

Research paper

Comparative effect of pig manure and NPK fertilizer on agronomic performance of tomato (*Lycopersicon esculentum* Mill)

By

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ABSTRACT

Field experiments were performed at Oba-Ile and Iju in the rainforest zone of Southwest Nigeria to investigate the effectiveness of pig manure (PG) used alone and combined with NPK fertilizer on nutrients composition, growth and yield of tomato (*Lycopersicon esculentum*). Six treatments compared were: (a) the control, (b) 25t/ha pig manure, (c) 250kg/ha NPK (15:15:15) fertilizer, (d) 187kg/ha NPK + 6t/ha PG (75:25), (e) 125kg/ha NPK + 12t/ha PG (50:50) and (f) 62kg/ha NPK + 18t/ha PG (25:75).

Treatments were replicated three times in a randomized complete block design and applied to tomato seedlings grown on beds. Soil and plant nutrients composition, growth parameters and fruit weight were determined. The test soils were sandy loam, low in organic matter and marginal in Nitrogen. Pig manure, NPK, used alone or combined at reduced rates significantly increased soil N, P, K, Ca, Mg, number of leaves, plant height, stem girth and fruit weight significantly. The 187kg/ha NPK + 6t/ha PG gave highest soil N, leaf N and fruit weight. Combinations of NPK and PG gave relatively high soil N, Ca and Mg and adequate concentrations of leaf N, P, K, Ca and Mg. Mean fruit weight per plant given by the control and 187kg/ha NPK + 6t/ha were 91 and 1016 g respectively.

Key words: Rainforest zone, nutrient composition, marginal, pig manure, adequate concentration.

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29 1. INTRODUCTION

30 Tomato (*Lycopersicon esculentum* Mill) is the most~~ly~~ widely grown vegetable in the
31 world; it improves income of growers and supplies vitamins and minerals. It is widely
32 used in the daily diet of Nigerians (Ojeniyi et al., 2007). However, the current production
figure

33 in Nigeria is ~~low, being~~ estimated at 600,000 tonnes from 50,000 ha indicating low
output. The average fruit yield

34 of about 10t/ha, ~~fruit~~ is lower than the average in tropical Africa (13.5t/ha), and the world
~~of 13.5 and~~

35 (21.9 t/ha) respectively (FAO, 1993). ~~Among the factors contributing to the low fruit~~
yield

36 of tomato are depletion of soil fertility, soil acidity and nutrient imbalance, arising from
37 continuous use of chemical fertilizers (~~Obi~~ and Akinsola, (1995). and high cost and
38 scarcity of fertilizers (Adediran et al., 2003). High soil bulk density also reduces nutrient
39 uptake, growth and yield of tomato (Adekiya and Ojeniyi, 2002). These problems can be
40 tackled by adequate application of animal manures, such as those of poultry, cattle, pig
41 and goat which pose disposal problems and environmental hazards on
accumulation(Adediran et al.,

42 2003). These manures can be used alone or in combinationed with chemical
fertilizers. ~~For~~

43 ~~example Samuel et al. (2003) asserted that~~ about 75% of farmers in the humid forest zone
of Nigeria ~~keep do rare~~ small ruminants

44 (~~Samuel et al, 2003~~). ~~I~~n Southwest and parts of the Middle belt of Nigeria such as Benue

45 State, pig dung is available in appreciatable quantity-, ~~B~~ut its use as source of crop
nutrients

46 has not received adequate research attention (Olatunji and Oboh, 2012). Giwa and

47 Ojeniyi (2004), investigated the effect of pig manure and its integrated application with
NPK

48 fertilizer on soil chemical properties and yield of tomato at Abeokuta in the derived

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- 49 Savannah zone of Southwest Nigeria. [The results indicated that P](#) pig manure and
its combination with NPK
- 50 fertilizer significantly increased growth and fruit yield of tomato and soil organic matter,
- 51 P, K and Mg. [The study by](#) Ojeniyi et al. (2007) found that pig manure increased soil

52 nutrients content and grain yield of maize. ~~Pot experiments were conducted at University~~
 53 ~~of Agriculture, Makurdi to compare effects of pig dung and other manures on production~~
 54 ~~of okra and tomato.~~ Application of pig manure at 4 and 8 t/ha significantly increased
 growth and pod

55 yield of okra significantly and ~~the manure~~ was more effective than goat manure (Olatunji
 and Oboh, 2012).

56 The need for thee use of renewable forms of energy and reduce costs of fertilizing
 crops has

57 revived the use of organic manures worldwide (Ayoola and Adeniyani, 2006). Large
 58 quantities of organic wastes such as pig and poultry manures which are effective
sources of nutrients for vegetables are abundant ~~available~~ especially in

59 urban centres ~~and are effective source of nutrients for vegetables~~ (Adediran et al, 2003).

60 ~~However,~~ The benefits derivable from of using organic materials for crop production have
 not been fully utilized in the humid

61 tropics, partly due to the huge quantities required to satisfy the nutritional needs of crops,
 62 transportation and handling costs. High and sustained crop yield can be obtained with
 63 judicious and balanced NPK fertilization combined with organic amendment (Osundare,
 64 2004). In the light of these issues, this study was conducted with these ~~se~~ objectives:

65 (a) To determine ~~ing~~ the growth, yield and nutrient composition of tomato and soil
properties as influenced

66 by integrated use of NPK fertilizer and pig manure in the rainforest zone of
 67 Southwest Nigeria.

68 ~~(b) To study the influence of integrated application of NPK fertilizer and pig manure~~
 69 ~~on soil nutrients composition in the rainforest zone.~~

70 ~~(c) To recommend suitable combination of NPK fertilizer and pig manure for tomato~~
 71 ~~production in the rainforest zone~~

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73 **2. MATERIALS AND METHODS**

74 2.1 Field Experiment,

75 Field experiments were carried out at Oba-Ile and Iju in Akure South and Akure North

76 Local Government Areas in the rainforest zone of Southwest Nigeria. The soil is

77 classified as *Alfisol*. Six treatments which included sole and combined applications
of

78 NPK fertilizers (NPK) and pig manure (PG) were applied on soil to tomato seedlings.

79 They were: (a) Control (no NPK, no PG), (b) NPK (15:15:15) fertilizer at 250kg/ha, (c)

80 PG at 25t/ha, (d) 187kg/ha NPK + 6t/ha PG (75:25), (e) 125kg/ha NPK + 12.5t/ha PG

81 (50:50) and (f) 62.5kg/ha NPK + 18t/ha PG (25:75). Treatments were replicated three

82 times using a randomized complete block design. The sites were manually cleared in June

83 2010 at both sites. Eighteen beds each 2.5 x 2.5m were made in each site in three blocks.

84 Seedlings were transplanted at 50 x 50 cm inter and intra rows spacings. Treatments were
applied

85 two weeks after transplanting using ring method. Each bed carried 25 transplants.

86 2.2 Plant Data Collection

87 Five plants were randomly selected per treatment plot (bed) for growth determination at

88 72 days after transplanting. The number of leaves, plant height (by tape rule), stem girth

89 by caliper, leaf area (by graph method) and perimeter were evaluated. The weight of

90 fruits per five selected plants was determined and accumulated between 72 and 90 days

91 after transplanting (Adekiya and Agbede, 2009).

92 2.3 Leaf Analysis

93 At harvest, leaf samples were collected per plot, oven-dried for 24 hours at 80°C and

94 ground for analysis for N, P, K, Ca and Mg as described by Tel and Hagarty (1984). Leaf

95 N was determined by Microkjeldahl digestion method. Ground samples were digested

96 with a nitric-perchloric-sulphuric acid mixture (AOAC, 1990). Phosphorus was

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97 determined colorimetrically by the Vanadomolybdate method, ~~k~~K by flame
98 photometer,

99 and Ca and Mg by EDTA titration. Air-dried pig manure used for the experiment was
100 analysed as described for leaf.

100 2.4 Soil Analysis

101 Before the making of beds, surface (0-15cm) soil samples were randomly collected from
102 fifteen different points on each experimental site and bulked [as described in](#) ~~(~~Adekiya and
Agbede, [\(2009\)](#)

103 for physical and chemical analysis. Samples were also collected per plot at harvest [for](#)
[post-harvest soil analysis](#). The

104 particle distribution analysis was done by Bouyoucos hydrometer method (Sheldrick and

105 Hand Wang, 1993). Chemical analysis was done as described by Carter (1993). The

106 organic carbon was determined by wet dichromate oxidation method (Nelson and

107 Sommers, 1996), available P was extracted using Bray-1 solution and determined by

108 molybdenum blue colorimetry (Frank *et al*, 1998). Exchangeable ~~k~~K, Ca and Mg were

109 extracted using Ammonium Acetate, ~~k~~K was determined using a flame photometer, and
Ca

110 and Mg by EDTA titration method (Hendershot and Lalande, 1993). Soil pH was

111 determined in a soil-water medium at a ratio of 1:2 using digital electronic pH meter

112 (Ibitoye, 2006).

113 2.5 Statistical Analysis

114 Data were subjected to analysis of variance and treatment means were compared using

115 the Duncan's Multiple Range Test at a 5% probability level.

116 3 RESULTS AND DISCUSSION.

117 3.1 Pre-trial Soil Analysis:

118 Table 1 presents data on pre-cropping soil analysis for the two experimental sites. The

119 soils [were](#) sandy loam, acidic, low in organic matter (OM), available P, marginal in N
and

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120 adequate in K, Ca and Mg considering critical levels set for crop production on tropical
121 soils and South-western Nigeria soils (Adeoye *et al*, 1984; Aune and Lal, 1997;
122 FMAWRRD, 1987). Therefore, it is expected that the soils would benefit from addition
123 of chemical and organic fertilizers. While NPK fertilizer would supply N and P, the
124 organic manure was expected to supply organic matter and enhance the levels of other
125 (Adediran, 2003; Adeniyi and Ojeniyi, 2005; Agbede *et al*, 2008). Also, the acidic
126 nature of the soil was expected to be controlled by the cations to be supplied by the
127 organic manure

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3.2 Effects of treatments on soil nutrient composition

Data on soil nutrients composition are shown in Tables 2 and 3 for Oba Ile and Iju sites respectively. Application of pig manure and NPK alone or combined increased soil N, P, K, Ca and Mg relative to the control. The increases are significant at Oba Ile, and in the case of N, P and Ca at Iju. The combination of 187kg/ha NPK + 6t/ha pH gave the highest soil N at Oba Ile and Iju. Combinations involving NPK and pig manure had relatively high soil Ca and Mg, N and K.

Table 2: Soil nutrient composition at harvest at Oba Ile

Treatment	N	P	K	Ca	Mg
	%	mg/kg	cmol/kg	cmol/kg	cmol/kg
Control	0.14a	3.2a	0.12a	1.6a	0.10a
25 t/ha PG					
250 kg/ha NPK	0.20b	7.8b	0.24b	2.7b	0.17b
187kg/ha NPK + 6t/ha PG	0.24b	3.4a	0.27b	3.5c	0.16b
125kg/ha NPK + 12t/ha PG	0.21b	6.1b	0.37c	3.6c	0.26c
62kg/ha NPK + 18t/ha PG	0.20b	7.8b	0.24b	2.7b	0.17b

NPK = NPK fertilizer (15:15:15)

PG = Pig Manure

Table 3: Soil Nutrient composition at harvest at Iju

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Treatment	N %	P Mg/kg	K	Ca Cmol/kg	Mg
Control	0.16a	2.0a	0.22a	1.8a	0.12a
25t/ha PG	02.6b	4.1b	0.26a	2.6b	0.17b
250kg/ha NPK	0.18b	6.1c	0.22a	1.8a	0.11a
187kg/ha NPK + 6t/ha PG	0.29b	3.6b	0.30b	2.2b	0.19b
125kg/ha NPK + 12t/ha PG	0.21b	2.8d	0.26a	3.6c	0.20b
62kg/ha NPK + 18t/ha PG	0.19b	3.8d	0.25a	2.4b	0.19b

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170 NPK = NPK fertilizer (15:15:15)

171 PG = Pig Manure

172

173 3.3 Effects of treatments on tomato leaf nutrients composition

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175 Data on leaf nutrients composition are on Tables 4 and 5 for Oba-ile and Iju respectively.

176 Pig manure and NPK fertilizer used alone or combined at reduced rates increased leaf N,

177 P, Ca and Mg at both sites of study relative to the control. The increases in N and P were

178 significant at Oba-Ile, and the increases in leaf P, Ca and Mg were significant at Iju.. In

179 plots given manure and NPK treatments, the leaf **NB** was generally less than 2.5%, P

180 varied from 0.28 to 0.63%, K from 1.8 to 2.6%, Ca 1.8 to 3.5% and Mg 1.4 – 2.1%. The

181 sufficiency levels for N given for tomato is 3.2 to 4.8%, P 0.32 to 0.48%, K 2.5 to 4.2%,

182 Ca 1.7 to 4.0% and Mg 0.45 to 0.70% (Brady and Weil, 1999). Therefore the treated

183 **plants** were adequate in the nutrients except N.

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186 **Table 4: Tomato leaf nutrient composition at Oba Ile (%)**

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Treatment	N	P	K	Ca	Mg
Control	1.40bc	0.30a	1.0a	2.0a	1.46a
25 t/ha PG	1.84abc	0.63b	2.3a	2.3a	1.7a
250 kg/ha NPK	1.74abc	0.37c	2.2a	2.5a	2.1a
187kg/ha NPK + 6t/ha PG	2.26a	0.34c	2.0a	3.5a	1.9a
125kg/ha NPK + 12t/ha PG	2.21a	0.56b	1.8a	3.4a	2.0a
62kg/ha NPK + 18t/ha PG	1.95bc	0.63b	2.3a	3.5a	1.8a

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189 **Table 5: Tomato leaf nutrient composition at Iju (%)**

Treatment	N	P	K	Ca	Mg
Control	1.69a	0.16c	2.2a	1.81d	1.1c
25 t/ha PG	1.99a	0.38a	2.5a	2.6bc	1.9a
250 kg/ha NPK	1.80a	0.28b	2.6a	1.9d	1.3bc
187kg/ha NPK + 6t/ha PG	1.99a*	0.34ab	2.6a	3.1ab	2.1a
125kg/ha NPK + 12t/ha PG	1.91a	0.33ab	2.5a	3.3a	2.0a
62kg/ha NPK + 18t/ha PG	1.79a	0.39ba	2.3a	2.3cd	1.7ab

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191 NPK = NPK fertilizer (15:15:15)

192 PG = Pig manure

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3.4 Effect of treatments on tomato performance

Data on growth and fruit yield of tomato are presented in Tables 6 and 7 for Oba Ile and Iju respectively. Generally, PG and NPK used alone or combined at reduced rates increased number of leaves, plant height, stem girth and fruit weight. At Oba Ile, the increases in number of leaves, plant height and stem girth relative to control were significant. The 187kg/ha NPK + 6t/ha PG gave highest value of fruit weight, and the differences relative to other treatments were significant. The combined treatments had highest values of stem girth and fruit weight. At Iju, the 187kg/ha NPK + 6t/ha PG also had highest fruit weight, number of leaves and plant height and relatively high stem girth. The mean values of fruit per plant given by the control and 187kg/ha NPK + 6t/ha PG were 91 and 1016 gm respectively. The treatment combination is recommended.

Table 6: Performance parameters of tomato at Oba Ile

Treatment	No of leaves per plant	Plant height (cm)	Stem girth (cm)	Fruit weight per plant (gm)
Control	15c	47d	0.47c	71d
25 t/ha PG	28b	64b	0.60bc	106d
250 kg/ha NPK	24b	53cd	0.59bc	156d
187kg/ha NPK + 6t/ha PG	25b	57bc	0.52bc	481b
127kg/ha NPK + 12t/ha PG	22bc	61b	0.96a	284c
62kg/ha NPK + 18t/ha PG	37a	76a	0.69b	208a

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213 **Table 7: Performance parameters of tomato at Iju**

Treatment	No of leaves per plant	Plant height (cm)	Stem girth (cm)	Fruit weight per plant (gm)
Control	20c	47b	3.0a	111b
25 t/ha PG	46ab	71a	3.7a	117b
250 kg/ha NPK	30bc	53b	4.0a	309b
187kg/ha NPK + 6t/ha PG	49a	60a	3.9a	1552a
125kg/ha NPK + 12t/ha PG	25bc	52b	3.5a	388b
62kg/ha NPK + 18t/ha PG	30c	51b	3.9a	236b

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215 NPK = NPK fertilizer 15:15:15

216 PG = Pig manure

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218 The sandy loam test soils were low in organic matter and inadequate in total N. This
 219 indicates that the soils and tomato crop require application of organic and inorganic
 220 fertilizers. The sandy nature of the soil should have enhanced N leaching since N is quite
 221 mobile. Pig manure, NPK used alone or combined at reduced rates increased soil N, P, K,
 222 Ca, Mg at both sites. However, the increases given by NPK in Ca and Mg were not
 223 significant expectedly. The increases could be due to increased mineralization of organic
 224 nutrients. The increases in nutrient [contents](#) due to pig manure are expected since manure
 is a

225 natural source of organic matter and nutrients. According to [Ano and Ubochi \(2007\)](#), pig
 226 manure is composed of 27% OC, 0.52% N, 1.30% Mg and 1.37% Ca and has C:N ratio
 227 of 19.8. Because of its relatively low C:N compared to goat, poultry and cow manures, it

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is expected to decompose faster (Ano and Ubochi, 2007). At Abeokuta in the derived Savannah zone, Giwa and Ojeniyi (2004) also found that pig manure singly or in combination with NPK fertilizer increased soil N, P, K, Ca and Mg. The manure also increased soil pH. The manure used alone or in combination with NPK increased N, P, K, Ca and Mg concentrations in tomato leaf which is consistent with the increases in soil nutrients contents. The study by Adekiya and Agbede (2009) had found that poultry manure + NPK increased tomato leaf N, P, K, Ca and Mg and the soil nutrients. Similar finding was recorded by Adeniyi and Ojeniyi (2003, 2005) with respect to maize production on alfisol of Southwest Nigeria. The authors also observed residual effect of manure on soil and crop nutrients contents. It was found that pig manure and its combination with NPK aside from ensuring adequate levels of P, K, Ca and Mg in tomato, increased the number of leaves, plant heightgirth, stem girth and fruit yield of tomato significantly. This observation is also consistent with increased availability of nutrients in soil and crop. Aside from the macronutrients, pig manure was found to contain 10.6% organic matter, 1.0% N, 0.72% P, 2.1% k, 3.3% Ca, 0.04% Mg, 410ppm Zn, 280ppm Fe, 30ppm Al, 50ppm Cu and 420ppm Mn (Adediran *et al*, 1999). Adediran *et al* (1999) also recorded increases in maize N, P and K uptake with application of same manure.

Other studies (Adediran *et al*, 1999; Adekiya and Agbede, 2009; Giwa and Ojeniyi, 2004; Ojeniyi *et al*, 2007; Olatunji and Oboh, 2012) affirmed that tomato performance responded positively to applications of organic manures which also served to raise soil pH and control acidity (Ano and Ubochi, 2007) aside from supplying nutrients. This is important because tomato yield and nutrients uptake are adversely affected by soil acidity (Obi and Akinsola, 1995). Thus, the manures served as liming

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251 material because of its Ca component. Ano and Ubochi (2007) found that pig manure
252 had highest Ca content compared with rabbit, poultry and cow manure.

253 It was found that combination of NPK and pig manure at 75:25 (187kg/ha NPK + 6t/ha
254 PG) gave highest fruit yield, and soil and plant N. This indicates that N had most
255 influence on tomato. It was also found that combinations of the two materials most
256 increased crop growth, crop N, Ca, Mg and ensured adequacy of P, k, Ca and Mg in the
257 crop. Hence, there is justification for integrated application of organic and inorganic
258 fertilizers in tomato production. Ayoola and Adeniyani (2006) also reported better
259 performance of maize, cassava and melon under poultry manure + NPK fertilizer
260 compared with NPK, poultry manure and control. According to Adekiya and Agbede
261 (2009), it can be said that addition of NPK fertilizer to manure aided mineralization of
262 nutrients in manure due to enhanced supply of nutrients, leading to better crop growth
263 and yield. Qian and Schoenan (2002) and Okwuguru and Alleh (2003) reported that high
264 and sustained crop yield could be achieved with a judicious and balanced NPK fertilizer
265 treatment combined with organic manure amendments. Ayoola and Adeniyani (2006)
266 reported that nutrients from mineral fertilizers enhanced establishment of crops, while
267 those from mineralization of manure promoted yield when both materials were combined.

268 Giwa and Ojeniyi (2004) also found that combined application of pig manure and NPK
269 fertilizer increased tomato fruit yield compared with pig manure or NPK treatments
270 alone. Adeniyani and Ojeniyi (2005) found that integrated application of poultry manure
271 and NPK fertilizer increased maize yield compared with poultry manure or fertilizer
272 alone. Adekiya and Agbede (2009) found that combined use of NPK fertilizer and
273 poultry manure increased tomato yield compared to application of NPK or manure alone

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and is therefore recommended for sustainable productivity. In addition, lesser quantities of manure and NPK fertilizer would be required, thereby reducing expenditure on chemical fertilizer.

4. CONCLUSIONS

In order to study the use of pig waste (manure) and its combined application with NPK fertilizer as sources of nutrients in tomato cultivation in the rainforest zone of Southwest Nigeria, field experiments were conducted at Oba Ile and Iju. Six treatments involving a control, 25t/ha pig manure, 250kg/ha NPK (15:15:15) fertilizer and the combined use of the materials at reduced levels were applied to tomato crop. The effects of treatments on nutrient availability in soil and crop and tomato performance were studied. The pig manures and its combinations ~~most~~ improved availability of N, P, K, Ca, and Mg growth and fruit yield. The combination of 187kg/ha NPK (15:15:15) fertilizer with 6t/ha pig manure ~~most~~ improved fruit yield and N availability to the crop most. Pig manure improved soil and crop N, P, K, Ca and Mg. It is indicated that the manure is a suitable source of nutrients for improving performance of tomato especially when combined with NPK fertilizer to combine the attributes of the two materials.

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