into higher number of fruits. This account for the reason why Ogbomoso local did not recorded the highest percentage fruit set. The implication of this is that plant with higher potential for flower formation must have efficient accumulation of photoshynthentates in order to support the flowers. This tendency is low in Ogbomoso local, hence many of the flowers produced were aborted. This culminated into having fewer number of fruits when compared to other varieties. This observation is supported by reports of Manna et al. (1999) and Adediran et al. (2003).

The main and interactive effects of fertilizer types and tomato variety on tomato fruit and seed parameters are presented in Table 2. Fruit length and diameter as well as per fruit number and weight of seeds were all significantly affected by the applied treatments. Fruit length varied from 8.2 cm in Califonia wonder to 7.4 cm in Roma VF.

Application of 75% NPK + 25% TC gave the longest fruit. This was significantly higher than values obtained with other treatments with the exception of 100% NPK treatment. In case of fruit diameter, Ogbomoso had the widest, while Roma VF had the least. Application of

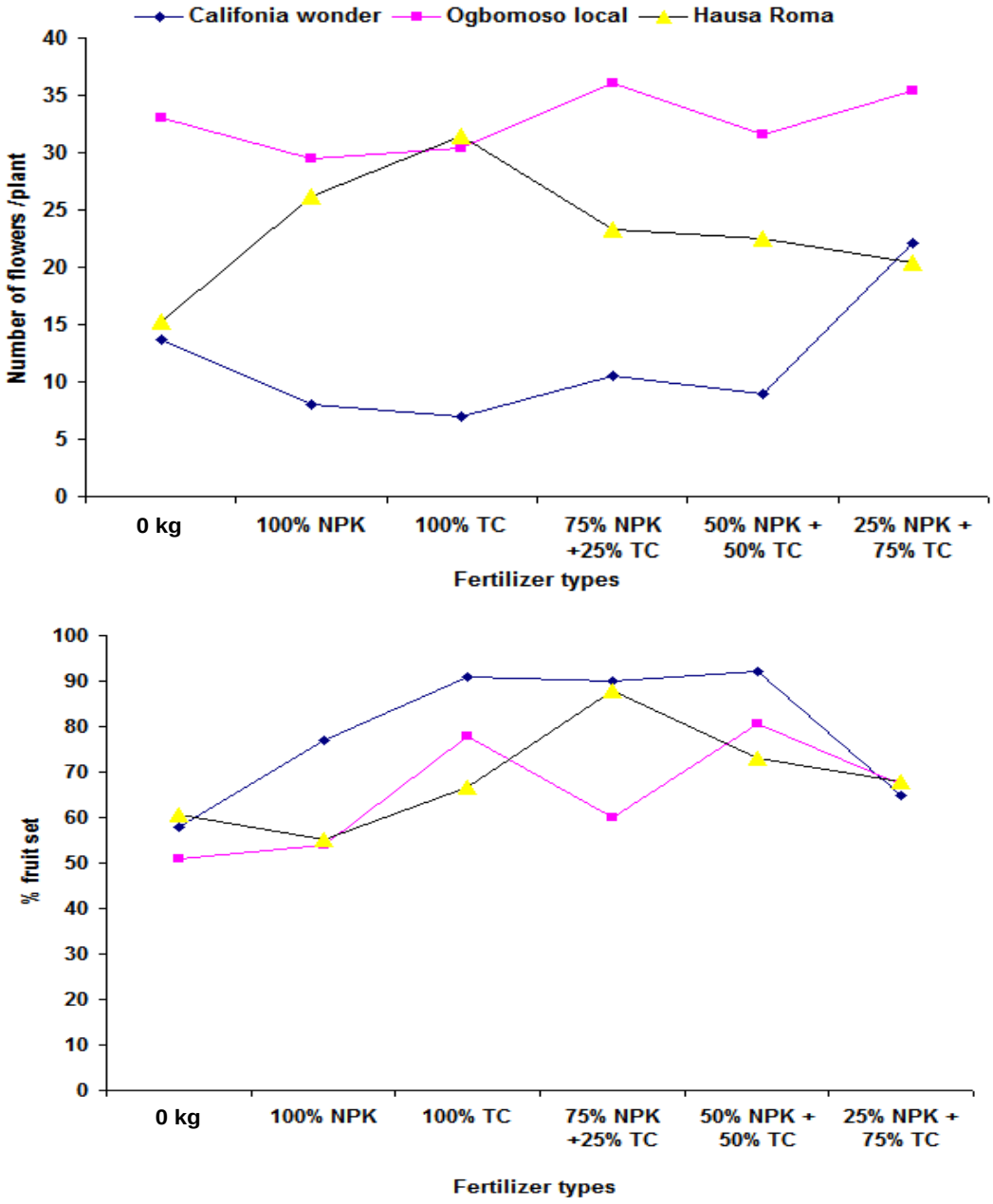

Figure 1. Effect of fertilizer types on number of flowers/plant and percent fruit sets of three varieties of tomato.

100% NPK gave the widest fruit diameter (15.9 cm), while the least (13.8 cm) was obtained with the use of 100% TC.

Per fruit number and weight of seeds varied significantly ($P \leq 0.05$). Ogbomoso local had the highest number of seeds per fruit. The value obtained with this variety was 34 and 48% higher than what was observed with Califonia wonder and Roma VF, respectively. Application of 100% TC had the highest number of seeds/fruit and it was significantly higher than other treatments. For interactive effects, Ogbomoso local that received 100% TC produced fruit that has the highest number of seeds. As much as seed weight /fruit is concern, Ogbomoso local had the highest (0.36 g /fruit) followed by 0.24 and 0.16 g/fruit obtained from Roma VF and Califonia wonder, respectively. Again, fertilizer types had significant effect on seed weight/fruit. Irrespective of variety, non fertilized plants had the heaviest seed weight, while 100% NPK treatment had the least. It is worthy to note that among the treatments that contained TC, the higher the compost content, the heavier the seeds weight per fruit.

Table 2. Effect of fertilizer types and variety on fruit and seed parameters of tomato.

Fertilizer type	Tomato variety			Mean
	Califonia wonder	Ogbomoso local	Roma VF	
Fruit length (cm)				
0 kg	6.4	8.2	8.3	7.6^{c}
100% NPK	8.3	9.5	7.4	8.4^{a}
100% TC	8.5	6.3	7.4	7.4^{d}
75% NPK + 25% TC	10.1	8.2	7.3	8.5^{a}
50% NPK + 50% TC	7.4	7.1	6.7	7.1^{e}
25% NPK + 75% TC	8.2	8.0	7.3	7.8^{b}
Mean	8.2^{a}	7.9^{b}	7.4^{c}	
Fruit diameter				
0 kg	14.3	19.8	11.9	15.4^{b}
100% NPK	15.0	19.8	12.9	15.9^{a}
100% TC	16.2	17.7	7.4	13.8^{c}
75% NPK + 25% TC	16.0	18.5	7.3	13.9^{c}
50% NPK + 50% TC	15.2	19.2	12.2	15.5^{ab}
25% NPK + 75% TC	14.5	14.4	12.5	13.9^{c}
Mean	15.2^{b}	18.2^{a}	10.7^{c}	
Number of seeds/fruit				
0 kg	27.3	70.6	62.4	53.4^{d}
100% NPK	25.0	72.3	47.4	48.2^{e}
100% TC	60.3	106.6	64.4	77.1^{a}
75% NPK + 25% TC	41.0	73.1	65.7	59.9^{b}
50% NPK + 50% TC	33.0	71.0	62.0	55.3^{c}
25% NPK + 75% TC	41.0	76.0	62.0	59.7^{b}
Mean	37.9^{b}	78.3^{a}	60.7^{a}	
Seed weight/fruit (g)				
0 kg	0.14	0.53	0.24	0.32^{a}
100% NPK	0.18	0.12	0.17	0.13^{e}
100% TC	0.22	0.14	0.25	0.23^{d}
75% NPK + 25% TC	0.15	0.46	0.24	0.25^{c}
50% NPK + 50% TC	0.15	0.53	0.16	0.34^{b}
25% NPK + 75% TC	0.14	0.38	0.34	0.23^{c}
Mean	0.16^{c}	0.36^{a}	0.24^{b}	

Means followed by the same letter along the column are statistically similar (DMRT, 5%).

Responses of the tomato fruit yield in relation to applied treatments are presented in Figure 2. Significant varietal differences existed in fruit yield of the three tomato varieties tested in this study. Ogbomoso local produced highest fruit yield (20.9 t/ha), followed by Roma VF (15.3 t/ha) and the least was obtained from Califonia wonder (11.3 t/ha). Applied fertilizer types significantly influenced the fruit yield. Application of 100% TC produced the highest fruit yield, while the least was obtained from nonfertilized control treatment. The Ogbomoso local that received 100% TC, produced the highest interactive effect.

Table 3 contained data collected on effects of fertilizer types on elemental composition of fruit of three varieties of tomato. The varietal differences, fertilizer types and their interactions are significant on tomato fruit elemental compositions. The P content varied from 21.9 g/100 g in Roma VF to 18.5 g/100 g in Califonia wonder. The fruits harvested from tomato plants nourished with 100% TC contained the highest P. The value obtained with this treatment was significantly higher than what was obtained with other treatments with the exception of 25% NPK + 75% TC. The K, Ca and Mg contents of Ogbomoso local and Roma VF were similar and

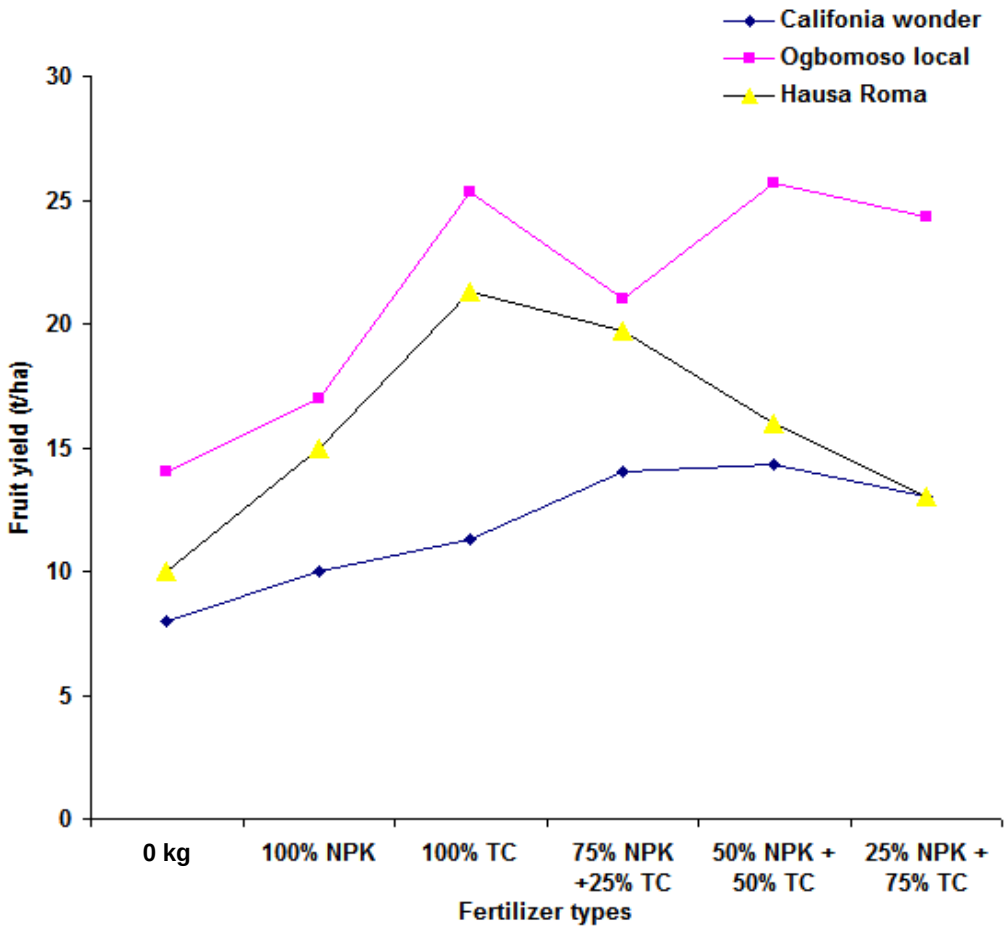

Figure 2. Effect of fertilizer types on fruit yield of three varieties of tomato.

significantly higher than that of Califonia wonder. The K and Ca contents of 25% NPK + 75% TC treatment were higher than values obtained from other treatments. Magnesium content of plants fertilized with 100% TC (19.9 g/100 g) was the highest, while that of 75% NPK + 25% TC (16.3 g/100 g) was the least. Tomato fruit proximate composition in response to varietal differences and fertilizer types are shown in Table 4. All the parameters considered were significantly influenced by variety, fertilizer types and their interaction.

The fruit pH ranges from 5.17 in Ogbomoso x 100% TC to 5.82 in Roma VF x 50% NPK + 50% TC. The crude protein content of Ogbomoso local (2.21 g/100 g) compared favourably with 1.81 g/100 g obtained from Califonia wonder. Among the two way interactions, Ogbomoso local variety fertilized with 100% TC had the highest crude protein, while the least was obtained from Roma VF fertilized with 100% TC. The crude fibre of Ogbomoso local was higher than those of the other two varieties. Non fertilized Ogbomoso local variety had the highest crude fibre contents. Ether extracts ranges from 1.27 g/100 g in non fertilized Ogbomoso local variety to 0.36 in Califonia wonder x 75% NPK + 25% TC. On the average, Califonia wonder contained higher amount of total soluble solid, this is followed by Roma VF, while Ogbomoso local had the least.

Effect of variety, fertilizer types and their interactions are significant on tomato fruit vitamin C and lycopene contents. The vitamin C content of Roma VF was the highest (30.1 mg /100 g), while the least (17.1 mg /100 g) was obtained from Ogbomoso local. Among the fertilizer types used, 75% NPK + 25% TC and 50% NPK + 50% TC had similar vitamin C contents, and their values were significantly higher than vitamin C contents of other treatments. The two way interactive effects of variety and fertilizer types revealed that Roma VF nourished with 75% NPK + 25% TC or 50% NPK + 50% TC had the highest vitamin C content.

Results in Table 5 showed that fertilizer types had significant effects on fruit lycopene contents of three varieties of tomato used. As with the vitamin C, Roma VF variety had the highest lycopene content (0.59 mg/100 g) which was similar to 0.52 mg/100 g obtained from the fruit of Califonia wonder. The lycopene contents of these two varieties were significantly better than that of Ogbomoso local (0.41 mg/100 g). Fertilizer types had

Table 3. Effect of fertilizer types on the phosphorus, potassium, calcium and magnesium contents of three variety of tomato.

Fertilizer type	Tomato variety			Mean
	Califonia wonder	Ogbomoso local	Roma VF	
Phosphorus content (g 100 g^{-1})				
0 kg	13.7	22.5	28.5	21.6^{b}
100% NPK	15.6	16.4	16.8	16.3^{e}
100% TC	24.8	17.7	25.2	22.6^{a}
75% NPK + 25% TC	21.7	18.3	18.6	19.5^{c}
50% NPK + 50% TC	15.9	19.3	19.9	18.4^{d}
25% NPK + 75% TC	19.6	26.3	22.4	22.8^{a}
Mean	18.5^{c}	20.1^{b}	21.9^{a}	
Potassium content (g 100 g^{-1})				
0 kg	3.1	5.4	4.2	4.2^{d}
100% NPK	3.6	3.7	5.5	4.2^{d}
100% TC	4.5	4.4	6.1	5.0^{c}
75% NPK + 25% TC	3.9	5.7	7.4	5.7^{b}
50% NPK + 50% TC	4.4	6.3	6.6	5.8^{b}
25% NPK + 75% TC	4.9	9.5	5.9	6.8^{a}
Mean	4.1^{b}	5.8^{a}	5.9^{a}	
Calcium content (g 100 g^{-1})				
0 kg	3.1	5.4	4.2	4.2^{d}
100% NPK	3.6	3.7	5.5	4.2^{d}
100% TC	4.5	4.4	6.1	5.0^{c}
75% NPK + 25% TC	3.9	5.7	7.4	5.7^{b}
50% NPK + 50% TC	4.4	6.3	6.6	5.8^{b}
25% NPK + 75% TC	4.9	9.5	5.9	6.8^{a}
Mean	4.1^{b}	5.8^{a}	5.9^{a}	
Magnesium content (g 100 g^{-1})				
0 kg	15.2	18.6	21.3	18.4^{c}
100% NPK	17.3	19.3	19.5	18.7^{b}
100% TC	18.8	18.6	22.4	19.9^{a}
75% NPK + 25% TC	16.9	17.5	14.6	16.3^{e}
50% NPK + 50% TC	18.3	16.2	17.5	17.3^{d}
25% NPK + 75% TC	14.9	15.7	18.8	16.5^{e}
Mean	16.9^{c}	17.7^{b}	19.0^{a}	

Means followed by the same letter are statistically similar (DMRT, 5%).

significant effect on tomato fruit lycopene content. Application of 100% TC gave the highest value (0.71 mg/100 g), while the least (0.38 mg/100 g) was obtained from non fertilized plants. The interactive effects of the two factors tested showed that Roma VF variety fertilized with 100% TC produced fruits that contained the highest amount of lycopene.

Crop growth, yield and product quality in relation to application of compost or in combination with small doses of mineral fertilizer has been widely reported (Togun et al., 2003). High fruit yield and nutrient contents of plants nourished with organic fertilizer could be due to the fact that the materials not only contained sufficient nutrients but the nutrients are slowly released to the plants. This prevents nutrient loss and leaching, as well as improving nutrient use efficiency. All these facilitate higher production of economic part of the plant. It could be observed that the higher the compost contents of some treatments, the better the plant performance in terms of fruit yield and quality. Many research works have reported higher nutritional values of organically grown vegetables when compared with inorganic ones. This

Table 4. Effect of fertilizer types on some fruit proximate qualities of three varieties of tomato.

Tomato variety	Fertilizer type	pH	Moisture Content (%)	Crude protein (g/100 g)	Crude fibre (g/100 g)	Ether extract (g/100 g)	Total Soluble solid (g/100 g)
Califonia wonder	0 kg	5.38^{b}	90.12^{d}	1.66^{d}	1.33^{c}	0.64^{d}	4.1^{c}
	100% NPK	5.40^{b}	91.78^{c}	1.45^{e}	1.24^{e}	1.03^{b}	4.2^{c}
	100% TC	5.48^{b}	91.89^{c}	2.30^{b}	1.44^{b}	0.93^{c}	6.7^{a}
	75% NPK + 25% TC	5.81^{a}	91.76^{c}	1.73^{d}	1.31^{c}	0.36^{f}	5.6^{ab}
	50% NPK + 50% TC	5.70^{a}	91.64^{c}	1.92^{c}	1.35^{c}	0.77^{c}	6.2^{a}
	25% NPK + 75% TC	5.80^{a}	91.44^{c}	1.80^{d}	1.41^{b}	0.84^{c}	5.9^{a}
	Mean	5.60	91.44	1.81	1.35	0.76	5.45
Ogbomoso local	0 kg	5.02^{d}	90.05^{d}	1.98^{c}	1.72^{a}	1.27^{a}	2.9^{d}
	100% NPK	5.30^{b}	90.08^{d}	2.50^{ab}	1.68^{a}	1.25^{a}	3.9^{c}
	100% TC	5.17^{c}	90.48^{d}	3.08^{a}	1.53^{ab}	1.18^{b}	3.8^{c}
	75% NPK + 25% TC	5.31^{b}	90.66^{d}	2.80^{ab}	1.62^{a}	1.21^{ab}	4.2^{c}
	50% NPK + 50% TC	5.28^{c}	92.68^{b}	1.52^{d}	1.22^{e}	0.41^{e}	5.0^{b}
	25% NPK + 75% TC	5.31^{b}	91.89^{c}	1.40^{e}	1.20^{e}	0.35^{e}	4.1^{c}
	Mean	5.23	90.97	2.21	1.50	0.95	3.98
Roma VF	0 kg	5.38^{b}	92.67^{b}	1.60^{d}	1.28	0.82^{c}	3.9^{c}
	100% NPK	5.40^{b}	92.65^{b}	2.10^{b}	1.34^{c}	0.97^{c}	5.2^{b}
	100% TC	5.50^{b}	93.24^{a}	1.42^{e}	1.29^{d}	0.53^{d}	4.8^{b}
	75% NPK + 25% TC	5.34^{b}	93.45^{a}	1.57^{d}	1.28^{d}	0.45^{d}	5.6^{b}
	50% NPK + 50% TC	5.82^{a}	92.88^{a}	1.48^{d}	1.23^{e}	0.56^{d}	5.2^{b}
	25% NPK + 75% TC	5.80^{a}	94.38^{a}	1.64^{d}	1.38^{c}	0.58^{d}	4.9^{b}
	Mean	5.54	93.21	1.64	1.30	0.65	4.93

Means followed by the same letter along the column are statistically similar (DMRT, 5%).

Table 5. Effect of fertilizer types on fruit vitamin C and lycopene contents of three varieties of tomato.

Fertilizer type	Tomato variety			Mean
	Califonia wonder	Ogbomoso local	Roma VF	
Fruit vitamin C (mg /100 g)				
0 kg	12.4	12.4	16.8	13.9c
100% NPK	22.1	18.9	28.5	23.2b
100% TC	19.6	15.3	28.9	21.3bc
75% NPK + 25% TC	26.7	19.2	38.0	27.9a
50% NPK + 50% TC	26.1	21.6	38.2	28.6a
25% NPK + 75% TC	25.1	15.0	30.4	23.5b
Mean	22b	17.1c	30.1a	
Fruit lycopene content (mg /100 g)				
0 kg	0.41	0.32	0.42	0.38d
100% NPK	0.40	0.31	0.57	0.43c
100% TC	0.78	0.57	0.79	0.71a
75% NPK + 25% TC	0.54	0.42	0.61	0.52b
50% NPK + 50% TC	0.50	0.38	0.63	0.50b
25% NPK + 75% TC	0.49	0.48	0.51	0.48c
Mean	0.52a	0.41b	0.59a	

Means followed by the same letter along the column are statistically similar (DMRT, 5%).

could explain the better quality of tomato fruit nourished with pure compost (100% TC) or that contained high amount of compost. Compost contained many active sites which improved soil cation exchange capacity (CEC) and fertility. This stimulates better nutrient uptake and utilization by the crop. In the present study, combine application of compost with small amount of NPK improved the efficiency of the former.

Conclusion

Application of fertilizer whether organic or inorganic, improved the growth and fruit yield and fruit quality of tomato. Integrated use of organic and inorganic fertilizers was found to be better than using each alone. In this study, combine application of 50% NPK and 50% TC was found to be the best treatment. This same treatment produced the highest fruit yield which compared favourably with what was obtained with 100% NPK treatment.

Conflict of interests

The author(s) did not declare any conflict of interest.

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