Growth, Yield Performance And Profitability Of Tomato Under Different Soil Amendments In Humid Forest

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ABSTRACT

Studies were conducted at the Teaching and Research Farms of Benson Idahosa University, Benin City, Nigeria to evaluate the effect of different soil amendments on some soil properties and crop performance in terms of growth, yield and profitability of tomato. The experiment, which was organized in a randomized complete block design, with three replicates including control, Compost manure, cured poultry manure, (NPK) and (organomineral fertilizer); All treatments were applied at the rate of 20 t ha^{-1} aside NPK that was applied at 100 kg ha^{-1}. Results showed that soil pH, organic carbon, total N, available P, exchangeable Ca, Mg and K were significantly ($p<0.05$) increased after the incorporation of organic and organomineral fertilizers. Stem girth, plant height, number of branches, number of leaves and days to 50% flowering was influenced positively by the soil amendments. Fruit yield was significantly enhanced by soil amendments. The optimum fruit yield was obtained from tomato treated with organomineral fertilizer (27.30 t $ha^{-1)}$ with equivalent revenue of which also had the highest ₦1, 187,550.00, gross margin ₦1, 104, 611.50, net farm profit ₦1, 091, 892.65 and Benefit-cost rate 12.41.

Keywords: Growth, herbage yield quality, soil amendment, soil properties and yield.

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INTRODUCTION

The tomato (L*ycopersicon esculentus)* is a plant in the Solanaceae or nightshade family, native of Central and South America. The tomato was spread around the world following the Spanish colonization of the Americas, and its many varieties are now widely grown, often in greenhouses in cooler climates.

The tomato fruit is rich in lycopene, which have beneficial health effects. It increases the alkalinity of the blood and helps remove toxins, especially uric acid, from the system. As a liver cleanser, tomatoes are wonderful, especially when used with the green vegetable juices. Tomatoes are very high in vitamin value and certain types of hormones precursors in addition to protein and energy (Boamah *et al*. 2010).

FAO (2003) reported that tomato productivity in Nigeria is below Africa average (20.51t $ha^{-1)}$. The decline in productivity is due to low native soil fertility resulted from the practice of slash and burn farming system associated with bush fallow and with excessive leaching of the soil (Steiner, 1991).

Maintenance of high crop yields under intensive cultivation is possible only through the use of soil amendments (organic and inorganic fertilizers). In highly weathered soil, the use of chemical (inorganic) fertilizer in crop production has not been sustainable due to its high cost and scarcity, soil acidity and nutrient imbalance. The use of mineral fertilizers has not been helpful as it is associated with increased soil acidity and nutrient imbalance (Kang and Juo, 1980). The inorganic fertilizers are usually not available and are always rather expensive for the low-income, small-scale farmers. Consumers have an increasing interest in organic products because they are thought to be environmentally sound or of high quality (Nakano *et al.*2002). They release nutrients rather slowly and steadily over a longer period and also improve the soil fertility status by activating the soil microbial biomass (Ayuso *et al*., 1996; Belay *et al*., 2001). Organic manure application sustains cropping system through better nutrient recycling and improvement of the soil physical attributes (El-Shakweer *et al*., 1998). High and sustained crop yields can be obtained with judicious and balanced NPK fertilizer application combined with organic matter amendment (Kang and Balasubramanian, 1990; Makinde *et al*., 2001).

This trial was therefore conducted to determine the appropriate soil amendment that will produce the optimum yield from the available fertilizer.

MATERIALS AND METHODS

Experimental site and design

Field experiments were conducted in 2008 and 2009 at Teaching and Research farms of Benson Idahosa University, Benin City Nigeria (5^0 04' N, 6^0 35' E). The study area lies within rainforest, belt of Nigeria. The soil used was an ultisol of the Benin formation (Smith and Montgomery, 1962).

There were 5 treatments, 3 replicates fitted into a randomized complete block design. The treatments, consisted of control, poultry manure, compost manure, NPK and organomineral fertilizer 2 week before transplanting. The treatments were applied at the rate of 20 tha^{-1} except NPK fertilizer that was applied at the rate of 100 kg ha^{-1} by 1 week after transplanting.

Analysis of poultry and compost used

Samples of poultry manure and compost were separately air-dried at ambient temperature (26 ± 2^0c) for seven days. powered compost and poultry manure were digested with Nitric-perchloric-sulphuric acid mixture. Resulting aliquots were used to chemically characterize the either the poultry manure or compost.

Soil analysis

Soil analysis was carried out before and after the experiment. pH was determined using glass electrode pH meter. The particle size analysis of the soil was done by Hydrometer (Gee and Or, 2002). The Total Nitrogen was determined by Microkjeldahl procedure as describe by Jackson (1962). The available phosphorus was extracted following Olsen method (Emteryd, 1989). Exchangeable captions (Ca, Mg and K) were determined by EDTA titration method, while K was determined by flame photometry (Jackson, 1962).

Field trials

At every trial, tomato seeds (cultivar "Roma VF") were sown in the nursery at Teaching and Research farms, Benson Idahosa University, Benin city Nigeria. After three weeks, the seedlings were transplanted to a well prepared beds in the field and spaced 50 cm by 50 cm to achieve a population of 40, 000 plants per hectare. Appropriate nursery and field management practices were carried out as at when due to obtain healthy and uniform seedlings.

Data collection

Data were collected on the stem girth, plant height, number of branches per plant, number of leaves per plant, days to 50% flowering; days to first fruiting, number of fruit per plant, fruit girth, fruit weight and fruit yield per hectare. Data were also collected on physical and chemical properties of soil, compost and poultry manure. Profitability of to make grown under humid forest using different soil amendments was also put on record.

Profitability analysis

Gross margin analysis (Adeniyi, 2001) was used to access the net return of each of the treatment used in the trial for both years. This was based on the formulae:

GM = TR = TV

Where GM = Net profit

TR = Total revenue, and

TV = Total variable cost

Net Profit = TR – TC

Where; TR= Total Revenue

TC = Total Cost

Benefit-cost ratio was calculated as the ratio of crop total value to total cost of production.

Data analysis

Data collected during the two year trails were pooled together aand analysed using two tail Analysis of Variance. The Least Significant Difference (LSD) test was used for detecting significance differences between means at 5% of probability level.

RESULTS AND DISCUSSION

Soil Natural fertility

Pre-cropping physical and chemical analysis of the soil at the experimental site, compost and poultry manure were presented in Table 1. The soil is slightly acidic (pH 4.90) and textually sandy loam. The soils had been classified as ultisols derived from coastal plain sand

(smith and Montgomery, 1962). The soils contain less than 1.50 – 2.00 % N, 25.00 Mg kg^{-1} available P, exchangeable K 0.40 cmol kg^{-1}, exchangeable Ca 0.20 – 0.40 cmol kg^{-1} and exchangeable Mg 0.40 cmol kg^{-1}. Soils below these critical levels are regarded as being low in these nutrients (Ibedu *et al*., 1988). Consequently, optimum growth and yield cannot be achieved without supplementary nutrients through organic manure and/or inorganic fertilizer.

The chemical properties of the compost and poultry manures showed that it contains high amounts of organic carbon and nutrients (N, P, K, Mg and Ca) that can boost agricultural productivity on the soil through gradual release of nutrients to crops. The high organic matter improves the soil structure leading to improvement of soil physical conditions.

Growth

Soil amendments had a significant effect on stem girth, plant height, number of branches, number of leaves and days to 50% flowering (Table 2). Application of NPK gave the greatest stem girth of 1.20 cm which was at par with organomineral fertilizer and significantly greater than plant treated with poultry manure, compost manure and control in that order. Increase in stem girth with soil amendment treatment resulted in retention of appreciable amount of assimilates in the stem for node and leaf production.

Plant heights from all the fertilized plots were significantly higher than control, with plants fertilized with organomineral fertilizer (50.15 cm) and NPK (50.00 cm) giving significantly tallest plants, followed by poultry manure, compost manure and untreated control in that order. A reflection of the low nutrient status of the soil was manifested by the untreated tomato plants which were the shortest (37.18 cm). Tomato plant height favoured positively by soil amendments is an indication of adequate nutrients, required to support growth can be attained from organic fertilizer application by enrichment with inorganic nutrient (Ayoola and Makinde, 2007).

All fertilized plots had plants comparable in number of branches, but were significantly higher than plants from the untreated plants (Table 2). Greater plant height resulted in an increase in the number of branches as there was positive correlation between plant height and number of branches ($r = 0.65$).

Table 1: Physical and Chemical properties of soil compost and poultry manures

Tested item	Chemical Properties							Physical properties (g kg^{-1})		
	pH	Organic C (%)	Total N (%)	Available P (mg kg^{-1})	Exchangeable cations (c mol kg^{-1}) K	Mg	Ca	Sand	Silt	Clay
Soil	4.90	1.30	0.08	4.97	0.12	0.18	0.15	860	50	90
Compost manure	7.80	1.02	6.08	0.62%	2.7%	155%	3.60%	Nd	nd	nd
Poultry manure	6.00	3.78	6.04	1.36%	90%	205%	6.95%	Nd	nd	nd

nd - not determined

Table 2: Effect of some soil amendments on the growth of tomato

Treatment	Stem girth (cm)	Plant height (cm)	Nos of branches (plant^{-1})	Nos of leaves	Days to 50% flowering
Control	0.80	37.18	13.00	59.67	49.33
Compost manure	1.00	47.12	15.00	73.00	45.67
Poultry manure	1.10	49.50	15.33	74.00	43.00
Organomineral fertilizer	1.15	50.15	16.67	75.33	41.00
NPK	1.20	50.00	16.00	77.00	40.67
Mean	1.05	46.79	15.20	71.80	43.93
LSD(0.05)	0.074	0.490	1.898	6.445	1.612

Table 3: : Effect of some soil amendments on the yield of tomato

Treatment	Days to first fruit set	Nos of fruit (plant^{-1})	Fruit girth (cm)	Average fruit (g)	Fruit yield (t ha^{-1})
Control	52.67	17.13	3.50	15.60	10.42
Compost manure	47.50	23.17	4.30	26.50	24.50
Poultry manure	46.47	25.10	4.40	27.30	25.59
Organomineral fertilizer	44.60	24.20	4.50	28.17	27.30
NPK	46.74	25.20	4.40	27.30	26.06
Mean	47.59	22.96	4.22	24.98	22.79
LSD(0.05)	3.087	2.876	0.436	0.628	0.855

Table 4: Profitability analysis

Item of cost and revenue

	Control	Compost manure	₦ Poultry manure	Organomineral	NPK
Variable cost					
Land preparation	25861.50	29861.50	29861.50	27861.50	25861.50
Fertilizer/soil amendment	0	9000.00	10000.00	12146.50	10293.00
Planting material	1352.50	1352.50	1352.50	1352.50	1352.50
Stakes	4068.00	4068.00	4068.00	4068.00	4068.00
Sowing	3378.00	3378.00	3378.00	3378.00	3378.00
Staking	2034.00	2034.00	2034.00	2034.00	2034.00
Weeding	25861.50	25861.50	25861.50	25861.00	25861.00
Fertilizer application	0	0	0	3037.50	6075.00
Harvesting	1575.00	1575.00	1575.00	1575.00	1575.00
Transportation	1624.50	1624.50	1624.50	1624.50	1624.50
Fixed cost					
Rent	2586.00	2586.00	2586.00	2586.00	2586.00
Depreciation	1839.00	1839.00	1839.00	1839.00	1839.00
Opportunity cost of running capital	6575.50	7875.50	7975.50	8293.85	8212.25
Total cost of Production	76755.00	91055.50	92155.50	95657.35	94759.75
Revenue	453270.00	1065750.00	1113165.00	1187550.00	1133610.00
Gross margin	387515.50	986995.00	1033410.00	1104611.50	1051487.50
Net farm profit	3765515.00	974694.50	1021009.50	1091892.65	1038850.25
Benefit: Cost Ratio	5.90	11.70	12.08	12.41	11.96

Numbers of leaves were all comparable among the four fertilizer sources and significantly superior to the control plants (Table 2). Increase in the number of leaves was a precursor to greater amount of assimilate and thus allowing more translocation to the berry. Changes in leaf number are bound to affect the overall performance of the plants as the leaves serves as the photosynthetic organ of the plant. Increased leaf number leads to better utilization of solar radiation.

Days to 50% flowering in response to different soil amendments are shown in Table 2. The most significant earliness to 50% flowering were plants treated with NPK (40.67 days) and organomineral fertilizer (41.00 days) treated plants were earliness to 50% flowering than other treatments. Poultry manure treated plants which flowered in 43.00 days while it took 45.67 and 49.33 days for compost manure treated plants and untreated control to 50% flowering, respectively. The treated plants were earliness to 50% flowering due to acceleration of the vegetative phase through the simulative effect of the absorbed nutrients on

photosynthesis process which certainly reflected positively on both vegetative growth and flowering initiation (Kawthar *et al*., 2010).

Fruit yield

The effect soil amendments on fruit yield of tomato are shown in Table 3. Days to first set were all comparable among the four fertilizer sources and significantly earlier than the untreated control plants. At harvest, Numbers of fruits per plant were significantly lowest with unfertilized, control plots. Number of fruits per plant gave comparative values in all treated plants. The same trend was observed with fruit girth. Average fruit weight was highest from organomineral fertilizer; it was followed by fruits from poultry manure, NPK, compost manure and untreated control in that order. The unfertilized, control plots had fruits with the lowest average. There were significant differences among the treatments. The poultry manure and NPK treated plants were similar. The application of organomineral fertilizer and NPK resulted in significantly higher fruit yield per hectare when compared to the rest of the treatments. This was mainly attributed to increased uptake of available nutrients present in the soil. The test crop used for this trial showed a huge potential of soil amendment usage as their fruit yield was reduced where soil amendment was not applied at the control plots.

Profitability

Profitability analysis of tomato production using various soil amendments are shown in Table 4. The highest total cost of ₦95, 657.35 was recorded for the application of organomineral fertilizer, followed by NPK (₦94, 759.25) and the least was control (₦76, 755.00). Though, the organomineral fertilizer was the most expensive, however, the highest revenue (₦118755.00) was obtained from plants treated with organomineral fertilizer which was 262% higher than control. The highest gross margin was ₦1, 104, 611.50 obtained from organomineral fertilizer application and the least was control with a value of ₦387, 515.00. The treated plots produced higher net values than control and ranged from ₦376, 515.00 to ₦1, 091, 892.65 with the highest value obtained from organomineral fertilizer. In terms of viability, organomineral fertilizer was the most viable as indicated through its highest benefit: cost ratio in tomato production (12.41).

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