Growth and yield of tomato (Lycopersicon esculentum Mill) as influenced by poultry manure and NPK fertilizer

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Growth and yield of tomato (*Lycopersicon esculentum* Mill) as influenced by poultry manure and NPK fertilizer

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Abstract: Four field trials were conducted during the years 2006 and 2007 at Owo, the forest-savanna transition zone in southwest Nigeria, to study the effect of poultry manure (PM), NPK 15-15-15 fertilizer and NPK 15-15-15 fertilizer + poultry manure on the growth and yield of tomato. Seven treatments were applied to the soil: 0, 10, 20, 30, 40 t ha^{-1} poultry manure , 300 kg ha^{-1} NPK 15-15-15 fertilizer and 150 kg ha^{-1} NPK 15-15-15 fertilizer + 10 t ha^{-1} poultry manure. These were laid out in a randomized complete block design and replicated three times. The treatments were compared on the basis of their effect on soil chemical properties, leaf nutrient content, growth and yield of tomato. All levels of poultry manure and NPK 15-15-15 fertilizer + poultry manure increased leaf N, P, K, Ca and Mg levels. The soil chemical properties except pH increased with amount of poultry manure. NPK 15-15-15 fertilizer alone did not increase the soil and leaf Ca and Mg. All levels of poultry manure, NPK 15-15-15 fertilizer alone and NPK 15-15-15 fertilizer + poultry manure increased the number of leaves, plant height, leaf area, number of fruits and fruit weight significantly. Among poultry manure levels, 30 t ha^{-1} poultry manure gave the highest fruit yield. Among the seven treatments, NPK 15-15-15 fertilizer + poultry manure gave the highest yield. On an average over the two years, 10, 20, 30, 40 t ha^{-1} poultry manure, 300 kg ha^{-1} NPK 15-15-15 fertilizer alone and 150 kg ha^{-1} NPK 15-15-15 fertilizer + 10 t ha^{-1} poultry manure treatments increased fruit weight by 19, 36, 51, 14, 20 and 83%, respectively. Results revealed that poultry manure is a suitable source of nutrients for tomato especially if applied at 30 t ha^{-1} in the forest-savanna transition zone of southwest Nigeria. The combined use of NPK 15-15-15 fertilizer and poultry manure increased tomato yield compared to the application of NPK 15-15-15 fertilizer or poultry manure alone and is therefore recommended for sustainable productivity. In addition, lesser quantities of poultry manure and NPK 15-15-15 fertilizer would be required, therefore, reducing the amount of money spent on chemical fertilizer.

Keywords*:* Chemical properties, nutrient content, tomato, fruit yield, Nigeria.

تأثير إضافة سماد الدواجن والسماد الكيماوي المركب على نمو وإنتاج الطماطم

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الملخص: أجريت 4 تجارب حقلية خلال عام 2006-2007 في أوي في المنطقة الانتقالية لغابات السافانا في جنوب غرب نيجيريا وذلك لدراسة تأثير إضافة سماد الدواجن العضوي على نمو وإنتاج الطماطم. تم استخدام 7 معاملات بإضافتها على التربة وهي كالتالي: 5، 10، 20، 30، 40، طن/هكتار سماد الدواجن العضوي، سماد كيماوي مركب (15-15-15) بمعدل 300 كغم/هكتار، وخليط من سماد الدواجن العضوي والسماد الكيماوي بمعدل 10 و150 طن/هكتار على التوالي. صممت التجربة باستخدام القطاعات ا لعشوائية الكاملة لثلاث مكررات لكل معاملة . تم دراسة تأثير المعاملات المختلفة على خواص التربة الكيماوية، محتوي الأوراق من العناصر، ونمو وإنتاج الطماطم . أظهرت النتائج أن جميع مستويات سماد الدواجن العضوي وخليط السماد الكيماوي المركب (15-15-15) وسماد الدواجن العضوي بأن تركيز العناصر الغذائية في الأوراق قد ارتفعت (نيتروجين، فسفور، بوتاسيوم، كالسيوم، مغنسيوم) كما أن جميع الخواص الكيمائية للتربة قد ارتفعت باستثناء درجة الحموضة تحت معاملات سماد الدواجن العضوي . معاملات إضافة السماد الكيماوي المركب (15-15-15) لم تزيد من تركيز الكالسيوم والمغنسيوم في الأوراق والتربة . أظهرت جميع المعاملات زيادة معنوية في عدد الأوراق، طول النبات، مساحة الورقة، عدد الثمار ومعدل وزن الثمرة. أظهرت معاملة سماد الدواجن العضوي 30 طن/هكتار أعلى إنتاج من بين معاملات السماد الدواجن

المختلفة. كما أظهرت معاملة خليط السماد الكيماوي المركب (15-15-15) وسماد الدواجن أعلى إنتاج من بين جميع معاملات المستخدمة. زاد الإنتاج للمعاملات المختلفة بنسبة 19، 35، 51، 14، 75% وذلك للمعاملات 10، 20، 30، 40 طن/هكتار سماد الدواجن العضوي، سماد مركب (15-15-15)، وخليط السماد المركب والسماد العضوي على التوالي.

الكلمات المفتاحية: الخصائص الكيميائية، المحتوى الغذائي، الطماطم، إنتاج الثمار، نيجيريا.

Introduction

Food is one among the most important basic necessities of man. For Nigeria to meet the millennium development goal in food production, food including tomato must be readily available. Low soil fertility could threaten the security of food production and supply. Soil fertility is a major overriding constraint that affects all aspects of crop production (Mbah, 2006).

In the past years, inorganic fertilizer was advocated for crop production to ameliorate low inherent fertility of soils in the tropics. In addition to being expensive and scarce, the use of inorganic fertilizer has not been helpful in intensive agriculture because it is often associated with reduced crop yield, soil acidity and nutrient imbalance (Ojeniyi, 2000; Ano and Agwu, 2005; Agbede et al., 2008). The need to use renewable forms of energy and reduce costs of fertilizing crops has revived the use of organic fertilizers worldwide (Ayoola and Adeniyan, 2006). Large quantities of organic wastes such as poultry manure are available especially in urban centers and are an effective source of nutrients for vegetables such as tomato (Adediran et al., 2003). Soil fertility status varies considerably with different ecological zones. Infact, even in the same zone, there are micro-differences in soil characteristics. The crop yield response to organic waste is highly variable and depends on the types of wastes, crop type and species, soil type and climate conditions (Adediran et al., 2003).

Akanni and Ojeniyi (2007) carried out a study in the rainforest zone of southwest Nigeria and recommended 20 t ha^{-1} poultry manure for tomato production. Adediran et al. (2003) also found that poultry manure at 20 t ha^{-1} gave the highest tomato yield in the rainforest region of southwestern Nigeria. There is a need to extend this study to the forest-savanna transition zone where there is a different soil type in order to recommend a suitable rate of poultry manure for tomato.

Furthermore, the benefits of using organic materials have not been fully utilized in the humid tropics, partly due to the huge quantities required to satisfy the nutritional needs of crops, transportation and handling costs (Ayoola and Adeniyan, 2006). High and sustained crop yield can be obtained with judicious and balanced NPK fertilization combined with organic matter amendment (Osundare, 2004). In light of these issues, a study was conducted to determine the growth, nutrient content and yield of tomato as influenced by different levels of poultry manure, NPK fertilizer and integrated use of NPK fertilizer and poultry manure in the forest-savanna transition zone of southwest Nigeria.

Materials and Methods

Site and crop establishment

Field experiments were conducted during the 2006 and 2007 early and late cropping seasons, respectively at Owo, Nigeria. Owo is located at latitude 5^0 12'N and longitude 5^0 35'E within the forest-savanna transition zone of southwest Nigeria. The average annual rainfall varies from 1000-1240 mm. The type of soil is Alfisol classified as Oxic Tropuldalf (USDA) or Luvisol (FAO) derived from quartz, gneiss and schist (Agbede, 2006). There are two rainy seasons, one from March to July and the other from mid-August to November. The farm site was recovered from a four-year fallow after arable cropping. The dominant weeds at the site were Siam weed (*Chromolaena odorata*), Haemorrhage plant (*Aspilia africana*) and Guinea grass (*Panicum maximum*). The experiment was laid out on a randomized complete block design (RCBD) with three replications. The treatments were 0, 10, 20, 30, 40 t ha^{-1} poultry manure (PM), 300 kg ha^{-1} NPK 15-15-15 fertilizer and 150 kg ha^{-1} NPK 15-15-15 fertilizer + 10 t ha^{-1} poultry manure (PM). Each plot was 8 m x 8 m, with a 2 m margin round each plot per plant. The site was manually heaped. Three weeks old local variety of tomato seedlings were transplanted to the field at a spacing of 1 m x 1 m in April and August of each year (2006 and 2007) for early and late crops, respectively, giving a tomato population of 10,000 plants ha^{-1}. The same site was used for the experiments. Poultry manure (PM) and fertilizer were applied by ring method two weeks after transplanting. Two manual weedings were done for each experiment.

Leaf and soil analysis

During each season, at mid-flowering stage, leaf samples were collected randomly from each plot, oven-dried for 24 hr at 80^0C and ground in a Willey-mill. These samples were analysed for leaf N, P, K, Ca and Mg as described by Tel and Hargarty (1984). Leaf N was determined by the micro-Kjeldahl digestion method. Ground samples were digested with a nitric-perchloric-sulphuric acid mixture (AOAC, 1990). Phosphorus was determined colorimetrically by the vanadomolybdate method, K was determined using a flame photometer, and Ca and Mg were determined by the EDTA titration method.

Before the experiment in 2006, surface soil samples (0-15 cm) were randomly collected from fifteen different points on the experimental site, bulked together and analysed for physical and chemical properties. After the fruit harvest in 2007, the fertilizer material (poultry manure) used and soil samples were collected randomly from each plot up to a 15 cm depth from five sampling points per plot. These were analysed for chemical properties as described by Carter (1993). The particle size analysis was done using the Bouyoucos hydrometer method (Sheldrick and Hand Wang, 1993). The organic carbon content in the soil was determined by the dichromate wet oxidation method (Nelson and Sommers, 1996); total N by the micro-Kjeldahl digestion method (Bremner, 1996), and available P was extracted using Bray-1 solution and determined by molybdenum blue colorimetry (Frank et al., 1998). Exchangeable K, Ca and Mg were extracted using ammonium acetate, K level was determined using a flame photometer, and Ca and Mg by the EDTA titration method (Hendershot and Lalande, 1993). Soil pH was determined by using a soil-water medium at a ratio of 1:2 using the digital electronic pH meter (Ibitoye, 2006).

Determination of growth and yield components

Ten plants per plot were selected for biweekly determination of plant height and number of leaves. The leaf area was determined at the mid-flowering stage of the tomato plant in each plot. The number and weight of the fruits were evaluated between 72 and 90 days after transplanting.

Statistical analysis

The data collected were subjected to analysis of variance, and treatment means were compared using Duncan's Multiple Range Test (DMRT) at a 5% probability level (Steel and Torrie, 1987).

Results

Properties of the soil prior to experimentation in 2006 and poultry manure used are shown in Table 1. The soil was sandy loam in texture, low in organic carbon, total N, available P and exchangeable Ca. The exchangeable K and Mg were adequate according to the critical levels of 3.0% OM, 0.20% N, 10.0 mg kg^{-1} available P, 0.16-0.20 cmol kg^{-1} exchangeable K, 2.0 cmol kg^{-1}

exchangeable Ca, and 0.40 cmol kg^{-1} exchangeable Mg recommended for crop production in ecological zones of Nigeria (Akinrinde and Obigbesan, 2000). It was found that poultry manure is high in major nutrients required for the growth of fruit crops such as tomato. Application of poultry manure and NPK fertilizer is expected to improve soil fertility and yield of tomato.

Table 2 contains data on the tomato leaf nutrient composition during 2006 and 2007. Compared to 0 t ha^{-1} poultry manure (control), all levels of poultry manure alone and NPK fertilizer + poultry manure increased leaf N, P, K, Ca and Mg amounts significantly. In both years and seasons, the concentration of nutrients increased with the amount of poultry manure up to 40 t ha^{-1}. NPK fertilizer + poultry manure gave higher leaf N, P and K contents than poultry manure alone. NPK fertilizer alone increased leaf N, P and K, but did not increase leaf Ca and Mg. Hence, NPK fertilizer alone gave lower leaf Ca and Mg contents as compared to the control.

Data on the chemical composition of the soil at the end of the experiment in 2007 is presented in Table 3. Relative to the control, all levels of poultry manure, NPK fertilizer alone and NPK fertilizer + poultry manure increased the soil N, P and K levels significantly. NPK fertilizer alone did not increase soil Ca and Mg significantly. Soil organic carbon (SOC) increased with increasing amounts of poultry manure up to 40 t ha^{-1}. NPK fertilizer alone did not increase SOC. However, soil pH was reduced from 0 t ha^{-1} poultry manure to 40 t ha^{-1} poultry manure. There were no differences in the soil pH of NPK fertilizer + poultry manure, 10, 20, 30 and 40 t ha^{-1} poultry manure.

Table 1. Soil physical and chemical properties (0-15 cm depth) at the experimental site before planting tomato in 2006 and chemical composition of poultry manure used.

Soil Property	Soil Sample Value	Poultry Manure	
		Property	Value
Sand (g kg^{-1})	675	PH	6.8
Silt (g kg^{-1})	149	Organic C (%)	14.9
Clay (g kg^{-1})	176	Nitrogen (%)	2.23
Textural class	Sandy loam	C:N	6.7
pH (Water)	5.9	Phosphorus (%)	0.83
Organic carbon (g kg^{-1})	1.47	Potassium (%)	2.35
Nitrogen (g kg^{-1})	0.18	Calcium (%)	1.42
Phosphorus (mg kg^{-1})	9.8	Magnesium (%)	0.58
Potassium (cmol kg^{-1})	0.95		
Calcium(cmol kg^{-1})	1.0		
Magnesium (cmol kg^{-1})	0.96		

Table 2. Effect of poultry manure (PM), NPK 15-15-15 fertilizer and their combination on leaf nutrient composition of tomato crop in 2006 and 2007.

Treatments	N (g $100g^{-1}$)				P (g $100g^{-1}$)				K (g $100g^{-1}$)				Ca (g $100g^{-1}$)				Mg (g $100g^{-1}$)			
	2006		2007		2006		2007		2006		2007		2006		2007		2006		2007	
	[a]E	[b]L	[a]E	[b]L	[a]E	[b]L	[a]E	[b]L	[a]E	[b]L	[a]E	[b]L	[a]E	[b]L	[a]E	[b]L	[a]E	[b]L	[a]E	[b]L
0 t ha^{-1} PM	1.72g	1.60g	1.63f	1.78f	0.28e	0.21f	0.25f	0.27f	1.71e	1.60e	1.50f	1.66f	0.18d	0.20d	0.25e	0.23f	0.30e	0.40d	0.42f	0.45f
10 t ha^{-1} PM	1.90f	1.90f	3.20e	3.40e	0.34d	0.31e	0.32e	0.34e	1.89d	1.99d	1.79e	1.98de	0.36c	0.38c	0.40d	0.38e	0.51d	0.70c	0.77cd	0.76d
20 t ha^{-1} PM	3.40d	3.10e	3.95d	4.20d	0.41c	0.46cd	0.40d	0.42cd	2.05cd	2.60c	1.98cd	2.20c	0.48b	0.49b	0.56c	0.50c	0.58c	0.72c	0.81c	0.85c
30 t ha^{-1} PM	4.20c	4.40c	4.50c	4.95b	0.50b	0.55b	0.56b	0.49b	2.60b	3.20b	2.70b	2.72b	0.60a	0.65a	0.78a	0.70a	0.80a	0.89a	0.98a	0.99a
40 t ha^{-1} PM	4.50bc	4.70bc	5.20b	5.50a	0.40c	0.43d	0.42d	0.39d	1.91d	1.67e	1.60f	1.99de	0.60a	0.65a	0.68b	0.60b	0.67b	0.81b	0.90b	0.90bc
NPK (300 kg ha^{-1}) fertilizer	3.00e	3.50d	3.96d	4.41cd	0.41c	0.45cd	0.46cd	0.40d	1.91d	2.02d	1.90de	1.85e	0.17d	0.20d	0.23e	0.22f	0.31e	0.39d	0.43f	0.45f
NPK (150 kg ha^{-1}) fertilizer+10 t ha^{-1} PM	5.10a	5.30a	5.80a	5.60a	0.57a	0.63a	0.65a	0.55a	3.10a	3.90a	3.50a	2.98a	0.36c	0.39c	0.40d	0.42d	0.53d	0.71c	0.71de	0.66e

Values followed by the same letter(s) in a column are not significantly different at p = 0.05 according to Duncan's multiple range test (DMRT)
[a]E = Early season tomato crop
[b]L = Late season tomato crop

Table 3. Effect of poultry manure (PM), NPK fertilizer 15-15-15 and their combination on soil nutrient composition at the end of the experiment in 2007.

Treatments	pH (H_2O)	Organic carbon ($g\ kg^{-1}$)	Nitrogen ($g\ kg^{-1}$)	Phosphorus ($mg\ kg^{-1}$)	Potassium ($cmol\ kg^{-1}$)	Calcium ($cmol\ kg^{-1}$)	Magnesium ($cmol\ kg^{-1}$)
0 t ha^{-1} PM	6.98a	1.30d	0.14f	8.3e	0.80d	0.40d	0.81e
10 t ha^{-1} PM	6.60ab	2.20c	0.22e	20.1d	1.02c	0.94c	0.93d
20 t ha^{-1} PM	6.49ab	2.50b	0.35d	30.0c	1.56b	1.05b	1.30b
30 t ha^{-1} PM	6.39ab	2.72a	0.48c	42.2a	1.90a	1.46a	1.65a
40 t ha-1 PM	6.25bc	2.79a	0.54b	43.4a	1.98a	1.40a	1.60a
NPK (300 kg ha^{-1}) Fertilizer	6.10bcd	1.00e	0.35d	37.2b	1.02c	0.39d	0.79e
NPK (150 kg ha^{-1}) fertilizer +10 t ha^{-1} PM	6.55ab	2.21c	0.60a	43.9a	1.90a	0.95c	1.35bc

Values followed by the same letter(s) in a column are not significantly different at p = 0.05 according to Duncan's multiple range test (DMRT).

Data on the growth and yield of tomato are presented in Tables 4 and 5, respectively. Poultry manure, NPK fertilizer alone and NPK fertilizer + poultry manure significantly increased plant height, number of leaves and leaf area as compared to the control. NPK fertilizer + poultry manure mostly enhanced the growth parameters. Growth parameters during both years increased with the amount of poultry manure. 30 t ha^{-1} poultry manure gave the highest growth parameters. Values of these parameters reduced beyond 30 t ha^{-1} poultry manure. The numbers of fruits per plant and fruit weight (Table 5) increased with poultry manure alone and NPK fertilizer + poultry manure applications. The mean fruit weight (t ha^{-1}) for 0, 10, 20, 30, 40 t ha^{-1} poultry manure applications, 300 kg ha^{-1} NPK fertilizer alone and 150 kg ha^{-1} NPK fertilizer + 10 t ha^{-1} poultry manure in 2006 were 9.0, 10.2, 11.7, 13.0, 10.1, 10.1 and 14.9 t ha^{-1}, respectively. While in 2007, they were 7.9, 9.9, 11.1, 12.5, 9.1, 10.1 and 16.0 t ha^{-1}, respectively. Therefore, 10, 20, 30, 40 t ha^{-1} poultry manure, 300 kg ha^{-1} NPK fertilizer alone and 150 kg ha^{-1} NPK fertilizer + 10 t ha^{-1} poultry manure increased fruit weight by 13.3, 30.0, 44.4, 12.2, 12.2 and 65.6, respectively in 2006; and 25.3, 40.5, 58.2, 15.2, 27.8 and 102.5, respectively in 2007. The corresponding increases in the number of fruits per plant were 37.5, 37.5, 65.6, 25.0, 25.0 and 93.8, respectively in 2006; and 36.4, 39.4, 75.8, 21.2, 21.2 and 93.9, respectively in 2007. During both years, among poultry manure levels, 30 t ha^{-1} poultry manure gave the highest fruit yield after which the amount decreased with the use of 40 t ha^{-1} poultry manure. All levels of poultry manure out-yielded NPK fertilizer alone except in 2007 where NPK alone out-yielded the 40 t ha^{-1} poultry manure level. NPK fertilizer + poultry manure mostly enhanced fruit yield in both years.

Table 4. Effect of poultry manure (PM), NPK 15-15-15 fertilizer and their combination on the growth of tomato crop in 2006 and 2007.

Treatments	Plant height (m)				Number of leaves/plant				Leaf area (m^2)			
	2006		2007		2006		2007		2006		2007	
	^{a}E	^{b}L	E	L	E	L	E	L	E	L	E	L
0 t ha^{-1} PM	0.65e	0.69e	0.50f	0.55e	29g	26g	31g	28g	0.17f	0.21e	0.20f	0.25e
10 t ha^{-1} PM	0.77d	0.79d	0.61e	0.68d	44f	40f	48f	43f	0.19e	0.35d	0.26d	0.30d
20 t ha^{-1} PM	0.88c	0.91c	0.78c	0.83c	79c	68c	78c	79c	0.25c	0.49b	0.29c	0.37c
30 t ha^{-1} PM	0.98b	1.01b	0.88b	0.93b	93b	99b	103b	92b	0.28b	0.68a	0.37b	0.45b
40 t ha^{-1} PM	0.78d	0.80d	0.69d	0.73d	59d	50e	59e	56d	0.22d	0.39c	0.23e	0.30d
NPK (300 kg ha^{-1}) Fertilizer	0.79d	0.82d	0.67d	0.70d	48e	60d	68d	47e	0.20e	0.40c	0.30c	0.31d
NPK (150 kg ha^{-1}) fertilizer + 10 t ha^{-1} PM	1.08a	1.12a	0.99a	1.03a	105a	115a	120a	102a	0.31a	0.69a	0.42a	0.50a

Values followed by the same letter(s) in a column are not significantly different at p = 0.05 according to Duncan's multiple range test (DMRT)
^{a}E = Early season tomato crop
^{b}L= Late season tomato crop

Table 5. Effect of poultry manure (PM), NPK 15-15-15 fertilizer and their combination on the yield of tomato crop in 2006 and 2007.

Treatments	Fruit weight (t ha^{-1})				Number of fruits per plant			
	2006		2007		2006		2007	
	^{a}E	^{b}L	E	L	E	L	E	L
0 t ha^{-1} PM	8.9e	9.1e	7.7f	8.0f	15d	17e	16e	17f
10 t ha^{-1} PM	10.0d	10.3d	9.6de	10.1d	20c	24c	20d	25c
20 t ha^{-1} PM	11.5c	11.9c	10.9c	11.3c	20c	24c	21cd	25c
30 t ha^{-1} PM	12.9b	13.0b	12.3b	12.7b	22b	31b	23ab	35b
40 t ha^{-1} PM	10.2d	10.0d	9.0e	9.2e	20c	20d	16e	24cd
NPK (300 kg ha^{-1}) fertilizer	10.0d	10.3d	9.8de	10.3d	20c	20d	17ef	23de
NPK (150 kg ha^{-1}) fertilizer + 10 t ha^{1} PM	14.8a	14.9a	17.2a	14.7a	25a	37a	24a	40a

Values followed by the same letter(s) in a column are not significantly different at p = 0.05 according to Duncan's multiple range test (DMRT)
^{a}E = Early season tomato crop
^{b}L = Late season tomato crop

Discussion

The increase of N, P, K, Ca and Mg contents of tomato due to the application of poultry manure is consistent with the use of poultry manure as fertilizer for tomato production (Agele et al., 2001; Akanni, 2005). It was found that 30 t ha^{-1} poultry manure gave the most growth and highest fruit yield among all poultry manure levels, although leaf N increased with amount of poultry manure up to 40 t ha^{-1} poultry manure. Olasantan (1991) also found that fruit yield of the tomato plant was reduced at higher N application rates. It was suggested that there was a nutrient imbalance in tomato with a large increase in N supplied from poultry manure. Reduction in growth and yield when more than 30 t ha^{-1} poultry manure was used could also be adduced to soil acidity. Soil pH tended to reduce with a rise in the amount of poultry manure suggesting that poultry manure lead to increased acidity in the soil. Excess N in the soil and soil acidity could cause nutrient imbalance in the tomato crop and a reduction in the uptake of certain nutrients (Ewulo et al., 2008). The finding that all levels of poultry manure performed better than the NPK fertilizer alone was adduced to the fact that poultry manure supply more nutrients than NPK fertilizer. The poultry manure could have supplied micronutrients which are essential for tomato growth and yield. Stephenson et al. (1990) and Oladotun (2002) reported that poultry manure contains macro and micro nutrients such as N, P, K, S, Ca, Mg, Cu, Mn, Zn, Bo and Fe. Agele (2001) also found that poultry manure litters resulted in better growth and yield of tomato than NPK fertilizer alone. In this study, tomato performed best in terms of growth and yield under NPK fertilizer + poultry manure treatment in both years. This could be attributed to increased nutrient use efficiency, following the inclusion of the NPK fertilizer. As recorded for the treatment, the highest tomato fruit yield recorded for this treatment is consistent with the maximum presence of N, P, K, Ca and Mg in the soil and tomato leaf. Ayoola and Adeniyan (2006) also reported better performance of maize, cassava and melon under poultry manure + NPK fertilizer. The trend observed was NPK fertilizer + poultry manure > NPK fertilizer > poultry manure > no fertilizer. It can be said that, the addition of NPK fertilizer to poultry manure aided mineralization of nutrients in poultry manure due to enhanced supply of nutrients, leading to better growth and yield. This study agrees with the findings of Makinde et al. (2001) who reported that the most satisfactory method of increasing maize yield was by judicious combination of organic wastes and inorganic fertilizer. Qian and Schoenau (2002), and Okwugwu and Alleh (2003) reported that high and sustained crop yield could be achieved with a judicious and balanced NPK fertilizer treatment combined with organic matter amendments. Ayoola and Adeniyan (2006) reported that nutrients from mineral fertilizers enhance the establishment of crops, while those from mineralization of organic manure promoted yield when both fertilizers were combined. The combined application of pig manure and NPK fertilizer also increased tomato fruit yield compared with pig manure or NPK fertilizer treatments alone (Giwa, 2004). Also, Adeniyan and Ojeniyi (2005) found that integrated application of poultry manure and NPK fertilizer increased maize yield compared with poultry manure or fertilizer applications alone.

Conclusion

Poultry manure improved soil nutrient status as indicated by increased soil organic carbon, total N, available P and exchangeable K, Ca and Mg. The manure at 30 t ha^{-1} significantly increased growth and fruit yield when compared with the other levels. Results revealed that poultry manure is a suitable source of nutrients for improving soil fertility and yield of tomato especially if applied at 30 t ha^{-1} in the forest-savanna transition zone of southwest Nigeria. Compared with NPK fertilizer (300 kg ha^{-1}), poultry manure improved the performance of tomato and its nutrient status. The combined application of poultry manure and NPK fertilizer increased the tomato fruit yield compared with the application of poultry manure or NPK fertilizer alone and is therefore recommended for a more sustainable tomato yield in the forest-savanna transition zone of Nigeria. In addition, the quantities of poultry manure and NPK fertilizer required would be reduced and tomato crop performance enhanced, therefore reducing the amount of money spent on chemical fertilizer.

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