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The Performance of Two Guava (*Psidium guajava* L.) Varieties Supplied with Organic and Inorganic Fertilizer under Tropical Conditions

Gbenga Akinwumi* • **Vincent Umeh** • **Isaac Olabode** • **Semeton Amosu** • **Babashola Adelaja**

National Horticultural Research Institute. P.M.B.5432, Ibadan, Oyo State, Nigeria

Corresponding author: * **gbenakinwumi@yahoo.com**

ABSTRACT

Mineral nutrition is a factor that can easily be modified for plant growth, and consequently soil can be amended to alleviate limitations of nutrient availability and/or absorption in many horticultural practices. Generally, the amendments provide soil and biological factors necessary for improved plant growth by affecting changes in plant growth and development, and particularly soil chemical composition. A trial was conducted to evaluate the performances of two varieties of guava supplied with poultry manure and inorganic fertilizers applied alone or in combination for over a period of two years. Two varieties of guava seedlings namely 'Allhabad' and 'White delicious' were transplanted to the field. Cured poultry manure and NPK15:15:15 were used as organic and inorganic fertilizer respectively at the rates of 0.28 t/ha organic fertilizer + 75 kg/ha NPK inorganic fertilizer at four application per year (F_1), inorganic fertilizer at 150 kg/ha NPK at four application per year (F_2), 0.56 t/ha organic fertilizer only (F_3) and control (no fertilizer) F_0. Result showed that a combination of organic + inorganic fertilizers performed better in terms of growth parameters assessed among the treatments in both varieties than plants supplied with full organic fertilizer (0.56t/ha poultry manure). However, 'Allahabad' had the highest stem girth and canopy cover while 'White delicious' had the tallest plants. The combined application of poultry manure and NPK fertilizer gave the best growth performance.

Keywords: cured poultry manure, fertilizer mixture, guava varieties, Nigeria

INTRODUCTION

Guava (*Psidium guajava* L.) is one of the mostly cultivated fruit tree crops in the tropics and subtropics. It is native to tropical parts of America and the only member of Mytaceae cultivated worldwide (Rehm and Espig 1991). It has a great potential for extensive commercial production because of its ease of cultivation, high nutritional value and wide range of value added products.

Guava is one of the most nutritionally complete tropical fruits, with high vitamin C level (Malavolta and Soybihe 1951), reasonable mineral salt contents (Ca, Se, Cu, P, Mg, Fe), folic acid and vitamins A and B complex. Guava is also rich in Zn, fiber, niacin, lycopene, and vitamin E (Choudhury *et al.* 2001). It also contains 82.5% water, 2.45% acid, 4.45% reducing sugars, 5.23% non reducing sugars, 9.73% Brix and 0.48% ash. It is used in many preparations such as jellies, cheese and juice. Nevertheless, these characteristics are dependent upon cropping conditions including variety, mineral nutrition, maturity stage, and weather conditions during fruit development (Cardoso *et al.* 2002).

In Nigeria, guava production has attracted many socio-economic benefits to stakeholders as a component of the regional agribusiness. Nevertheless, guava growers from this region have neither improved their cropping systems nor adopted ideal postharvest practices for export beyond regional boundary.

Guava is adapted to different rainfall condition ranging from 1000 to 2000 mm per annum and can be grown at an altitude of 1500 mm above sea level, though areas below 1000 mm above sea level are most suitable (Macdonald and Low 1984). Guava tolerates a wide range of soil acidity (pH 4.5-8.2) and often displays some tolerance to salinity (Rehm and Espig 1991). It tolerates temperatures between 16 and 45°C, although highest yields are obtained at mean air temperature of 23 to 28°C (Menzel 1985).

Research on the improvement of guava cropping practices such as mineral requirements and harvesting time, can produce different results with regard to fruit quality and better post harvest conservation. Besides, more attention is being paid to cultivar peculiarities and this can explain specific responses of guava in various locations. The extrapolation of data from one region to another cannot be appropriate. Hence local research for factors influencing fruit quality is needed (Esteves and Carvalho 1982).

Studies on the effect of fertilizer rates on the growth of guava are able to give the information about the role nutrients play on the synthesis of specific components in the fruit formation. For example high nitrogen (N) and potassium (K) requirements for guava have been reported in various studies (Natale 1993; Gonzaga Neto *et al.* 1998). Nitrogen is part of amino acids, proteins and nucleic acids, and plays a role in important processes such as ionic absorption, photosynthesis, respiration, cell division and differentiation (Malavolta *et al.* 1989). Potassium acts in the cell turgor mechanism, carbohydrate transportation, and fruit quality (Marschner 1995). Consequently, while nitrogen is fundamental for plant structure, facilitating growth and yield, potassium promotes, by transportation of assimilates, an increase of fruit weight, flavor, taste, and storability.

Guava is a fast grower and a heavy feeder and benefits from regular applications of fertilizer. The plant respond to a fertilizer mix applied once a month at the early growth and bimonthly in the second year with gradual increase in fertilizer quantity by the end of the second year (Morton 1987). It is believed that any measure taken to boost both the growth rate, fruit yield and fruit quality will definitely have positive effect on overall economic returns and crop utilization this explain the need for the present study to be undertaken. Therefore, the objective of this study was to

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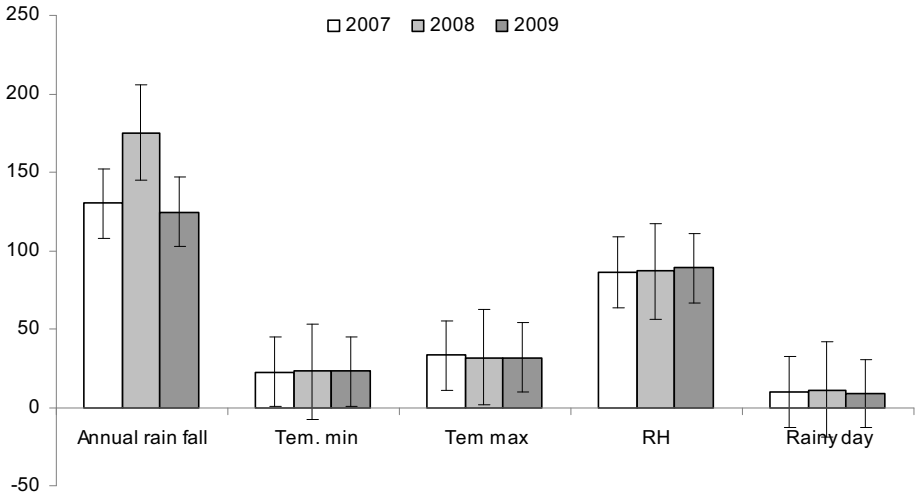

Fig. 1 Annual mean climatic data of experimental station (2007-2009). Computed from NIHORT, metrological station weather for Ibadan.

evaluate the performance of two varieties of guava seedlings supplied with organic and inorganic fertilizer alone or in combination with the ultimate aim of improving the productivity of the crop.

MATERIALS AND METHODS

This study was conducted at the National Horticultural Research Institute (NIHORT), Ibadan, Oyo State (7° 30' N, 3° 54' E, 234 m above sea level). The experimental site, Ibadan is located in the savannah rain-forest transition agroecological zone and the soil belongs to the broad group Alfisol (USDA 1975) of the basement complex, though, locally classified as Ibadan series (Smyth and Montgomery 1962). The rainfall is bimodal, with a total of annual mean rainfall of 1299.2, 1750.6 and 1245.2 mm in 2007, 2008 and 2009, respectively. The average annual mean minimum and maximum temperatures were 22.60, 22.83 and 22.83°C and 33.08, 31.83 and 31.92°C, respectively (**Fig. 1**).

The site was ploughed and harrowed. Prior to planting, 10 core soil samples, randomly taken from 0-15-30 cm soil were thoroughly mixed inside a plastic bucket to form a composite which was later analysed for physical and chemical properties. The organic fertilizer (cured battery cage poultry droppings) used for the experiment was analysed for major nutrients. Two varieties of guava seedlings 'White delicious' (V_1) and 'Allhabad' (V_2) of 8 months old were transplanted at a spacing of 6 m × 6 m. The experimental design was a 2 × 4 factorial, laid out in randomized complete block with three replicates. The imposed treatments were:

i) 0.28 t/ha organic fertilizer + 75 kg/ha NPK inorganic fertilizer at four application per year (F_1).
ii) inorganic fertilizer at 150 kg/ha NPK at four application per year (F_2).
iii) 0.56 t/ha organic fertilizer only (F_3).
iv) Control (no fertilizer) F_0.

NPK 15:15:15 fertilizers from norres fertilizer company Port-Harcourt, Nigeria and cured poultry manure served as sources of inorganic and organic fertilizer respectively. Weeding was done on a regular basis, using a slasher to run in between stand rows and manual hoeing to remove left over weeds in the immediate surroundings of the stands. Poultry manure was collected from a local farmer and analyzed for chemical characteristics as follows: Cations (Ca, Mg and K) were determined by dry ashing in a muffle furnace at 500°C, diluted using *aqua regia* (acid mix of HCl/HNO_3) and analyzed using an atomic absorption spectrophotometer. Phosphorus was extracted by dry ashing and analyzed by colorimetry (Murphy and Riley 1962). Data were reported as a percentage of dry matter. Total N was determined from a wet acid digest (Buondonno *et al.* 1995) by colorimetric analysis (Anderson and Ingram 1993).

Data were collected on plant height, stem girth, number of leaves and canopy cover from 4 - 28 months after transplanting and were subjected to analysis of variance using General Linear Model (GLM) procedure of Statistical Analysis System (SAS Inst. 2003). Means of significant tests were compared using Duncan's Multiple Range Test (DMRT) at the 0.05 level of probability.

RESULTS

The results of the experimental site's soil physical and chemical analyses before cropping and those of the organic fertilizers used are presented in **Table 1**. The soil is loamy sand in nature, with pH of 5.17. This level is suitable for many tropical crops. The organic carbon of 0.57% and total nitrogen of 0.14% were low. The available P of 2.37 cmol/kg was very low. The exchangeable bases (K, Ca, Mg and Na) were low. The extractable minerals such as Zn and Mn were high. Poultry manure was slightly acidic and low in macronutrient with very low contents of cation. The C:N ratio = 4:1 reveals a normal nitrogen content and a good capacity for mineralization. **Table 2** shows the effects of fertilizer types and guava varieties on the plant height of guava. Significant differences were observed in the various months of observation after transplanting. Twenty eight month after transplanting (that is the last month of observation), there were significant differences in plant height under various fertilizer types (135.02-194.03 cm) with combined fertilizers (F_1) having highest value. A significant difference was also observed in the two varieties with 'White delicious' having the highest value. There was no interaction effect between the fertilizer and variety on plant height 28 months after transplanting.

Table 3 shows the effects of fertilizer types and guava varieties on stem girth. Significant differences were observed in the treatments between the various months of observation after transplanting but variety did not significantly affect stem girth. Significant increases were observed under various fertilizer types compared to the control. However organic fertilizer combined with inorganic fertilizer (F_1) recorded highest value (20.75 cm). There was no interaction between the fertilizer and variety on stem girth at 28 months after transplanting.

Although significant differences in canopy cover were observed between the treatments and varieties during all the months of observations up to 25 months after transplanting, no significant differences were observed at 28 months after transplanting (**Table 4**). Organic fertilizer (F_3) applied alone and 'Allhabad' showed the highest values of 209.32 and 178.81 cm, respectively. There was also no interaction between fertilizer and variety.

Vegetative growth was improved by the three treatments (F_1, F_3 and F_2) tested, compared with non-fertilized control (F_0). The best performance of guava variety was consistently observed under the combination of organic and inorganic fertilizers which shows that there was provision of more nutrients (assimilates) by the combination. This abun-

Table 1 Physicochemical characteristics of composite soil (0-15-30 cm) at the experimental site before planting and poultry manure.

Soil (%)			pH	Available P	Exchangeable				Extractable				
Organic matter	Organic carbon	Total nitrogen	H_2O	(cmol/kg)	Ca	Mg	K	Na	Zn	Mn	Sand	Silt	Clay
					(cmol/kg)				(ppm)		(%)		
0.98	0.57	0.14	5.17	2.37	1.03	0.73	0.14	0.10	79.63	126.23	86.53	9.40	4.06
Poultry manure (%)					(%)								
					Ca^{2+}	K^+	Mg^{2+}	Na^+	Mn^{3+}	Fe^{2+}	Zn^{2+}	Cu^{2+}	
11.58	2.80	0.66	5.9	5.6	0.009	0.004	0.005	0.019	0.069	0.11	0.029	0.006	

Table 2 Effect of organic and inorganic fertilizer on the plant height of two varieties of guava.

Plant height (cm)									
Months after transplanting									
Treatments	**4**	**7**	**10**	**13**	**16**	**19**	**22**	**25**	**28**
Fertilizer types									
F_0	26.38 c	36.17d	50.33 b	72.28 b	90.08 b	111.98 b	121.33 b	132.77 b	135.20 b
F_1	58.37 a	72.50 a	78.60 a	90.12 a	116.38 a	135.63 a	146.90 a	173.58 a	194.03 a
F_2	39.50 b	48.23 c	59.73 b	86.18 a b	107.55 a	130.33 a	140.41 a	159.67 a b	165.27 a b
F_3	47.20 b	61.02 b	80.35 a	96.42 a	118.43 a	142.00 a	155.28 a	183.03 a	190.55 a
SE	3.36	2.85	3.53	4.84	4.40	5.23	5.38	10.50	10.26
Varieties									
V_1	28.39 b	40.66 b	53.19 b	79.44 b	107.61 a	133.27 a	146.73 a	178.54 a	190.96 a
V_2	57.33 a	68.30 a	81.32 a	93.01 a	108.61 a	126.70 a	135.23 a	145.98 b	151.57 b
SE	2.38	2.02	2.50	3.42	3.11	3.70	3.80	7.43	7.25
F X V	*	*	*	*	NS	NS	NS	NS	NS

Values followed by the same letter under each treatment in the same column are not significantly different at $P < 0.05$ (DMRT). F : Fertilizer, V: Varieties, NS: Not significant, *: Significant

Table 3 Effect of organic and inorganic fertilizer on the stem girth of two varieties of guava.

Stem girth (cm)									
Months after transplanting									
Treatments	**4**	**7**	**10**	**13**	**16**	**19**	**22**	**25**	**28**
Fertilizer types									
F_0	1.43 c	2.04d	2.38 c	6.06 c	7.86 b	9.73 b	10.27 b	12.19 b	12.61 b
F_1	3.23 a	4.39 a	4.84 a	9.19 a	11.81 a	14.42 a	15.53 a	19.56 a	20.75 a
F_2	2.18 b	3.02 c	3.80 b	7.35 b c	9.71 a b	12.17 a b	12.80 a b	16.55 a b	17.62 a
F_3	2.77 a b	3.69 b	4.71 a	8.10 a b	10.29 a	12.58 a b	14.22 a	16.98 a	18.24 a
SE	0.20	0.18	0.29	0.49	0.71	1.06	1.04	1.48	1.55
Varieties									
V_1	1.66 b	2.15 b	2.73 b	6.31 b	8.64 b	11.08 b	12.23 a	15.88 a	16.93 a
V_2	3.15 a	4.41 a	5.14 a	9.05 a	11.20 a	13.38 a	14.18 a	16.76 a	17.67 a
SE	0.14	0.13	0.20	0.34	0.50	0.75	0.74	1.05	1.10
F X V	*	*	NS	NS	NS	NS	NS	NS	NS

Values followed by the same letter under each treatment in the same column are not significantly different at P < 0.05 (DMRT). F : Fertilizer, V: Varieties, NS: Not significant, *: Significant

Table 4 Effect of organic and inorganic fertilizer on the Canopy cover of two varieties of guava.

Canopy cover (cm)									
Months after transplanting									
Treatments	**4**	**7**	**10**	**13**	**16**	**19**	**22**	**25**	**28**
Fertilizer types									
F_0	36.98 b	39.53 b	50.15 c	79.05 c	103.23 b	127.55 b	130.38 c	153.88 c	162.25 a
F_1	61.13 a	71.71 a	78.63 a	139.98 a	141.02 a	165.83 a	176.83 a	209.32 a	192.75 a
F_2	41.83 b	50.82 b	54.57 b c	117.57 b	128.10 a	139.32 b	149.55 b c	167.12 b c	179.93 a
F_3	51.19 a b	57.15 a b	72.55 a b	122.50 b	133.18 a	143.97 b	162.98 a b	187.65 a b	200.30 a
SE	5.62	5.62	6.02	3.62	6.75	6.96	6.93	9.17	18.12
Varieties									
V_1	24.31 b	31.89 b	42.89 b	95.90 b	111.83 b	128.75 b	142.33 b	178.81 a	176.54 a
V_2	71.26 a	77.72 a	85.06 a	133.65 a	140.94 a	159.58 a	167.54 a	180.18 a	191.08 a
SE	3.98	3.98	4.25	2.56	4.78	4.92	4.90	6.48	12.81
F X V	NS	NS	NS	NS	NS	NS	NS	NS	NS

Values followed by the same letter under each treatment in the same column are not significantly different at P < 0.05 (DMRT). F: Fertilizer, V: Varieties, NS: Not significant, *: Significant

dance of nutrients would have contributed significantly to the better growth of guava when compared with the non-fertilized control plot.

DISCUSSION

The best performance of the combination can also be attributed to the fast release of readily available mineral nutrient from chemical fertilizer in addition to the slow rate of mineralization of organic fertilizer, with attendant improvement of soil physical, chemical and biological properties (Grichs 1990). Apart from the role of organic manure as a store house for plant nutrients, major contributor to the cation exchange capacity and as a buffering agent against pH fluctuation, organic fertilizer plays a key role in sustaining soil physical, chemical and biological conditions for satisfactory growth and development of crops. The best performance of guava plant observed under a combination of

organic and inorganic fertilizers could be attributed to increased nutrient use efficiency, following the inclusion of the NPK 15-15-15 fertilizer (Iwegbue *et al.* 2011). The superiority of fig production in integrated nutrient management practices (Farm yard manure at 8.25 t/ha + Poultry manure at 2.5 t/ha + 75% Recommended dose of inorganic fertilizer) may be attributed to various reasons. The fig plants supplemented with above manurial combination resulted in vigorous growth and development. These results are in conformity with the findings of various researchers working on banana, coconut, guava, and Nagpur orange (Corrales *et al*. 2000; Goramanagar *et al.* 2000; Jayabaskaran *et al.* 2001; Marimuthu *et al*. 2001; Tirkey *et al.* 2002).

Fuchs (1970) reported that nutrients from mineral fertilizers enhanced the establishment of crops, while those from the mineralization of organic manure promoted yield when both fertilizer were combined. Ayoola and Makinde (2007) reported that the most satisfactory fertilizer treatment for improving crop performance was a judicious fortification of organic fertilizers with inorganic fertilizers. Ayoola and Adeniran (2006) reported that high and sustained crop yield could be achieved with a judicious and balanced NPK fertilizer combined with organic amendments. ICAR (1986) also reported that the incorporation of farm yard manure of 10-15 t/ha every year along with recommended dose of NPK fertilizer produced higher crop yield than the NPK treatment alone in trials conducted in India.

CONCLUSION

The use of organic fertilizer influenced the growth of guava in short run, but the combination of organic and inorganic fertilizer in right doses gave better growth compared to others fertilizer treatments applied.

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